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Use of Robots to Support Those Living with Dementia and Their Caregivers

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Abstract

Dementia and other related diseases causing symptoms of mild cognitive impairment are being increasingly diagnosed. These diseases are placing a significant strain on the healthcare system. Robotic technology research has also been increasing, specifically in the field of healthcare and assisted living. This scoping review explores the research at the intersection of dementia and robotic devices. More specifically, this paper looks at how robots can be used in dementia care to gain a deeper understanding of the potential benefits this technology may have on patient and caregiver lives. This research was conducted using PRISMA guidelines. Data were extracted from 13 articles. The researchers found that there is a lack of evidence regarding how robotics can assist patients living with dementia; however, robotic devices can be used by patients to perform some daily tasks in the home.

Keywords:

Dementia, Robotics, Assistive Technology

Introduction

Dementia is a devastating disease that places a serious burden on patients, caregivers, and health practitioners across Canada [1]. There are over half a million Canadians living with dementia [2] and more than 47 million people are affected worldwide [3]. Of the estimated 564 000 Canadians living with dementia, over 65% are women [4]. By 2031, the number affected by dementia in Canada is expected to increase by 66% to a total of over 900 000 individuals [4]. There is a growing need for support and assistance for Canadians and families that have been affected by the disease, as the number of individuals being diagnosed with dementia is rising sharply. Dementia can also create an economic challenge, costing approximately 33 billion USD in 2011, with a future cost estimate of 293 billion USD by 2040 [5]. The use of technological tools, even those that are simple by nature have the potential to transform the care that patients and caregivers are receiving from the healthcare system and healthcare providers. Additionally, the use of technological solutions will challenge the healthcare system to deliver a higher level of care that is fully accessible and able to communicate healthcare information.

Research Objective

The objective of this scoping review is to explore the research at the insection of the use of robotic technology in the home and the use of robots to supervise and assist patients and caregivers, who are affected by dementia. Specifically, the scoping review examines how robotic devices can assist the patient and the caregiver with activities of daily living (ADLs) and instrumental activities of daily living (IADLs). Additionally, it is intended to achieve an understanding of the potential life changing potential that robotic devices have for individuals who are struggling with the impacts of dementia.

Background

Robotic technology has the potential to assist many people and their caregivers suffering from several different conditions. These conditions can include cognitive, physical or emotional impairments affecting patients and those who provide support to caregivers and the clinical workforce [6]. By definition, robots are "physically embodied systems capable of enacting physical change in the world" [6]. Robotics can assist patients with cognitive tasks such as problem-solving, finance management and housekeeping, as well as basic daily living tasks such as grooming, feeding and moving [6]. All of the above activities are potential examples of how a robot can assist patients or caregivers, who are suffering with the effects of dementia.

The use of robotics in the home setting can provide solutions to health-related problems [7]. Dementia is a progressive disease, going through several stages at a different pace for each patient, and the use of a robotic device in the home environment to provide assistance [7,8]. Older adults with dementia, who continue to reside in their homes, often require assistance with activities of daily living (ADLs) such as grooming and personal hygiene, and instrumental activities of daily living (IADLs), such as housekeeping (see Table 1) [9].

 Table 1 – Activities of Daily Living and Instrumental Activities

 of Daily Living

Activities of Daily	Instrumental Activities of
Living	Daily Living [9]
Personal hygiene	Transportation and shopping
Grooming	Managing finances
Dressing	Shopping and meal preparation
Toileting	House cleaning and home
	maintenance
Transferring	Managing communication with
	others (e.g. telephone, mail)
Ambulating	Obtaining and taking
	medications
Eating	

This study seeks to explore the use of robotic technology as a method of providing supervision and assistance to patients and caregivers affected by dementia. Specifically, how robotic devices can assist the patient and the caregiver with ADLs and IADLs will be explored. Additionally, the authors will develop an understanding of the life changing potential that robots have on individuals who are struggling with the impacts of dementia.

Methods

The current state of the literature was assessed using a scoping review using the Arksey and O'Malley [10] and Levac [11]. The procedure for the scoping review adheres to the Preferred Reporting Items for Systematic Reviews (PRISMA) guidelines for scoping reviews.

Literature Search

A comprehensive search of 4 electronic databases: MEDLINE®, PubMed®, IEEEXplore® and Web of Science® was conducted. The search terms that were used were "dementia" and "robotics", and articles were extracted between the years of 2005 and 2020, in order to obtain relevant results. After the initial database searches, all articles were extracted using Zotero® software. Once all relevant articles were pulled from the databases, the cumulative search results were imported into Covidence for title and abstract screening. Before being imported, the search results were checked for accuracy, and unrestricted ability to access and download the document.

Inclusion Criteria

For articles to be eligible for inclusion, they must have been empirical research studies about human-robot interaction in the context of ADLs and IADLs involving robotics, service robotics, dementia, and aging. Articles were included if they were published between the years of 2005 and 2020.

Exclusion Criteria

Articles were excluded if: (1) they were not available in English or French, or (2) they did not report on empirical research studies. Studies were also excluded if they did not focus on humanrobot interaction for dementia specific to ADLs and IADLs (e.g. articles were excluded if they primarily focused on a smart home environment, involving sensors, remote patient monitoring or artificial intelligence not involving human-robot interaction). Published abstracts, poster presentations and genetics studies were excluded. Additionally, studies involving robotic surgery, neuroscience, robotic limbs and social robots were also excluded. If a study did not mention nor address the topic of robotics or dementia or mild cognitive impairment disorders, it was excluded as well. Furthermore, studies primarily concerned with ethical implications of robotic devices being used in the home were excluded.

Procedure

The article screening process was conducted using the PRISMA guidelines for scoping reviews [12]. Two reviewers screened the titles and abstracts using Covidence® [13]. One reviewer downloaded the final set of articles from the searched data-bases, and imported the results into Covidence® for review. After the titles and abstracts were screened by both reviewers, the full texts were reviewed, again by both reviewers. All of the included articles at both the abstract and full text review level were agreed upon by both reviewers.

Data Extraction

Extracted data from the included articles following the full text review included the year of publication, country in which the study took place, study design and participants. Additionally, specific details that were included in the article that were specific to the inclusion criteria, and the study objectives were added to the data extraction. These details included the specific functions of the robotic device, whether ADLs or IADLs were mentioned, how the device can impact the healthcare system, what setting the robot can be used in (home, hospital, long term care), and any gaps in the research.

Results

Following an initial article search, 907 articles were imported into Covidence® for screening. After 54 duplicates were removed, 853 titles and abstracts were screened. A total of 54 studies were screened as full text, with 41 further studies being excluded based on the reasons outlined in the exclusion criteria (see Figure 1). Following the full text review, 13 articles were included in the scoping review (See Figure 1). One reviewer (EW) extracted the data from the 13 included articles.

Figure 1. PRISMA Diagram



Article Characteristics

Most of the articles were published between the years of 2013 and 2020, although the search criteria that was applied included articles published after 2005. Articles were included from several journals (n=10). Most of the articles were published in the International Journal of Social Robotics (23%[3/13]). Nearly all of the studies were qualitative, using focus groups, interviews or user questionnaires for data collection (85%[11/13]), and nearly one third of the studies were literature reviews (38%[5/13]). Other article types were mixed methods and quasi experimental studies.

The authors of the studies (i.e. the first authors) represented 7 different countries, with the most common being the United States (46%[6/13]). The remaining 7 articles were from several different countries (i.e. Poland, Finland, France, Austria, Spain, Canada, New Zealand).

Article Themes

There were three principle themes identified in the research. They incuded:

- 1. Robot Functions
- 2. Research Areas
- 3. Assisted Living

Robot Functions

Each of the articles included in this scoping review discussed the functions that a robotic device could perform. The majority of the studies were focused on the IADL functions of a robot. Specifically, the functions that were discussed in the articles involved tasks that do not require the robot to physically touch the patient. Examples of IADLs that were discussed include medication reminders, housework, meal prepping and emergency assistance (e.g. calling EMS). Very few ADL functions (e.g. washing, eating, mobility) were discussed as functions the robotic devices could undergo, and patients would continue to rely on human assistance for these tasks.

Areas of Research

The studies in this scoping review were completed in several different contexts; for example, studies were done in a technical setting, including the technical functions that the robotic device would feature, while others were primarily focused on the patient safety impacts and the acceptance of older adults and clinical staff.

Assisted Living

The majority of articles included in this study included keywords, background or discussion of assisted living. Additionally, the majority of the studies were intended to study the home environment, and the interaction or benefit of using the technology for patients/residents, caregivers and/or other health care providers.

Discussion

The results of the review displayed the current state of the literature involving empirical studies of dementia examining how robotic devices can be used to care for patients with dementia who are living at home and their caregivers and support workers. Early research studies focused on the specific needs of older adults requiring support in the home [8], which later developed into descriptions of the role of robots in the healthcare delivery process, and how they can impact the quality of life of patients and caregivers. However, there was a gap in the knowledge surrounding the specific needs of patients and their health conditions. The principle focus of this review was dementia or other MCI conditions; however, there was sufficient evidence in the literature to date to provide enough information regarding how dementia patients can benefit from these devices specifically. The impacts and acceptance rates were discussed [14], with patients and clinical staff; however, there was no mention of informal caregivers (e.g. such as daughters, sons or spouses). In this context, informal, non-medical caregivers (e.g. family members) were of particular interest; however, there was a gap in the knowledge surrounding how robotic devices can assist the caregiver, when providing assistance to demetia patients.

Several studies discussed the ability of robots to do IADLs as a principle activity; for example, reminders to drink water and assistance with making phone calls were considered instrumental activities, requiring no physical human assistance (e.g. physical touch). Additionally, it was found that robotic devices are more commonly used for IADL assistance in the home rather than ADLs. This could be due to the complex nature of ADLs and the physical support that the patient requires for these tasks [15]. It should be noted there is a vast difference between ADLs and IADLs. A patient must be able to perform ADLs proficiently in order to remain in the home safely without continuous nursing care supports [15]. Currently there is no robotic device

that can address the needs of an individual who requires assistance with their ADLs, especially when the patient requires physical assistance to complete their tasks. The literature surrounding robots states that ADLs can be done in the home, while the *clinical* literature suggests that it is more feasible for assistive technologies to be used for IADL assistance. This discrepency in the literature must be noted, due to the overlap in technical and clinical fields that this intervention would involve. It was also found that upon screening the articles, the use of the language "assistive robot" and "social robot" were used interchangeably. A social robot, as defined in the literature is meant to assist the patient with symptoms of cognitive decline [16], therefore not assist them with ADLs or IADLs. Therefore the use of the word "companion robot" for a device that is deployed for psychological purposes would be more appropriate. It can be argued that social or companion robots can assist the patient in improving their cognitive symptoms, thus improving the patient's ability to perform ADLs and IADLs in the home; however, the device is not directly assisting the patient, therefore it is not considered and assistive robot.

From this scoping review, one can conclude that there are few sufficient definitions surrounding what a robot is in the context of patient care, what functions the robot should perform, how the robot will perform the tasks, and where they can be performed. Additionally, further consideration of the definitions for an ADLs and IADLs are required to ensure that the robotic device is a feasible and safe technology to be used in the home with patients and non medical caregivers. Further research is needed to better understand how robots can safely support older adults in their homes without introducing new hazards [17].

Although the significant benefits associated with using robots is discussed within the literature, there is very limited discussion about the full impact of robots that can be expected for improving the healthcare system as a whole. It is already known that the use of assistive technology in the home can allow residents presenting with mild cognitive symptoms to remain in the home safely for long periods of time [15]. Therefore, whilst allowing patients to remain in the home with minimal intervention from clinical staff, the observed over-reliance on institutional long term care can be decreased. Futher investigation and study surrounding the benefits of providing care to older adults in Canada should be conducted.

Limitations

Although this review was conducted according to a scoping review methodology, there were several limitations that are worth nothing. First, the studies that satisfied the inclusion criteria had relatively small study samples. The sample sizes for the studies ranged from a size of 8 to 45 participants. Research conducted with a small number of participants is less generalizable. There is a need to conduct studies with a larger number of individuals to obtain more representative results. It should also be noted that the field of robotics and assistive technology is continually evolving rapidly, and it is important to acknowledge that this research provides data from a specific point in time.

Conclusion

Robots are considered for at home assistance of patients with dementia and their caregivers. Further investigation is required to assess the suitability of robotics use for the assistance with ADLs in the home. However, there is evidence to confirm that utilizing robotic devices for IADL assistance can be beneficial for patients and caregivers, as well as make a noticable impact on the healthcare system as a whole. Additionally, further investigation into the definitions of different types of robotic devices is required to ensure that the device is performing the appropriate tasks required to suit the patient's needs.

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