ORIGINAL ARTICLES

Global policies on assistive robots for care of the elderly: A scoping review

Christina Plaschka*[1], Diane Sawchuck[2,3], Timothy Orr[2], Thomas Bailey[2], Dawn Waterhouse[2], Nigel Livingston[4]

[1]University of Victoria, Victoria, British Columbia, Canada
[2]Vancouver Island Health Authority, British Columbia, Canada
[3]University of Victoria, Centre for Evidence Informed Nursing and Healthcare (CEiNHC), Victoria, British Columbia, Canada
[4]School of Public Health and Social Policy, Faculty of Human and Social Development, University of Victoria, Victoria, British Columbia, Canada

ABSTRACT

The elderly are the fastest growing portion of the world population. The majority of elderly want to remain independent as long as possible, with responsibility for their care often falling to family or caregivers. Assistive robots could help maintain independence in the elderly while relieving the burden of care on families and healthcare professionals. This scoping review seeks to examine the type and scope of global policies on the use of robotic technology for care of the elderly in international jurisdictions and to assess how they align with current Canadian policies. This review also seeks to determine current perceptions on the use of robotics in care of the elderly and potential barriers to their use that policy makers could encounter. A comprehensive literature search was conducted for articles related to robotic care of the elderly, perceptions of robotic care of the elderly and related policies, using a global lens. A three-step strategy was used to review and identify articles. The search identified 10 primary and secondary studies and 13 grey literature sources. Studies reported that response to robotic care for the elderly had both positive and negative aspects, and that concerns around privacy and cost were prevalent. Japan and the EU had the most comprehensive policy strategies and proposals. Robotic policy in healthcare is relatively new but will become increasingly important in the coming years. Canada needs to strengthen and anticipate its national policy strategy to ensure it can stay aligned with the fast pace of technological change. Further robust research should continue to explore potential for, and concerns over robotic care.

Key Words: Robot, Elderly, Assistive technology, Policy

1. INTRODUCTION

1.1 Background

The elderly population over 60 years of age accounts for 12 percent of the world population, and by 2050, the United Nations[1] estimates that this group will represent almost 22 percent. As the global population continues to age, so will the demand on healthcare professionals, perpetuating the shortages already faced for home care workers. The space requirements in long-term care facilities and nursing homes will also increase. Many elderly adults prefer to continue living in their own homes for as long as possible to remain independent, thus there is a growing need for novel and efficient methods to maintain a high quality of life for this specific population.

One aspect of care of the elderly that is gaining traction globally is the use of assistive robots. A simple definition

---

for an assistive robot is a device that physically assists people with disabilities. However, as Feil-Seifer and Mataric[2] point out, a better definition may include assistive robots that work through non-contact interaction as well, such as monitoring an elderly patients' movement to detect falls and providing verbal medication reminders. For the purpose of this paper, an assistive robot is defined as a device that is at least semi-autonomous, and can sense, process information, and perform actions to assist and benefit elderly adults in their daily living activities beyond companion roles.

Ugalmugale and Mupid[3] have estimated that the market for healthcare and assistive robots in the USA will grow from $200 million in 2015 to around $950 million by 2024. Expanding the development and use of these robots could dramatically reduce health care costs while maintaining autonomy of the individual and improving health outcomes. Assistive robots have a wide range of potential uses, such as retrieving food and drink and reminding the individual to eat or drink,[4] helping an individual from their bed to a wheelchair,[5] or helping an individual with washing, dressing, and using the toilet.[6]

1.2 Importance of the research

While the use of these assistive robots seems promising, the question as to how to govern their use through policy, has not yet been fully answered. Currently, countries such as Canada, the United States and Japan classify robots used in healthcare as medical devices for regulatory purposes.[7] The question remains however, whether these existing regulations are sufficient to account for the broad variety of assistive robots that are recently available to the elderly, and whether the regulations will be able to keep up with the rapidly new technology that is presently emerging in the field.

With the rapid rate of technological advances in robotics, there is a need for swift policy decisions and efficient change management strategies in order to keep ahead of the inevitable demand for robotic healthcare solutions for the elderly. The development and implementation of policy related to use of robotics in care of the elderly will present a unique challenge to policy-makers as issues of privacy, ethics, and varied perceptions are likely to arise in response to the new use of these assistive robots. A scoping review to examine what policy makers are developing globally in response to the demand of robotics in home healthcare for the elderly will allow Canadian decisionmakers to keep up with technological advances while staying informed on best practices, in order to provide the safest solution to the public. Further examination into how the public perceive these assistive robots, along with other potential issues that could arise, will better inform policy-makers on barriers they will likely encounter

when addressing these questions.

1.3 Objectives

This scoping review focuses on the pertinent issues related to use of assistive robots for elderly individuals either living at home or in a healthcare setting, and was guided by the following research questions:

(1) What policies related to use of robotics in healthcare have been developed or suggested globally?
(2) What are the perceptions or attitudes of the elderly and related healthcare professionals around the use of assistive robotics in healthcare for the elderly, and could this act as a barrier when implementing policy?
(3) What other potential barriers could policy makers encounter when developing or implementing policy related to the use of assistive robots in healthcare for the elderly?

2. METHOD

2.1 Inclusion and exclusion criteria

Sources were included if they were published in English between January 2000 to when the research for the review was completed in August 2019. As this is a new and rapidly emerging field, the type of technology available to the public is constantly shifting and evolving. Resulting laws, regulations, policies and studies included had to be recent enough to keep up with the current trends. Including publications prior to the year 2000 ran the risk of including policy, technology and resulting perceptions that are outdated, and do not accurately reflect current trends.

Literature on surgical, telepresence, and companion robots was excluded, as it did not meet the scoping reviews' definition of an assistive robot. Literature that focused solely on either user requirements or technical specificities was excluded, as it did not include findings around perceptions or attitudes towards assistive robots, or policy was not discussed. Literature that focused on different assistive technology that did not meet the scoping review's definition of an assistive robot or where the device was for a child or adult under 60 years of age was also excluded. While therapeutic robotic "pets" which serve as companions are popular among dementia patients and show evidence of health benefits,[8] literature addressing these robots was excluded as they do not fit within this scoping reviews' definition of an assistive robot. Finally, literature that discussed the philosophical or ethical nature of assistive robots without addressing perceptions or attitudes towards the robots was excluded.

2.2 Participants

The elderly population for the purpose of this review is defined as equal to or greater than 60 years of age, as outlined by the United Nations.[1] Only literature that identifies key populations as falling into this age category were included. Articles that focus on caregivers and/or nurses to the elderly population and their perceptions and attitudes were also included (i.e., caregiver's perceptions of assistive robots in nursing homes). Grey literature that focuses on policy around robots or artificial intelligence (AI) in healthcare was also included.

2.3 Concept

The main concept of interest for this scoping review were the types of policies currently in use or suggested for robots in healthcare around the world, and how these policies compare to Canada's current regulatory framework. The secondary concepts of the review were "perceptions" or "attitudes" towards use of assistive robots for the elderly. For the purpose of this review, potential barriers policymakers could encounter when developing or implementing policy related to assistive robots for the elderly were also considered.

2.4 Context

The context of this scoping review is on global policy related to use of assistive robots in healthcare and how it compares to current Canadian policy. To capture as much relevant information as possible, the review accepted policy and governmental papers on assistive robots in general healthcare, and were not excluded if care of the elderly was not mentioned. In addition, this review considered studies and grey literature that examined perceptions of assistive robots for the elderly, as well as other potential barriers to policy development and implementation. To obtain a broad picture, the review considered all studies of assistive robots in all types of care settings (i.e., intensive care, acute care, chronic care, outpatient/inpatient rehabilitation, homecare and community settings) where perceptions or other potential barriers of these assistive robots were discussed.

2.5 Types of studies

This review included all study designs, including quantitative, qualitative, and mixed-methods studies. Descriptive observational study designs such as cross-sectional were also included, as were secondary studies such as literature reviews and systematic reviews. Grey literature, including published policy papers, governmental reports, and strategy papers were also included. Opinion articles from non-reputable sources were excluded.

2.6 Research design

2.6.1 *Search strategy*

To identify both published and grey literature, a three-step strategy as outlined by the Joanna Briggs Institute[9] was used. The first step was an initial search of online databases relevant to the topic. The databases MEDLINE, CINAHL, AGELINE, Proquest Dissertations and Theses, and the Applied Science and Technology Index were searched.

Search criteria for each database included robot* AND (polic* or frame* or regulat* or barrier* or percept* or experience* or attitude*) AND (elderly or old age or dementia or geriatric*). Robot* was searched in all major headings, and the other key search terms were searched in all fields.

This initial search was followed by an analysis of the text words contained in the title and abstract of retrieved papers, and of the index terms used to describe the articles. A second search of all full texts was undertaken. Thirdly, hand citation searches and use of pearl growing techniques were completed to ensure full scope of literature was covered.

A separate global grey literature search was conducted through reviewing conference proceedings, policy and white papers, and government documentation (e.g., Health Canada, National Institute of Health, National Institute for Health and Care Excellence, World Health Organization).

2.6.2 *Study selection*

Following the search, all identified sources were uploaded into the citation management system Zotero, which included dates of access. Titles and abstracts were screened by the authors for assessment against the inclusion and exclusion criteria for the review. The same process was used for full-text inclusion in the review. Decisions for exclusion of full-text articles are shown in Figure 1.

2.6.3 *Data extraction*

Two Appendixes were developed as recommended by Joanna Briggs Institute methodology for scoping reviews to capture key information on the selected results.[9] The relevant data as seen in Appendix 1 for studies and secondary studies included author(s), year of publication, title, type of literature, country of interest, aim/purpose, methodology/sampling, and key findings related to the scoping review questions. In Appendix 2, relevant data for grey literature captured included author(s), year of publication, title, type of literature, country of interest, aim/purpose, and key findings related to the scoping review questions.
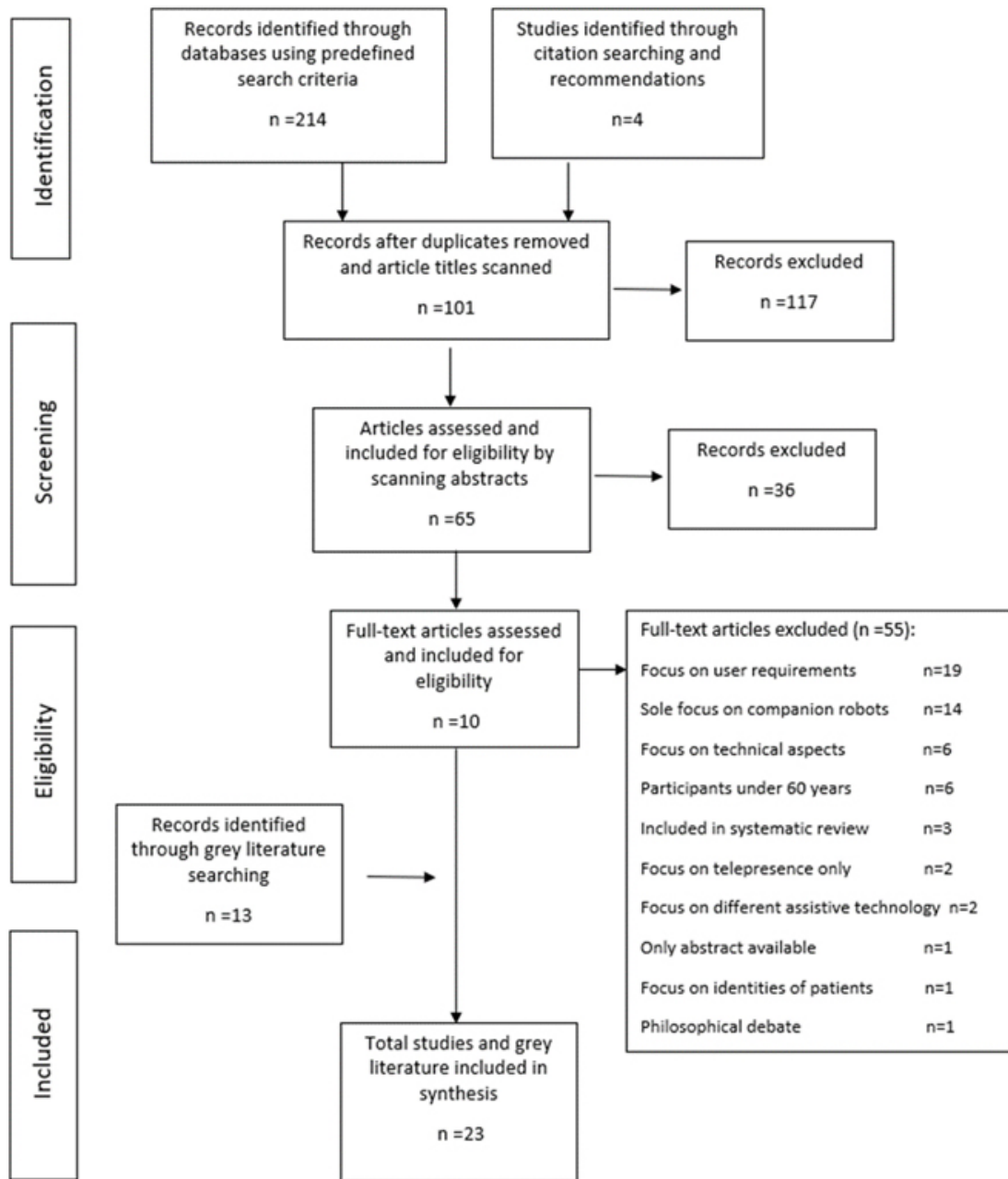
Figure 1. Article screening process

3. RESULTS

3.1 Study inclusion

The search of 5 databases yielded 214 results. Four further results were added through citation searching and pearl growing techniques. After removal of duplicates and scanning titles, 101 sources were screened by reading the abstract. A further 36 results were excluded after reading the abstract and further removing duplicates. A total of 65 results were assessed by a read through of full-text, resulting in 10 articles selected for inclusion. In addition, through a separate search of grey literature, an additional 13 sources were added that

mostly consist of policy papers and government reports.

3.2 Characteristics of included literature

A complete search of the electronic literature identified 23 relevant publications. These publications include five different studies (see Appendix 1), of which three used a qualitative cross-sectional methodology, and two were observational mixed-methods studies. Similar methods were used across studies to obtain data to answer the research questions. All five of the studies used questionnaires, three used solely questionnaires,[5, 6, 10] one used focus groups and question-

naires,[11] and one used individual user tests and question-naires.[4] Out of the 23 publications included in this review, there were five secondary studies of differing types, including two literature reviews,[12,13] one integrative review,[14] one rapid evidence review,[15] and one systematic review.[16]

The ten primary and secondary studies outlined in Appendix 1 were conducted in many different countries, indicating an interest in robots for care of the elderly that spans a large part of the globe. The five secondary studies included literature from around the world, while out of the five primary studies, one compared data from Finland and Japan;[6] and one each was conducted in South Korea, Finland, the Netherlands, and New Zealand.[4,5,10,11]

The remaining 13 publications outlined in Appendix 2 are grey literature sources and include: four governmental reports;[17–20] three project or research reports;[21–23] two policy/white papers;[24,25] two strategy papers;[26,27] one draft paper;[28] and one infographic.[29] Four of the publications came from the United States of America;[19,24,25,28] four came from the European Union;[18,20,23,29] two from Canada;[17,27] two from South Korea;[21,22] and one from Japan.[26]

3.3 Outcomes

3.3.1 *Policy*

Within the grey literature, there was a general consensus that in order to more fully understand the emerging topic and possibilities of robots in healthcare, more dedicated research on a national level is needed.[19,22,25,27] The need to create a separate legislative body, agency or working group to focus specifically on robot regulation to ensure safety and economic standards was also strongly encouraged.[18,23,24,28] Encouraging public discussion in order to promote awareness of robotic technologies, remain transparent, and foster healthy discussion was also a common suggestion.[19,20,23] Broad, sweeping suggestions for regular review of existing policies and practices and to be pro-active in policy-making decisions in order to keep ahead of fast emerging technologies were popular recommendations for both the USA and the EU.[20,25,28] The USA and UK also identified the need to create ethical frameworks to establish roboethical principals to protect humans.[18,19]

Both Canada[17] and Japan[26] expressed the need to set global standards and encourage international discussion on use of robotics in an effort to keep current on emerging technologies and promote collaboration between countries. Further, the EU[20] and South Korea[22] both suggested the need to develop new legal grounds to determine liability for autonomous robots along with the aim to ultimately protect the public.

3.3.2 *Perceptions and attitudes*

Out of the 23 sources included in this review, over half included discussions on perceptions or attitudes towards assistive robots. These discussions included both positive and negative reactions, sometimes related to safety concerns and ethical debates over using these robots for care of the elderly. Out of the 12 sources that examined perceptions or attitudes, the majority found mixed responses to use of assistive robots for the elderly.[4–6,10,11,13,16,18,25] Only one governmental report[20] found overall no negative attitudes or refusal of assistive and care robotics, as they allowed users more autonomy with less dependence on caregivers or families. In contrast, an infographic by the European Commission[29] reported that while the majority of EU and Danish citizens had positive views of robots and thought they could be useful in different areas of healthcare, the majority thought they should not be used for care of the elderly, children or the disabled. The last study conducted by Papadopoulos & Koulouglioti[14] looked at cultural backgrounds related to attitudes towards robots but could not conclude with certainty which specific countries feel more positively or negatively towards robots due to limitations within studies included in their review.

3.3.3 *Privacy*

Another common theme that emerged from the literature was concern around privacy in relation to use of assistive robots for the elderly. Concerns included surveillance, consent to surveillance and data security in terms of where data is stored and who has access to the data. Two of the sources cited privacy concerns from potential users and healthcare staff[11,16] in terms of monitoring personal moments such as dressing or bathing. Other sources recognized that more robust privacy and data laws would need to be put in place.[12,13,15,17,18,20–23,28]

3.3.4 *Cost and equitability*

A third theme that emerged as a potential barrier to policy-makers was the notion of cost and equitability, including financial concern for both researchers and consumers, along with issues of equitable distribution to the public. Six sources in the review discussed cost or potential for inequitable outcomes. Ienca et al.[12] and Nevejans[18] both noted a potential to further increase socioeconomic divides if prohibitive measures are not taken to counter the potentially exorbitant costs of these assistive robots, while Veruggio[23] explored how manufacturers and companies funding researchers could lead to potential conflicts of interest between the ethical and objective duties of the researcher. A further three sources simply cited cost as a potential constraint or barrier to further implementation of robots in healthcare settings.[13,15,20]

4. DISCUSSION

The results of this scoping review are broad and heterogeneous with respect to global policy strategies and recommendations. Common themes emerged within the policy papers with respect to focusing on strengthening research, creating separate or new governing bodies or agencies dedicated to robotic regulation to ensure high standards, and instilling regular policy reviews and proactive policy making decisions, to stay on top of the rapid technologic changes occurring.

When examining policy strategies or recommendations by regions, differing and notable gaps are evident. For example, within this review, four of the policy papers came from the USA.[19, 24, 25, 28] All four papers focused on the need to build good policy now around robotics and AI, perhaps with a dedicated agency overlooking robotics. However, only one draft report[28] actually mentioned healthcare in relation to robots and pointed out the demand and potential use for robotics in healthcare. The remaining reports focused their attention on production automation, driverless cars, drones, surveillance, and military defense. This highlights the difference in focus and needs across countries, suggesting the USA is currently focusing the potential for robotic development in areas other than healthcare.

Comparatively, policy papers and reports from the EU, South Korea, and Japan all focused attention (in addition to the other areas), on the need for robots and AI in healthcare, and produced more comprehensive recommendations for areas that need more research or focus. The EU, for example, recommended updated security and safety measures, roboethics committees,[23] producing a general ethical framework for protecting human interest,[18] and even policies for training caregivers on using assistive robots.[20] South Korea duly noted that the current legal systems have not adequately responded to the changes seen in commercialization of AI technologies,[22] and recognized the need to begin discussions on specific countermeasures against possible socioeconomic impacts that this new technology could cause.[21]

The most detailed policy recommendations were observed in the Japanese national strategy for robotics.[26] These policy recommendations include key performance indicators specifically for nursing and medical fields, including lowering the risk of caregivers suffering backaches to zero by using assistive robots for transfers of the elderly. These specifically detailed and measurable goals outline exactly how and when Japan plans to utilize assistive robots in care for the elderly. The goals uphold the basic principal of "help people continue their self-sustaining lives in a region they are familiar with even when they have reached the age at which they need nursing and medical care".[26]

4.1 Policy considerations for Canada

In contrast to Japan, Canada's current strategy on AI, found within CIFAR's *Pan-Canadian Artificial Intelligence Strategy*,[27] outlines four major goals that center around investing in AI research and talent. Canada's Standing Senate Committee on Social Affairs, Science and Technology[17] released a report in 2016 that focused on how to integrate robots and AI into Canada's healthcare system. 14 recommendations were made that centered around the federal government creating a national conference to identify current efforts to integrate robotic, AI and 3D printing into healthcare, and to establish working groups that would focus on ethical and privacy considerations, healthcare delivery including home and remote care, workforce adjustments and regulatory oversights. While Canada is the only country noted in the review to recommend a national conference focused on robotics, this recommendation is similar to Japan's encouragement to promote national discussion.[26] It is also similar to the USA's and EU's recommendations to promote public discussion to increase awareness of robotic potential in healthcare.[19, 20, 23]

The Canadian strategy put forward by CIFAR[27] differs from other countries in that its focus is on building talent and research, rather than, for example, South Korea[22] which focuses on policies related to safety, data and privacy. While the Standing Senate Committee on Social Affairs, Science and Technology[17] reported the need for working groups for issues related to privacy and data, this review found no evidence that these working groups have since been assembled or have commenced policy work towards integrating these robots into the healthcare system. In the context of this review, Canada has shown interest in robotic technology specifically in health care areas. However, Canada should better prepare for the inevitable rush of robotic technology that will emerge in coming years by developing a national policy framework to best manage the safety of its citizens and ensure the population is benefiting, to the fullest extent, from what robots can offer in care of the elderly. Policy-makers may wish to draw inspiration from the EU's government report,[20] which puts forward a series of policy recommendations to enhance their current legal framework. These recommendatons include: improved definition of assistive robots, and separating them from other medical devices; promoting independent living by introducing assistive robots to enhance traditional forms of care; ensuring liability is well defined for manufacturers, consumers and insurance companies; ensuring safety and security measures are consistent for assistive devices; and tackling privacy issues, including limiting storage of personal data by assistive robots to only what is needed for a legitimate purpose and is clearly conveyed to the consumer.

By following in the footsteps of the EU, Japan and South Korea, Canada can ensure that global concerns around robotics in healthcare are appropriately researched, analyzed, considered, and developed into a national policy framework that is best suited within the context of the Canadian healthcare system, to ensure standards are met between provinces and territories. The next section further explores potential barriers and considerations for policymakers around use of assistive robots in care of the elderly.

4.2 Policy implications

4.2.1 *Perceptions and attitudes*

While over half of the sources used in this scoping review noted the importance of perceptions and attitudes of robots in healthcare, the majority found that both public and healthcare professionals had positive and negative reactions to the use of assistive robots in care of the elderly. Both Bedaf et al.[4] and Zafrani and Nimrod[13] discuss that direct experience with robots appears to lessen ambivalence and promote acceptance among users and healthcare staff. This may link to the importance of public discussion as noted by the USA[19] and the EU[20, 23] to increase transparency with policy, laws, and decisions for safety regarding assistive robots for the elderly. Canada appears to be on the right track with this suggestion for the Standing Senate Committee on Social Affairs, Science and Technology[17] proposing to hold national conferences to promote discussions on robotics. Perhaps on a smaller scale, informal public discussions could be incorporated into provincial government mandates to encourage open discussions that may pique public interest, dispel rumours, and promote acceptance of robots among the general population.

Also noted along with perceptions were many ethical considerations of assistive robots.[18, 19] Beyond the span of this review, ethical considerations of care for the elderly with robots is needed as technology continues to develop, so that morally ambiguous areas within the topic, such as trusting robots to attend to a vulnerable population, and potential attachments made to these robots can be explored and unpacked within academia and the professional world.

Interestingly, cultural differences affecting attitudes towards robots were found multiple times in different studies and reports.[6, 14, 18, 25] Consensus from the various sources was that Western cultures seem to inherently link robots to fear, as seen in Hollywood's dramatization of scary robots such as the Terminator or Robocop,[25] or even from Stephen Hawking and Elon Musk and their warnings of artificial intelligence's ability to end the human race if managed incorrectly. Eastern cultures appear to be more positive towards robots, potentially due to factors such as having a Shintoism point of view originating out of Japan, which believes that everything has a soul, including robots.[18] Further, Nevejans[18] also speaks to how terminology comes into play, for example, using the term "smart robot" may instill undue fear among the public as a device which may outsmart them, therefore careful consideration must be made to categorize robots and other assistive devices appropriately. Whatever the cause for the generalized differing perceptions between Eastern and Western cultures, this may be an important distinction for policy makers to remember. Considering this, Canada could approach the topic of robotics with the knowledge that the population may be initially wary, meaning more public discussion and transparency about their uses, benefits, and limitations should be made clear. This again links back to the importance of public engagement and discussion, so that the population can educate themselves and become more open to the idea of assistive robots.

4.2.2 *Privacy*

Almost half of the sources included in this review mentioned privacy concerns related to robotics in healthcare, whether it be in terms of surveillance and consent, or data storage and security. The *European Charter of Fundamental Rights* is mentioned by both Palmerini et al.[20] and Veruggio[23] as current law that protects an individual's right to privacy; they suggest this could be challenged by the introduction of assistive robots in care for the elderly, especially if surveillance for fall detection and storage of data is expected within these devices. SimShaw et al.[28] suggests looking to the *USA's Health Insurance Portability and Accountability Act* (HIPPA) for guidance, which is designed to protect personal information as well as data collected and stored in medical records. Other countries such as South Korea suggest improvements to their own privacy act to protect against invasion of privacy and rules around data collected on patients.[21] The underlying tone is the realization that data and privacy will likely become major issues as assistive robots become more mainstream, and therefore updates to regulations and policy need to occur now so that citizens can have transparency and choices over the collection of sensitive medical information, regardless of who or what collects it.[28] Canadian policymakers will benefit from cross-referencing both the *Privacy Act* and the *Personal Information Protection and Electronic Documents Act*, as well as applicable provincial acts to fully understand whether assistive robots are compliant with the provincial and national standards.

4.2.3 *Cost and equitability*

The EU appears to delve deepest into the potential risk of furthering a socioeconomic divide if assistive robots are made available to the public at high costs with no governmental support. As mentioned above, the *European Charter of Fun-*

damental Rights, discussed by both Palmerini et al.[20] and Veruggio,[23] is part of current EU law which establishes the right of an individual to live an independent life with dignity, which could be challenged by further introduction of assistive robots in healthcare for the elderly if appropriate measures are not taken. Suggestions were made for insurance coverage for assistive robots if they were needed following an accident, as well as the idea of integrating assistive robot access into social assistance policies.[18] While it is unclear whether tax incentives, insurance policies or other solutions would be best for alleviating unequitable issues surrounding robotic care, the relative paucity of mention around cost and equitability from government and professional organizations shows a need for further and immediate research into the area to ensure equal access to robots for all, regardless of socioeconomic background.

4.3 Limitations

There are numerous limitations in this scoping review. The search of sources may not have been exhaustive due to language restrictions. This may be especially true for policy papers from foreign countries, which are more likely to be published in languages other than English. Another potential limitation in the search for sources was the broad definitions and search terms that encompass the concept of robots. Robot, robotic, artificial intelligence, assistive technology, assistive devices, medical devices, smart technology, etc. are all terms used throughout different articles when discussing similar issues. Trying to include such broad search terms in the databases resulted in tens of thousands of results, which were too cumbersome for review due to limited time and resources; therefore, narrowing the criteria to only "robot" may have excluded other potential sources of interest. Attempts to mitigate this were made by citation searching articles and looking at key terms used through the different articles.

In addition, all the policy identified in this review was strategic in nature at the national level. No operational policies were reviewed, and as such, further research would be required to determine what policy is available to address issues on an operational level. Lastly, characteristic to the scoping review methodology, this review did not assess the quality of the studies included, thus the effectiveness of assistive robots, as interventions, were not reported.

5. Conclusion

Care for the elderly, whether at home or in a healthcare setting, will always involve human interactions with fam-

ily members and healthcare professionals; however, as the world population continues to age, the related operation and resource burden on healthcare systems is only set to increase. The use of an assistive robot in both healthcare and home settings may help relieve some of the pressure felt by nurses, care-aides and families, and ultimately augment the level of care and quality of life of the elderly population. This in turn prompts the need to pro-actively develop policy strategies to best support human-robot interactions within healthcare.

This scoping review sought to gather information to shed light on global policies related to use of robotics in healthcare and how that compares to current Canadian policy. It also sought to report current perceptions on assistive robotic use for care of the elderly. This topic is an area of emerging information for policy strategy and recommendations, as well as issues or barriers that could interfere with policy development. Common recommendations included developing separate governing bodies or agencies to deal with robotic regulation, as well as putting focus on strengthening robotic research and regularly reviewing existing policy to keep ahead of updates to the technology. Common barriers noted include potential negative perceptions or attitudes towards assistive robots by individuals and healthcare staff, as well as privacy issues and issues of cost and equitability.

Canada would benefit from development of a policy framework now to help govern the rapidly growing and diverse field of assistive robotics for the elderly. An ongoing issue across the world will be the struggle of governments to keep up with the technological advances related to robotics and AI. The healthcare industry, especially related to care of the elderly, stands to gain substantially from assistive robots, which makes it imperative that policymakers are proactive in their approach to decisions concerning robotics within healthcare.

Conflicts of Interest Disclosure

The authors declare no conflicts of interest.

REFERENCES

[1] United Nations. World population prospects: Key findings and advance tables. 2017. Available from: `https://esa.un.org/unpd/wpp/publications/files/wpp2017_keyfindings.pdf`

[2] Feil-Seifer D, Mataric M. Defining socially assistive robots. IEEE 9th International Conference on Rehabilitation Robotics. Chicago, IL. 2005; 1-5. Available from: `https://www.researchgate.net/publication/4170715_Defining_Socially_Assistive_Robotics`

[3] Ugalmugale S, Mupid S. Healthcare assistive robot market size by product. 2017. Available from: `https://www.gminsights.com/industry-analysis/healthcare-assistive-robot-market`

[4] Bedaf S, Marti P, Amirabdollahian F, et al. (A multi-perspective evaluation of a service robot for seniors: the voice of different stakeholders. Disability and Rehabilitation: Assistive Technology. 2018; 13(6): 592-599. PMid:28758532. `https://doi.org/10.1080/17483107.2017.1358300`

[5] Lee JY, Song YA, Jung JY, et al. Nurses' needs for care robots in integrated nursing care services. Journal of Advanced Nursing. 2018; 74(9): 2094-2105. PMid:29754395. `https://doi.org/10.1111/jan.13711`

[6] Coco K, Kangasniemi M, Rantanen T. Care personnel's attitudes and fears toward care robots in elderly care: a comparison of data from the care personnel in Finland and Japan. Journal of Nursing Scholarship. 2018; 50(6): 634-644. PMid:30354007. `https://doi.org/10.1111/jnu.12435`

[7] Underwriters Laboratories. Addressing regulatory considerations for medical robotic devices. 2017. Available from: `https://library.ul.com/wp-content/uploads/sites/40/2017/08/BNG-UL17-Medical-Robots-White-Paper-080117-1.pdf`

[8] Pu L, Moyle W, Jones C, et al. The effectiveness of social robots for older adults: a systematic review and meta-analysis of randomized controlled studies. The Gerontologist. 2019; 59(1): e37-e51. PMid:29897445. `https://doi.org/10.1093/geront/gny046`

[9] Peters MDJ, Godfrey C, McInerney P, et al. Chapter 11: Scoping Reviews. In: Aromataris E, Munn Z (Editors)Joanna Briggs Institute Reviewer's Manual. The Joanna Briggs Institute, 2017. Available from: `https://reviewersmanual.joannabriggs.org/`

[10] Rantanen T, Lehto P, Vuorinen P, et al. Attitudes towards care robots among Finnish home care personnel - a comparison of two approaches. Scandinavian Journal of Caring Sciences. 2018; 32(2): 772-782. PMid:28833309. `https://doi.org/10.1111/scs.12508`

[11] Broadbent E, Tamagawa R, Patience A, et al. Attitudes towards health-care robots in a retirement village. Australasian Journal on Ageing. 2012; 31(2): 115-120. PMid:22676171. `https://doi.org/10.1111/j.1741-6612.2011.00551.x`

[12] Ienca M, Wangmo T, Jotterand F, et al. Ethical design of intelligent assistive technologies for dementia: a descriptive review. Science and Engineering Ethics. 2018; 24(4): 1035-1055. PMid:28940133. `https://doi.org/10.1007/s11948-017-9976-1`

[13] Zafrani O, Nimrod G. Towards a holistic approach to studying human-robot interaction in later life. The Gerontologist. 2019; 59(1): e26-e36. PMid:30016437. `https://doi.org/10.1093/geront/gny077`

[14] Papadopoulos I, Koulouglioti C. The influence of culture on attitudes towards humanoid and animal-like robots: an integrative review. Journal of Nursing Scholarship. 2018; 50(6): 653-665. PMid:30242796. `https://doi.org/10.1111/jnu.12422`

[15] Consilium Research and Consultancy. Scoping study on the emerging use of artificial intelligence (AI) and robotics in social care. 2018.

Available from: `https://www.skillsforcare.org.uk/Documents/Topics/Digital-working/Robotics-and-AI-in-social-care-Final-report.pdf`

[16] Vandemeulebroucke T, de Casterlé BD, Gastmans C. How do older adults experience and perceive socially assistive robots in aged care: a systematic review of qualitative evidence. Aging & Mental Health. 2018; 22(2): 149-167. PMid:28282732. `https://doi.org/10.1080/13607863.2017.1286455`

[17] Standing Senate Committee on Social Affairs, Science and Technology. Challenge ahead: integrating robotics, artificial intelligence and 3D printing technologies into Canada's healthcare systems. Ottawa: Canada. 2017. Available from: `https://sencanada.ca/content/sen/committee/421/SOCI/reports/RoboticsAI3DFinal_Web_e.pdf`

[18] Nevejans N. European civil law rules in robotics. Policy Department for Citizens' Rights and Constitutional Affairs. 2016. Available from: `http://www.europarl.europa.eu/committees/fr/supporting-analyses-search.html`

[19] Office of Science and Technology Policy. Preparing for the future of artificial intelligence. 2016. Available from: `https://obamawhitehouse.archives.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf`

[20] Palmerini E, Azzarri F, Battaglia F, et al. Regulating emerging robotic technologies in Europe: robotics facing law and ethics. 2014. Available from:`http://www.robolaw.eu/RoboLaw_files/documents/robolaw_d6.2_guidelinesregulatingrobotics_20140922.pdf`

[21] Jang M. A study on the legal issues in the artificial intelligence age. Korea Legislation Research Institute. 2018. Available from: `https://www.klri.re.kr/eng/publication/1807/view.do`

[22] Woo S. Study on international discussion and legal policy on artificial intelligence technology. Korea Legislation Research Institute. 2016. Available from: `https://www.klri.re.kr/eng/publication/1659/view.do`

[23] Veruggio G. EURON roboethics roadmap. 2006. `https://doi.org/10.1109/ICHR.2006.321337`

[24] Calo R. The case for a federal robotics commission. 2014. Available from: `https://www.brookings.edu/research/the-case-for-a-federal-robotics-commission/`

[25] Knight H. How humans respond to robots: building public policy through good design. 2014. Available from: `https://www.brookings.edu/research/how-humans-respond-to-robots-building-public-policy-through-good-design/`

[26] Headquarters for Japan's Economic Revitalization. New robot strategy: Japan's robot strategy. 2015. Available from: `http://www.meti.go.jp/english/press/2015/pdf/0123_01b.pdf`

[27] Canadian Institute for Advanced Research (CIFAR). Pan-Canadian artificial intelligence strategy. 2018. Available from: `https://www.cifar.ca/ai/pan-canadian-artificial-intelligence-strategy`

[28] Simshaw D, Terry N, Hauser K, et al. Regulating healthcare robots in the hospital and the home: considerations for maximizing opportunities and minimizing risks [draft]. 2015. Available from: `http://www.werobot2015.org/wp-content/uploads/2015/04/Simshaw-Hauser-Terry-Cummings-Regulating-Healthcare-Robots.pdf`

[29] European Commission. Public attitudes towards robots [infographic]. 2012. Available from:`http://ec.europa.eu/commfrontoffice/publicopinion/archives/ebs/ebs_382_fact_dk_en.pdf`