

STANDARDS RESEARCH

Care-Informed Implementation of Active Assisted Living Technologies for Older Adults

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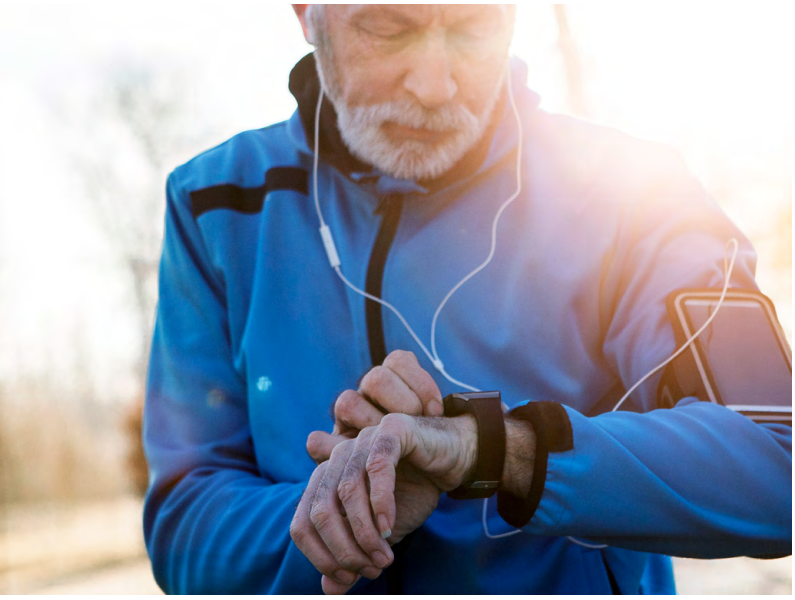
Executive Summary

Active Assisted Living (AAL) technologies encompass a wide range of digital devices and systems designed to promote independence, safety, and well-being for individuals who may require support, including older adults. Given Canada's increasing population of older adults, AAL technologies like smart home devices, remote monitoring systems, and mobile health applications offer tremendous potential to improve quality of life. These technologies could support aging in place, improve communication with care providers, and foster well-being. From the perspective of care recipients, AAL technology can provide greater autonomy, safety, and social connection. For care providers, they can enable more effective and responsive monitoring, managing, and coordinating of care. However, additional research is necessary to address the ethical and practical concerns that older adults and care providers have about using AAL in care.

This research explored how older adults and care providers view implementing AAL technologies and compared these perspectives with evidence from existing research and practice. This involved reviewing academic and grey literature and consulting key informants, including older adults and care providers. The information from these sources was synthesized to identify available guidance for implementing AAL technologies, expand on best practices from the perspective of older adults and care providers, and ascertain gaps in existing standards and guidelines to inform future research and standards development.

Recurring themes across the research included privacy and data security, accessibility, social inclusion and exclusion, user autonomy, and co-design. Perceived benefits, such as enhanced safety and security, better health management, and less institutionalization, as well as possible risks, including stigmatization and alienation, emerged as important ethical concerns. Older adults generally emphasized communicating clearly, being transparent, and co-designing to implement AAL technologies ethically and appropriately. Care providers reported uncertainty about what new expectations—for care and from care providers—would be included in an AAL-inclusive model of care, as well as the implications for professional workflows and required skills, underscoring the need for actionable guidance. These insights offer a foundation for how to apply best practices and implement guidelines to improve the experience of AAL technology use in the older adult care context.

This work highlights the need for guidance to help ensure that AAL systems align with these ethical considerations and do not reinforce adoption barriers or exclude vulnerable groups. It also points to opportunities for new standards for both developing AAL technology and training care providers to integrate technology into the provider-patient relationship. Finally, this report recommends incorporating ethical principles, co-design requirements, enhanced accessibility, robust data governance, and provider training into future standards to ensure AAL technologies are inclusive, safe, and aligned with older adults' needs.



"Active Assisted Living (AAL) encompasses a broad range of digital technologies "designed to improve the quality of life, aid in independence, and create healthier lifestyles for those who need assistance at any stage of their lives."

1 Introduction

Active Assisted Living (AAL) encompasses a broad range of digital technologies "designed to improve the quality of life, aid in independence, and create healthier lifestyles for those who need assistance at any stage of their lives" [1]. These technologies are wide-ranging and adaptable to the unique circumstances of care recipients. They support daily activities, provide non-intrusive monitoring, enhance security, and more [1]. Table 1 presents an overview of common categories of AAL technologies.

As older adults in Canada age, they often need more care and support to maintain their health and independence. Meeting these needs requires ongoing consent and respect for dignity. But care providers—professionals delivering care or medical services—often face increasing demands that challenge their capacity to meet the evolving needs of their patients. As such, the two sides of the care equation often face different and complementary questions when contemplating AAL integration. Older adults want these systems to align with their actual care needs while still respecting their autonomy. Care providers are unclear about how using AAL systems would affect their workflow and which features would genuinely benefit their care recipients, especially older adults [1], [2].

Existing research also often lacks a comprehensive analysis of the ethical issues of data management within AAL systems, which in turn affects the guidance used to develop standards [2]. By balancing these two perspectives, this report highlights key considerations missing from current or emerging AAL technology standards and guidelines, addressing both ethical and practical concerns.

1.1 Ethical Considerations for Active Assisted Living

Older adults are more likely to accept AAL technologies when they are implemented ethically. This includes respecting autonomy, privacy, and dignity while maintaining informed consent, transparency, and accountability in designing, deploying, and using these technologies, as well as in managing older adults' data. Ethical implementation also requires protecting older adults from surveillance or decision-making processes that undermine their independence or well-being [3].

However, a significant gap remains in understanding how older adults perceive these ethical principles and how to implement them in AAL technologies. Further research is needed to help ensure that AAL solutions align with older adults lived experiences, preferences, and values. Artificial intelligence (AI) provides a useful starting point for this exploration. AI has expanded rapidly in recent years, and it can support the AAL paradigm by analyzing trends, making predictions, assisting with social interactions through robots, and generating personalized content [4], [5], [6].

Table 1: Overview of AAL technologies

AAL technology	Function
Smart home devices	User-facing equipment and systems in the home environment to monitor and assist daily living activities, such as smart speakers or connected appliances.
Wearable devices	Devices like smartwatches and fitness trackers that monitor vital signs, physical activity, and provide health reminders.
Health monitoring systems	Devices and platforms that track health metrics such as blood pressure, glucose levels, and medication adherence. The health monitoring systems referred to here are low-risk, consumer-grade technologies, and thus distinguished from strictly regulated medical devices that would be used in a hospital setting.
Assistive robots	Robotics designed to help with household chores, mobility, and personal care tasks.
Emergency response systems	Technologies that provide immediate assistance in case of falls or other emergencies, often equipped with alert buttons and sensors.
Cognitive support technologies	Tools that aid in memory, planning, and cognitive tasks, such as digital reminders and brain-training apps.
Communication aids	Devices and applications that facilitate social interaction and communication, helping older adults stay connected with family, friends, and caregivers.
Lifestyle monitoring technology	Technologies that track various aspects of daily activities and summarize behaviour trends to provide individualized assistance and treatment.
Home automation	Devices integrated into the functional aspects of home design to automate various functions in the home including security, lighting, and temperature.

Ethical discussions in AI focus on being transparent, acting fairly, protecting privacy, and considering broader social impacts. The ethical implications of AI use in AAL and older adult care are not yet fully understood [2], [6], but standards could help ensure that AAL technology ecosystems are transparent, fair, and respectful of privacy rights. Current standards integrate human factors into design, such as International Organization for Standardization (ISO) 9241-210:2019, Ergonomics of Human-System Interaction [7]. They offer guidance on usability integration into medical device design to keep them safe and effective for health care providers and older patients.

Standards on protecting personally identifiable information (PII), such as ISO/International Electrotechnical Commission (IEC) 27018:2025, Information Security, Cybersecurity and Privacy Protection, outline requirements for cloud service providers to safeguard PII. This is especially vital for protecting sensitive data related to aging populations [8]. Likewise, the standards on the corporate governance of information technology (IT, ISO/IEC 38500:2024) set principles and guidance for aligning IT with organizational objectives and managing IT-related risks [9].

These standards are essential to help ensure that technology designed for aging populations meets ethical expectations and serves their needs effectively. Still, a gap remains in how to explicitly incorporate older adults' perspectives to make AAL technology use more ethical.

1.2 Practical Considerations for Active Assisted Living

On the provider side, past work in the AAL space shows that providers are generally interested in integrating these technologies into care [1]. Expected benefits include more personalized and efficient care using data from AAL systems, reduced workload, and greater confidence in the security of older adults at home [1]. However, to promote AAL adoption in care, it is necessary to clarify how AAL systems would fit into professional workflows and what actions may follow from these new sources of information.

The question of use and actionability is especially important to define, because it affects several other aspects of their implementation. These include what technological solutions might be eligible for financial reimbursement, what care providers might be legally liable for in the new data landscape, and what skills or competencies might be expected of care providers [10], [11], [5]. Unlike ethical considerations, however, AAL actionability lacks a relevant framework, so the process of understanding it is necessarily explorative.

Some existing standards and guidelines for training in technology use can provide useful reference points when preparing to integrate AAL technologies. For instance, IEC SRD 63314:2024, Active Assisted Living (AAL) Guidance for Education and Training of Persons Working in the Field of AAL [12], outlines recommended competencies for those working in AAL and provides structured training processes for various types of AAL professionals. ISO 13131:2021, Health Informatics — Telehealth Services — Quality Planning Guidelines [13], focuses on processes for analyzing the quality of technology-enabled remote care services (i.e., telehealth) and provides guidelines on specific professional responsibilities and implementing best practices. Given the rapid expansion of telehealth after the COVID-19 pandemic [14], telehealth can serve as a useful benchmark for implementing technology in outpatient care.

On the technology side, a 2024 ISO technical report on "Aging Societies" [15] provides guidance for designing home health care products and services, which may help address challenges faced by individuals who lack skills or expertise in using these tools. These standards and guidelines emphasize the importance of training professionals in technology use, but each addresses different aspects of the AAL space independently, leading to inconsistency and fragmentation.

1.3 Research Aims and Objectives

This report is the third deliverable of the CSA project on Smart Communities. The first report, "Data governance for AAL technologies along the continuum of care" [1], examined the broader AAL landscape and collected the views of informants in industry, care delivery, and lived experiences with older adult care. The second report, "Guidelines for smart home retrofits and new builds for aging at home" [16], focused on the physical built environment and infrastructure of smart living environments.

The current report focuses on older adults' perspectives because, as care recipients, they are central to designing and implementing AAL systems. This demographic is often excluded in decision-making and not consulted on the iterations of AAL technologies that will eventually affect them and require their input. This report will also examine the perspectives of health care providers who are responsible for AAL actionability and support these findings with literature and existing guidance.

AAL technologies are intended to assist care recipients such as older adults, but their deployment has been uneven. This disparity arises between the practical needs of health care providers and the ethical preferences of older adults, which appears to stem from differing views on autonomy, transparency, and real-world implementation. Older adults may be unwilling to adopt intrusive AAL technologies that conflict with their ethical priorities [17]. Health care providers, meanwhile, want greater clarity on how AAL technologies' fit into their workflows to deliver effective care for older adults, and their goals include care delivery, safety, and quality of life. However, meeting these goals often requires



continuous data collection, automated interventions, and monitoring, which might conflict with an older adult's priorities to maintain autonomy and privacy [17].

To realize the goals of AAL technologies, the interests of care receivers and providers should align to enable seamless integration into the continuum of care. This report draws on findings from a literature review and analyzes user and provider perspectives from published literature and empirical interviews.

Therefore, the objectives of this report are to:

1. Review the landscape of AAL technology implementation standards, guidelines, and best practices, with attention to ethical and practical concerns from older adults and care providers.
2. Identify opportunities to expand the best practices for implementing AAL technologies across the continuum of care, based on the evidence of ethical and practical considerations from older adults and care providers in Canada.
3. Reveal gaps in existing standards and guidelines to inform future research and standards development.

2 Methods

Research for this report involved two phases: (a) a literature review of academic and grey literature, and (b) consultations with older adults and care providers. To ensure that both perspectives appeared in the final findings, the project used parallel data collection.

2.1.1 Literature Review

The academic literature review used the web-based platform Covidence to organize the review process. Relevant references were imported from multiple academic databases, including PubMed, IEEE-Xplore, Scopus, and CINAHL. The review focused on peer-reviewed publications published after 2000. After import, duplicates were removed, and screening followed the steps in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses-Scoping Review (PRISMA-ScR) [18]. A later grey literature review and rapid review applied an abbreviated version of this procedure to accommodate the looser structure of their source databases.

For the review on the older adult perspective, the academic search strategy used the following groups:

older adults, active / ambient assisted living, sensors / devices / smart technology, ethics / rights, and smart communities / home care / independent living / retirement homes / retirement villages. Following PRISMA-ScR guidance [18], the screening phases were divided into title and abstract screening and full-text screening. Two screeners independently evaluated each reference using predefined inclusion and exclusion criteria (Table 2), and a third screener resolved any conflicts for the title and abstract screening. Three screeners then independently conducted the full-text screening.

The review of the care provider perspective followed a similar strategy, with additional keywords associated with different professional types (e.g., "doctor," "nurse," "occupational therapist," etc.).

The search plan for the grey literature review used concepts relevant to AAL technology in the context of older adults' care. Four search terms guided the database and organization searches: "active assisted living," "ambient assisted living," "ethical considerations for active assisted living," and "standards for active assisted living." Additional keywords included "ethical considerations of AAL technologies," "best practices for AAL technologies," "smart communities," "standards for AAL technology," "standards for active assisted living technology." All databases' results underwent screening, and the first five pages of results from target organizations and general search engine results were screened for each keyword. One additional document recommended by a CSA Group expert was also screened and included. Applying the eligibility criteria resulted in 12 standards and 29 non-standards for full-text screening.

To explore standards related to training for the use of AAL technology, targeted searches were conducted on ISO and IEC standards databases using Boolean search strings. Search terms combined key concepts related to training, health professionals, standards, and AAL, while excluding unrelated document types. A three-step screening process was then followed: title review, abstract and summary screening, and full-text review.

2.2 Key Informant Consultations

2.2.1 Interviews with Older Adults with Lived Experience

The Research Advisory Panel (RAP) helped create a list of potential sources for recruiting older adult participants. These sources included the Schlegel Villages in Waterloo, the Village of Wentworth Heights in Hamilton, VHA Home HealthCare in Toronto, Perley Health in Ottawa, and contacts of the Community Life at Elim Village in British Columbia. Participants had to be 65 or older, have direct experience with AAL technologies in smart home settings, provide informed consent, and communicate in English without an interpreter. Ethics approval was obtained from the University of Waterloo's research ethics board (REB #46529).

Eligible participants were contacted by email or through institutional channels. Informed consent was collected using a secure Qualtrics form. Participants were informed of their rights, including the option to withdraw at any time. Participants then completed a Qualtrics survey with background and sociodemographic questions, followed by a scheduled interview. In total, eight surveys were completed,

Table 2: Inclusion and exclusion criteria for literature review

Inclusion criteria	Exclusion criteria
1. Studies that used qualitative or mixed methods	1. Full text was unavailable
2. Studies that focused broadly on AAL technologies used by the older adult population	2. Full text did not include a discussion of ethics
3. Studies that focused on care recipients' and older adults' perspectives	3. No care recipients' perspectives reported
4. Studies that focused on care providers' perspectives	4. Book chapter, not peer-reviewed or part of unpublished conference proceedings
5. Studies that focused on care providers' perspectives	5. Not in English



"To help ensure a rounded perspective that considered the practical side of ethical implementation, participants came from several disciplines in older adult care, including medical doctors, nurses, social workers, and occupational therapists."

and seven interviews were conducted, each lasting 30–45 minutes. One older adult participant declined the interview. All interviews took place virtually on Zoom, with accommodations provided as needed, using a semi-structured guide. Discussions focused on ethical considerations related to AAL implementation, including their knowledge, attitudes, and behaviours; perceived benefits of AAL technologies; and potential innovations or improvements. The interviews were analyzed inductively to identify key themes and compared with findings from the literature review.

2.2.2 Interviews with Older Adult Care Providers

To help ensure a rounded perspective that considered the practical side of ethical implementation, participants came from several disciplines in older adult care, including medical doctors, nurses, social workers, and occupational therapists. As with the older adults, all potential participants needed to provide consent and communicate in English without an interpreter. Informal caregivers, or those providing unpaid, "lay" care services, were excluded to maintain the focus on professional care providers. An outreach list was developed in consultation with RAP, and potential participants received email invitations to participate. Ethics approval was obtained from the University of Waterloo (Research Ethics Board (REB) approval number 45785).

The interviews followed a process similar to that used with older adult participants to obtain informed consent and conduct the interviews. Four interviews took place: one with a medical doctor, one with a social worker, and two with occupational therapists. To accommodate participants' schedules, interviews lasted 30 minutes or less. Questions focused on the data care providers would find useful from AAL systems and technologies, their concerns about use and implementation, and potential standards or guidelines informed by their practice and training. Key insights from these interviews were compared with those from older adult participants to identify areas of overlap and any new points raised by care providers.

3 Considerations of AAL Technologies Use in Older Adult Care

Findings from interviews with older adults and care providers, along with surveys of older adults, were analyzed together with insights from academic and grey literature to contextualize informant insights within the larger implementation, training, and guidance frameworks. The results appear here in an aggregated, theme-based format.

3.1 Knowledge, Attitudes, Behaviours, and Perceptions

The research revealed a range of understandings and perceptions of AAL technologies among older adults. In the survey, participants rated the importance of communication on five items using a scale from one to ten, for a total score of 50. The items included: the purpose of using AAL, procedures for AAL technology use, risks of AAL use, benefits of AAL use, and ongoing communication from AAL providers about their goals and any software updates. Most older adults rated all items very highly (eight or above), although one participant expressed little concern for the process except for communication from AAL providers.

Given the participants' clear desire for information and communication, scores are summarized in Table 3. Interviews further explored older adults' expectations regarding the purpose, risks, and benefits of AAL.

Attitudes toward AAL technologies varied. One participant shared that although large, prominent, and loud devices for older adults mattered, they objected to them being too large or loud. Another participant reported that learning to use their smartwatch posed challenges, yet they had no concerns about privacy or data collection. Behavioural changes resulting from AAL technology use also emerged: one participant described decreased physical activity after switching to remote controls that allowed them to operate the devices without leaving the couch.

3.1.1 Perceived Improved Health Benefits

Participants identified several health-related advantages of AAL technologies. One participant highlighted smartwatches' utility in detecting atrial fibrillation, monitoring heart rate during workouts, and tracking blood pressure. Emotional well-being during COVID-19 was also supported by devices such as tablets for video conferencing and communicating with isolated patients in hospitals or older adults at home for several reasons, including travel restrictions.

Care providers similarly acknowledged that AAL technologies contribute to improved health outcomes. These technologies provide empirical, real-time data, allowing providers to deliver care without depending solely on self-reports. Further, follow-up care improves because older adults are not required to physically attend clinics. By facilitating social communication, AAL technologies can also reduce the negative impacts of isolation on older adults' mental health and alert providers to crises or falls.

Table 3: Scores on the importance of information and communication about AAL technologies

Participant	Purpose of using AAL tech	Procedures of using AAL tech	Risks of using AAL tech	Benefits of using AAL tech	Importance of having clear and ongoing communication from AAL providers	Total score out of 50
1	10	8	8	10	9	45
2	10	10	10	10	10	50
3	9	9	9	9	9	45
4	3	3	3	3	7	19
5	10	10	10	10	10	50
6	10	10	10	10	10	50
7	10	10	10	10	10	50
8	10	10	10	10	7	47

3.1.2 Other Perceived Benefits

Beyond health, participants described a range of practical and emotional benefits. Smart devices controlled via smartphone, such as lights and thermostats, enhanced comfort and convenience. Some participants also reported positive experiences with AI-enabled robots that provided cleaning support and served as empathetic companions for advice and interaction.

Care providers emphasized safety-enhancing features, such as stove auto-shutoff mechanisms, which support aging in place by reducing risks and delaying institutionalization. One care provider described the sense of being monitored and supported as reassuring, noting that it contributed to greater security and independence.

3.2 Themes and Use Cases

This section presents themes from the literature and key informant consultations on the ethical implementation of AAL in older adult care. The themes align with ethical considerations identified in the literature review: (1) privacy, (2) accessibility, (3) social inclusion and exclusion, (4) self-determination and autonomy, (5) co-design, (6) safety and security, and (7) stigmatization and alienation. These considerations largely match the findings of Zhu and colleagues from the literature review [19], which highlighted "privacy (information privacy and physical privacy), autonomy (independence, informed consent and user-centred control), safety guarantee, fairness and concerns about reduced human contact" [19].

Use cases are presented for older adults in implementation scenarios where that theme is relevant. The older adults in these cases are fictional, and represented with stock images, but their descriptions draw from the real experiences of older adults and align in part with AAL use cases in IEC TS 63134:2020 [20]. Each case includes the associated ethical considerations and relevant practice considerations for care providers evaluating such implementations.

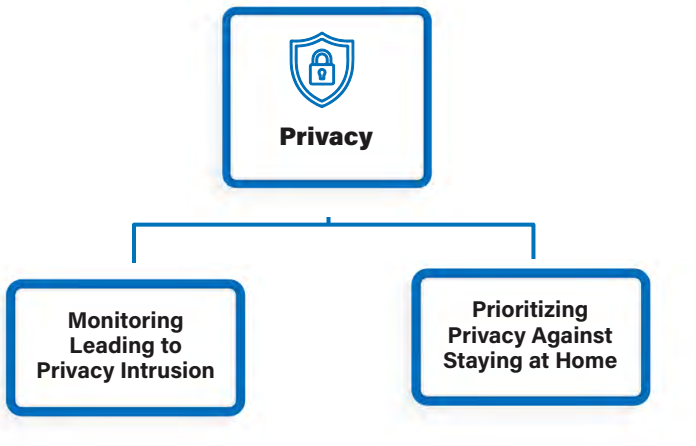
3.2.1 Privacy

The privacy theme is divided into two key subthemes (Figure 1). The first subtheme, "Monitoring leading to privacy intrusion," highlights the impact of surveillance or monitoring practices on personal privacy. Examples in the literature review include being observed returning home at midnight [21] or discomfort with a spouse or another person in the home, who is not a care recipient, being monitored [22]. Interviews with care providers indicated that invasion of privacy continues to be a major concern to be addressed when older adults use monitoring devices. One care provider also noted that a culturally safe approach could provide guidance in implementing AAL technology because culture strongly shapes how older adults perceive privacy and confidentiality, an issue also touched upon in the academic literature [23]. They further highlighted the importance of providing emotionally sensitive care that respects recipients' identities and preferences, especially when they are experiencing cognitive decline.

The second subtheme, "Prioritizing privacy against staying at home," emphasizes the compromises individuals may make when weighing their need for privacy against the requirements of remaining in a home or community setting [21], [24], [25]. Medical doctor and occupational therapist participants also addressed this subtheme, noting that older adults often must balance between preserving privacy and their ability to continue living independently and comfortably at home. The data security dimension of privacy, although often discussed in the literature [22], [26], [27], did not arise organically in the key informant consultations.

Grey literature indicates a "value trade-off" for an AAL system to be acceptable to its users; the health, care, or lifestyle benefits must justify any restriction of older adults' privacy, and AAL use should be completely voluntary [1]. These "restrictions on privacy" may be real or perceived, underscoring the need for communication and transparency. Additional concerns in the literature relate to privacy and feelings of discomfort surrounding digital monitoring and activity surveillance [28].

Figure 1: Privacy-related concerns in the use and implementation of AAL technologies in older adults' homes



3.2.1.1 Use Case 1: Prevention and Management of Chronic Long-Term Conditions



Anna is 84 years old, living independently, and taking multiple medications prescribed by her doctor. She uses a medication monitoring system to record her adherence and manage her prescription regimen. When the system detects non-compliance with her schedule, her daughter, one of her informal carers, is alerted. This use case targets users who require help with instrumental activities of daily living. The advanced medication monitoring (AMM) system may be configured by skilled AAL operators and plays several roles, including providing reminders to care recipients, informing their physicians about compliance, and notifying relevant caregivers about any observed irregularities [20].

Ethical Considerations: Privacy in AAL refers to data privacy and security and to personal privacy from care providers, care partners, and others in the older adults' lives [27], [28]. Improving acceptability of AAL therefore requires understanding what privacy means to older adults and maintaining transparency and open communication [20].

Practical Considerations: Anna's care team should have a strong understanding of her expectations for privacy, including who can access the AMM and receive alerts. This applies to both her formal care providers and her informal caregivers. Before implementing the AMM, Anna must be included in discussions about who should be alerted in cases of non-compliance. Her care team should also consider her cultural context and what information she feels comfortable sharing with her daughter. Independently of Anna's preferences, the AMM must also follow clear and compliant data privacy practices.

3.2.2 Accessibility

The broad theme of "Accessibility" includes subthemes focused on improving access for users with diverse needs (Figure 2). The subthemes address "Device usability issues due to physical limitations," as shown in a review article where a participant's hand tremors made operating a device difficult [29]. Other challenges for users with "Visual impairments impacting device use" included text that appeared too small and the need to keep the screen at its highest brightness setting [29]. All older adult participants also emphasized the importance of "Making technology user-friendly" by increasing device size [29] and providing "Customizable features for accessibility." One example from the literature review involved participants wanting television

sound transmitted directly into their hearing aids [29]. "Unified device controls" also emerged as a desirable feature, indicating the need for standardized controls across devices to improve user experience and accessibility [30]. Additional challenges included offline apps use, such as downloadable maps, smartphones with sound levels that do not accommodate older adults with hearing impairments, and language incompatibility issues.

Grey literature indicated that unintentional exclusion and unequal access to AAL technologies, driven by systemic factors such as economic and social disparities, raise significant ethical concerns [28]. AAL systems should consistently serve users in diverse contexts and with varying abilities, including accommodating declines in cognitive abilities [32].

Participants revealed that assistance from friends and family in using the AAL technologies was important and necessary, specifically with cell phone language settings and the operation of external house security camera. Several older adults highlighted that this support made the technologies more usable and helped them navigate otherwise inaccessible features.

However, one health care provider argued that "cost and affordability," rather than assistance, should remain the primary focus, since seniors are increasingly equipped to use these technologies independently.

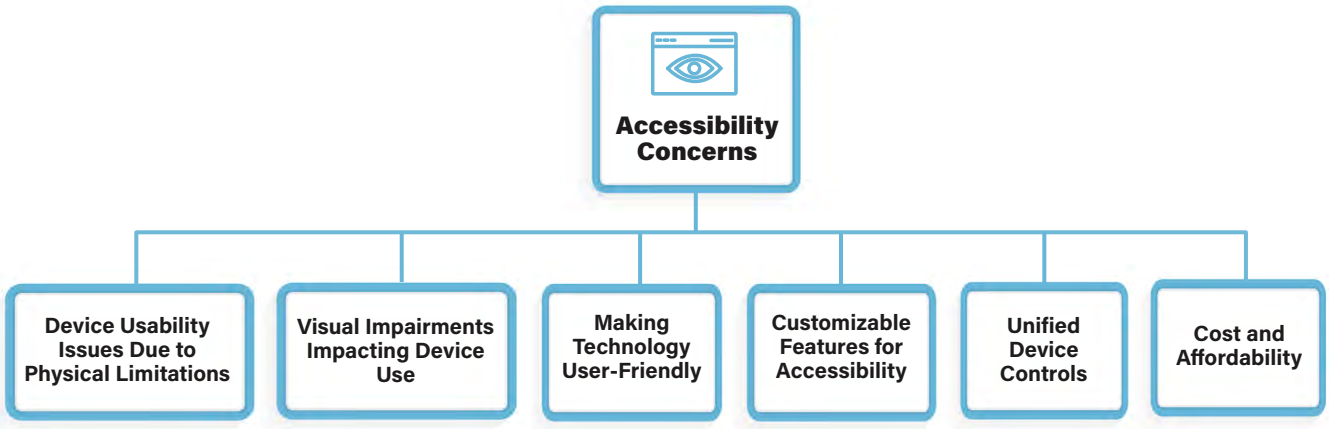
Participants raised financial costs and affordability as substantial concerns, as those with the greatest need for AAL are often least able to afford the devices. For example, the most vulnerable, marginalized, and dependent older adults, who clearly need AAL, struggle to afford newer technologies in their homes. In contrast, independent people with strong health support systems are more likely to afford these devices even when they do not substantially benefit from them. A medical doctor also highlighted the lack of guidance in purchasing decisions, noting that older adults often lack the knowledge and expertise necessary to choose the most appropriate AAL device for their needs.

3.2.2.1 Use Case 2: Smart Wheeled Walker Providing Guidance to Return Home



William is 78 years old and uses a smart wheeled walker to support his mobility, especially when he leaves his home. The walker is equipped with sensors and internet connection. It guides him along his preferred routes and helps him if he becomes disoriented. It also reminds him of appointments, communicates with him in his preferred language, giving him information, answering questions, and offering advice when he

Figure 2: Accessibility concerns in the implementation and development of AAL technologies for older adults' homes



needs it. William has not been diagnosed with dementia, but he does occasionally forget things. The smart walker supports his mobility and orientation and acts as a digital assistant [20].

Ethical Considerations: Among the challenges of independent living is the role of the physical environment, including the purpose of the space and the user's motor and mobility abilities. These physical and accessibility needs shape how older adults adopt and perceive AAL smart technologies [29].

Practical Considerations: William's care team spent time getting to know what he needed most from the walker so they could recommend the right features for him. As they set it up, they chose the language he was most comfortable with and showed him how to adjust other settings on his own. This attention helped him feel more confident using it daily. William was able to afford his smart walker out of pocket, but his care team noted that many other older adults they support would not be able to afford similar devices.

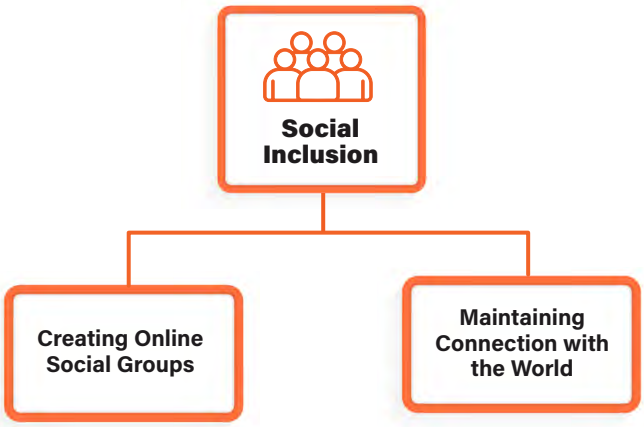
3.2.3 Social Inclusion/Exclusion

This theme is divided into subthemes that focus on fostering interpersonal connections and a sense of belonging in the digital world (Figure 3). The first subtheme, "Creating online social groups," highlights how AAL technologies can support social inclusion by enabling individuals who are isolated at home to form virtual communities and support networks, such as through group calls [29]. The theme also emphasizes "Maintaining connection with the world," helping older adults stay engaged and participate in society despite accessibility barriers or social isolation [29], [32]. Care providers are often part of these social connections, and AAL technologies are intended to complement, not replace, these relationships [5].

The grey literature also noted the risk that AAL devices could overcomplicate users' lives rather than simplify them, or even reduce social interactions that they value [33]. For example, replacing a caregiver who personally dispensed medication with an automated pill dispenser could result in less face-to-face contact [33]. Moreover, an older adult participant discussed using a chatbot for interactions and how it might affect their other social relationships. AAL technologies may unintentionally limit social connections and reduce human contact. And yet another participant expressed concerns about the transparency of technology providers regarding data use and a fear of losing control over personal information.

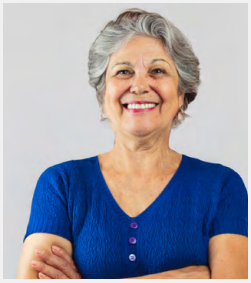
However, according to two care provider participants, a medical doctor and a social worker, AAL technologies can strengthen the relationship between care teams and care recipients. The social worker emphasized the need to avoid dehumanization by prioritizing autonomy over efficiency while integrating cultural sensitivity. However, some literature overlooked the influence of close social networks when adopting AAL smart technologies, citing fears of intrusive surveillance or stigmatization if nearby older adults are not constantly monitored [21].

Figure 3: Social inclusion considerations in the use of AAL technologies in older adults' homes





3.2.3.1 Use Case 3: Social Interaction with Caregivers



Sara is 76 years old and lives independently at home. She faces medical, physical, and cognitive challenges that limit her movement and social interactions and cause her to struggle to attend routine medical visits. Fortunately, she stays connected with family, friends, and caregivers through text, messages, emails, instant messaging, and voice or audio communication tools. Sara's care team encourages regular social interactions to help prevent depression and other negative physical and cognitive effects of isolation [20].

Ethical Considerations: Social inclusion is a key guiding principle for the ethical use of AAL technologies. The availability or absence of social networks either support [29] or hinder aging in place [34]. AAL smart technologies can help socially isolated individuals connect not only through the Internet of Things but also with other smart technologies. In this review, some users participated remotely in courses on dementia to ease their fears, while others joined online or virtual social clubs [29].

Practical Considerations: Sara's care team plays a minimal role in her social network, but supporting these connections is important for her overall care. The team may assist her in navigating technology and tools that enable social interaction. At the same time, it is crucial that the relationships among care providers, older adults, and technology are clear: AAL should not replace human interaction but rather support and enhance the ability of people to provide care.

3.2.4 Self-Determination Versus External Determination (Autonomy)

The central theme of "Autonomy" is broken down into three related subthemes (Figure 4). The first subtheme, "Reluctance to accept assistive technologies," highlights individuals' hesitation to adopt technologies designed to help them [34]. An occupational therapist participant noted a current shift from eliminating risk to supporting older adults in living with acceptable levels of risk, while respecting their autonomy and right to make informed decisions about care.

The second subtheme, "External pressure to use technology," focuses on outside influences or coercion to integrate technology into daily life [34]. Differing comfort levels within care teams, especially around liability, can create external pressure to adopt

assistive technologies and potentially compromise autonomy-centred approaches, according to the same occupational therapist. Older adults also require adequate knowledge about AAL technology to make informed decisions about whether and how to use it.

The third subtheme, "Concerns about intrusiveness," emphasizes worries that these technologies may invade personal space or limit independence [5], [35]. Two participants, an occupational therapist and an older adult, reported that some apps felt intrusive. One older adult and a social worker lamented the loss of dignity that sometimes accompanies medical support, while another older adult expressed a strong desire to retain decision-making authority unless cognitive impairment is present.

The grey literature further underscored the importance of user independence and autonomy. IEC SRD 63416:2023, Ethical Considerations of Artificial Intelligence (AI) When Applied in the Active Assisted Living (AAL) Context [28], recommends that designers and deployers of AAL devices respect older adults' autonomy and avoid limiting movement due to declines in mental or physical abilities [28]. Surveillance systems may discourage behaviours that users enjoy to prevent safety issues [36], effectively removing decision-making about risk from users while alerting caregivers [36].

Whenever possible, AAL users or their substitute decision makers should control who has oversight their personal health information [1]. Data from AAL technologies should not be used in isolation and independent from the end-user [1]. Human dignity must always be maintained, and older adults' perceptions of being controlled by an AAL system should be addressed expediently [1].

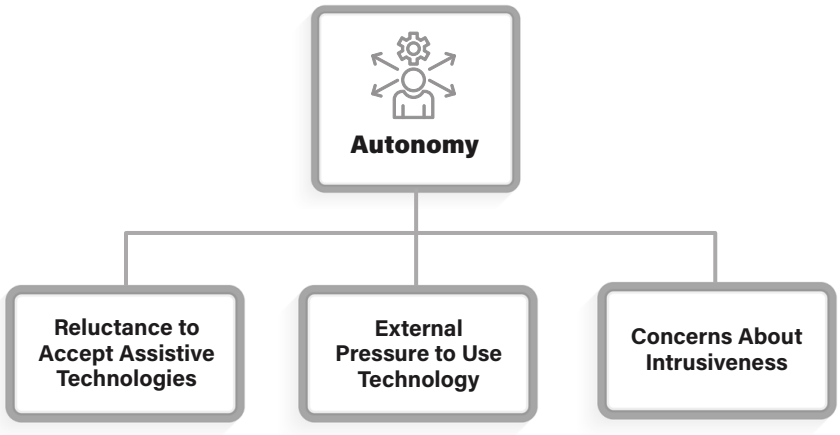
3.2.4.1 Use Case 4: Self-Management at Home



Gita is 73 years old, living alone for the first time, and takes great pride in her self-sufficiency. She faces several health and mobility challenges, and her doctor has advised that maintaining her independence depends on strictly following her medication and physical therapy regimen. To support this, she has been offered technologies and connected phone apps to monitor her adherence. While Gita is willing to follow her doctor's recommendations, she is resisting using the technologies. She thinks they are unnecessary and fears her care team may judge her negatively if they find her adherence unsatisfactory.

Ethical Considerations: In AAL smart technology ecosystems, actors influence the care and well-being of end-users, the older adult population. As the literature shows, autonomy and self-governance

Figure 4: Autonomy *considerations in the use and implementation of AAL technologies in older adults' homes*





"The participatory approach frames older adults as active contributors rather than passive care recipients, resulting in more accessible, user-friendly, and meaningful technological solutions that cater to their requirements."

are highly important for many older adults and their advocates [20], [30]. Independence, self-determination, and choice are integral to applying ethical principles of autonomy in technology adoption.

Practical Considerations: Gita's main concern is that the technology could restrict her autonomy. Therefore, reinforcing the importance of her autonomy and verbally confirm it during the decision-making process is critical. She must not be coerced into accepting the technologies. If she chooses to use them, clear expectations should be set regarding who can access her data and what actions may follow from that access.

3.2.5 Co-Design

The theme "Co-design" refers to a collaborative process in which several interested parties work together to create solutions that reflect real-world needs and circumstances (Figure 5). A key subtheme, "Involving care recipients in technology design," highlights the importance of considering older adults' needs, preferences, and challenges by engaging them repeatedly throughout the development process [30]. This participatory approach frames older adults as active contributors rather than passive care recipients, resulting in more accessible, user-friendly, and meaningful technological solutions that cater to their requirements. Co-design also avoids inappropriate uniformity by acknowledging the diversity of older adults' physical, cognitive, and social needs, thereby fostering equity in design [30]. Occupational therapists also noted that older adults tend to be more receptive to technology that resembles devices they are already familiar with; for example, AAL devices shaped like watches.

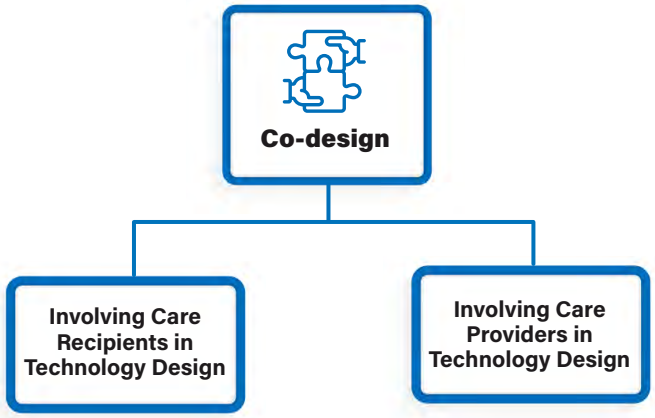
Co-design extends beyond care recipients to include care providers. The academic literature highlights the role of care providers, particularly nurses, as domain experts who can guide technology development to better support older adults [5], [26]. Because care providers' roles may change with the introduction of these technologies, ongoing collaboration is necessary to ensure that the solutions stay relevant to their work [5], [24], [37].

3.2.5.1 Use Case 5: Co-Designed Intelligent Apartment for the Elderly



Henry is 71 years old and recently retired. He now lives independently in a personalized smart home equipped with a telemonitoring system. The system tracks his biometric parameters, conducts routine health check-ups, and includes an internet-connected drug cabinet that records medication adherence and sends reminders as needed. His home security is linked to the smart home system. An alarm can alert his family and the residential home's head office to any unusual activities and responds promptly [20].

Figure 5: Ethical benefits of co-design in AAL technologies for older adults



Ethical Considerations: As highlighted in the review, AAL smart technologies without co-designed can pose greater risks, especially if usability and accessibility are not carefully considered [30]. Technology-induced anxiety is a poor indicator of successful aging in place. Developers and designers should therefore incorporate user feedback during pilot testing and future iterations [30].

Practical Considerations: Henry's smart home was designed around his preferences and needs, such as medication reminders and intelligent home security. This approach reinforces his role as an active and involved decision maker. At the same time, he benefits from his care team's guidance on technologies suited to his lifestyle, while the care team gains valuable insights from Henry on what works well and what does not.

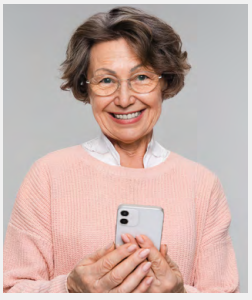
3.2.6 Safety and Security

Figure 6 highlights the theme "Safety and security" and its connection to a key subtheme. The main subtheme here, "Staying at home safely because of assistive technology," reflects the desire to remain in a familiar or highly independent environment and how technology can support safety and security. According to the literature, the vast majority of older adults prefer to age in place at home [35].

Care provider interviews revealed that security features help older adults avoid institutionalization while using empirical data to monitor mental state at home, which is not always possible through in-office assessments. Grey literature consistently emphasized that both user safety and data security are essential for effective aging in place [1], [20], [28], [31], [36], [38], [39]. These findings suggest that older adults prioritize feeling secure and maintaining safety while leveraging technology to live independently.

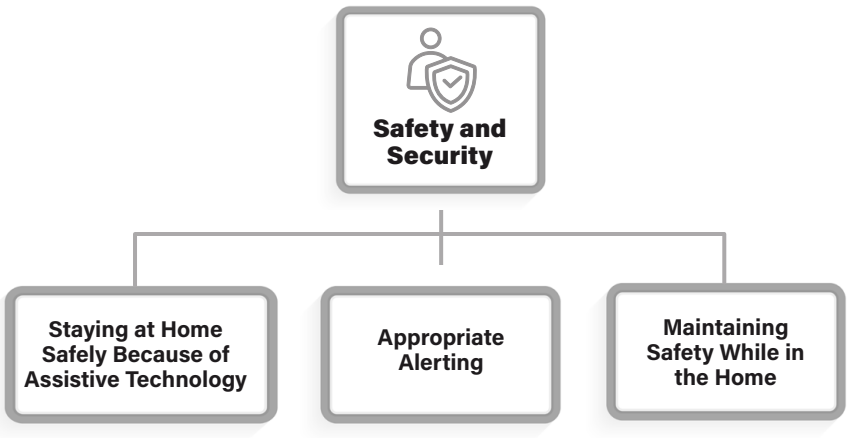
Academic literature and key informant consultations also highlighted the importance of "Appropriate alerting," meaning reliable alerts when action is required [22], [26], [40]. Alerts are desirable for immediate emergencies, such as medical incidents or falls [23], [25], [26], as well as for deviations in health and behavioural patterns that may indicate a need to adjust the care plan [26], [37]. These concepts form the broader theme of "Maintaining safety while in the home" and the confidence that older adults can continue living independently, as emphasized by care provider participants.

3.2.6.1 Use Case 6: Behaviour Monitoring and Alerting at Home



Olga is 82 years old. She has mild cognitive disabilities and lives in a naturally-occurring retirement community in a condo she owns. She uses an AAL system that detects and responds to potentially unsafe situations based on changes in

Figure 6: Safety and security considerations in the use and implementation of AAL technologies in older adults' homes



her routine, which she has agreed to mostly out of a desire to remain in her home rather than move to long-term care. If Olga falls and cannot get up immediately the system alerts an emergency call service. It also notifies her on the television she usually watches when she forgets something, like a pot on the stove. Her nephew and care team receive all notifications and emergency alerts, but the system is configured so that only her nephew is notified when her behaviour patterns change [20].

Ethical Considerations: In this context, AAL smart technologies can support behavioural change by providing access to data points that motivate the user to improve their health actively [30]. A reliable system must be transparent, accountable, and responsive to end-user feedback [21]. This responsive approach helps uphold ethical principles like respect and beneficence.

Practical Considerations: Olga's AAL system is designed to help her remain mostly independent. It provides both proactive support—responding to changes in patterns of behaviour that could point to decline—and reactive—responding quickly to a fall—to minimize the impact of adverse events on her health. While the AAL system supports monitoring, it is still necessary for both Olga's formal and informal care partners to respond appropriately and establish next steps.

3.2.7 Stigmatization and Alienation

The theme "Stigmatization and alienation" explores the feelings of exclusion or marginalization individuals may experience when using AAL technologies due to factors such as societal biases (Figure 7). The two subthemes identified through the literature and consultations, "Avoiding unwanted attention" and Not wanting to be different," describe how older adults encounter this exclusion [21]. "Avoiding unwanted attention" reflects the desire to avoid judgment or scrutiny. "Not wanting to be different" underscores the fear of standing out in ways that could lead to social rejection or being labelled as "other;" or, as many older adults worry, as especially dependent or "frail" [35], [29]. To help mitigate this, the literature review suggested that if AAL technologies are offered, they could be installed in all units of a facility to prevent singling out individuals [21].

The grey literature, including the 2024 guide for assistive technology by Age Space and the 2021 European Cooperation in Science and Technology report [21], [33], also noted that many users perceive AAL devices and sensors as amplifying their frailty and causing discomfort when used in public. An occupational therapist participant added that conventional monitoring technologies can be visually intrusive and may stigmatize recipients; for instance, visible alarm devices can signal that a person is frail. As such, it is often preferable to select AAL technology options with sleeker or more discrete form factors.

3.2.7.1 Use Case 7: Discreet and Transparent Monitoring



Sam is 82 years old and recently moved into a retirement community after his children became worried about his physical safety at home. His doctor is concerned about his risk for falls and heart attack, and Sam's children have encouraged him to use AAL devices that can alert his caregivers in an emergency, such as a motion and proximity sensors or a wearable fall detector. Sam feels uncomfortable with the idea, however. He dislikes the thought of being seen as frail, and he is unsure how he feels about being monitored throughout the day.

Ethical Considerations: Many examples of AAL implementation illustrate the internal struggle older adults face as they try to protect their health without feeling stigmatized [21], [33]. These tensions can be strongly felt for marginalized groups, who may have additional reasons to worry about bias or to distrust monitoring.

Practical Considerations: To help reduce Sam's concerns about being perceived as frail, he could have been offered discreet technologies, such as a smartwatch, that do not visibly signal assistance. Ongoing conversations among Sam, his care team, and his children are critical to clarify how his data will be used, who will have access, and how Sam can adjust these preferences over time.

4 Recommendations for Standardization

This research project aimed to expand the best practices for implementing AAL technologies across the continuum of care for older adults, with a focus on ethical considerations identified by older adults and care providers in Canada. At present, there are no standardized best practices grounded in a user-led and user-informed approach to designing and deploying AAL technologies for older adults. Drawing on insights from the literature review and interviews, this report contributes to the development of standards relevant to older adults' care contexts.

The findings showed that although AAL technologies offer clear benefits, supporting aging in place, prolonging independence, and improving well-being, their acceptance and adoption are limited due to the absence of ethical guidelines for implementation. Both the literature review and interviews highlight the need for AAL technologies that are accessible, inclusive, familiar, and safe, while upholding users' autonomy and privacy. Clear guidelines are necessary to ensure AAL technologies can operate ethically, so as not to reinforce existing adoption barriers or further marginalize vulnerable groups.

To improve real-world impact and encourage wider use, this report offers preliminary suggestions to help shape guidelines for how AAL technologies are used, put into practice, and designed across the continuum of care. AAL technologies should be accessible and inclusive, protect users' autonomy and dignity, reduce

Figure 7: Stigmatization and alienation fears for AAL technology use in older adults' homes



surveillance and data-misuse risks, and help people stay socially connected without compromising safety. This project shows why future AAL standards must embed ethical principles and creates an opportunity to guide AAL technologies toward being safe, efficient, inclusive, empowering, and aligned with diverse lived experiences of older adults in Canada.

The perspectives of care recipients identified in the literature also align with Zhu and colleagues' systematic review [19], which noted the need for an accompanying ethical framework to support the sustainable development of smart, home-based elderly care [19]. Through our analysis of use cases [20], we offer the beginnings of such a framework, rooted in empirical evidence, though based on a small sample that should be expanded in future work [2]. Zhu and colleagues argue for involving nurses in the design and implementation of AAL technologies, which can lead to more ethical practices [19], while we further advocate for the co-design of these technologies with care recipient themselves.

Finally, the rapid review focused on identifying standards related to training providers in AAL technology, resulting in three relevant standards. Their content aligns with the themes generated through the literature review and key informant consultations, as outlined in Table 4.

Co-creation was not considered in this context, as it falls outside the scope of AAL providers' training. However, it is a valuable dimension for AAL technology developers to consider.

Despite these overlaps, the identified standards did not address several key themes, highlighting an opportunity to improve provider training. The first theme, "Autonomy," appears in ISO/TR 25555:2024 [15], but the existing standards do not fully consider older adults' concerns about using assistive devices. Standards could strengthen this area by including training, as it could help providers understand why older adults may hesitate to adopt assistive technologies, improving service delivery and supporting autonomy.

The second theme, noted in the previous section, is the need for specific guidance on "Co-design" and how best to integrate older adults into the technology design process. It is also helpful to consider how members of older adults' circles of care can participate in this process, either as contributors or facilitators. Related to this is the third theme, "Stigmatization and alienation," which the identified standards do not address in the context of AAL environments. Providers would benefit from training on how to implement AAL solutions in ways that avoid "othering" older

Table 4: Existing standards and guidelines for AAL guidance and training

Standard/Guideline	Theme(s) addressed	Alignment
IEC SRD 63314:2024 Active assisted living (AAL) guidance for education and training of persons working in the field of AAL	Safety and security, accessibility, privacy	Highlights improving the competencies of AAL providers to understand the principles of safety and security in AAL environments, guides AAL providers on factors contributing to accessibility in AAL systems, and trains providers in the ethical handling of private information.
ISO/TR 25555:2024 Ageing societies – Accessibility and usability considerations for home health care products, related services and environments	Accessibility, autonomy	Focuses on accessibility and usability of products in the home health care environment, providing design considerations that support independence and autonomy for older adults and improve usability for non-professional users.
ISO 13131:2021 Health informatics – Telehealth services – Quality planning guidelines	Safety and security, privacy	Focuses on assessing risks and implementing mitigation strategies in the context of telehealth, which enable older adults to receive care in their lived environments while addressing safety and privacy concerns.



adults; that is, framing them as passive, dependent, or fundamentally different from other users. Case studies and real-world examples could help providers recognize and mitigate systems that contribute to stigmatization and alienation.

A fourth theme is "Social inclusion and exclusion." Standards may help structured approaches that help providers assess AAL systems and identify features that may lead to exclusion. Targeted guidance could include recommendations on form factors to make AAL technologies and systems more discrete and advice on evaluating AAL-related communication for transparency and tone.

Interviews with older adults culminated in a question about which AAL functions they hoped to see expanded or added. Designing AAL for accessibility emerged as the most prominent function. The standards described above, along with general accessibility standards such as CSA/ASC B652:23 for built environments [41] and ISO/TR 25555:2024 for home health care products and services [15] exist but they do not cover all the accessibility dimensions identified by participants. Participants conveyed their interest in features such as glasses with spatial map projections and improved physical and hearing accessibility. In general, existing standards address physical and visual disabilities well, but provide less guidance on device support, customizability, and affordability.

Beyond accessibility, participants identified additional AAL features that could benefit from stronger standardization. They highlighted the social functions of AAL, including AI chatbots and voice activation. Standards such as ISO 13482:2014, Robots and Robotic Devices [42], address physical safety, but a similar approach could help develop requirements for social and emotional safety.

Interactivity also emerged as a priority, both in relation to accessibility and to users' desire for meaningful engagement with others. Several participants expressed a preference for one-on-one training instruction over group sessions.

Finally, participants emphasized co-design and ethical-by-design approaches. Co-design should be a core requirement for all AAL technologies, and standards could specify minimum expectations for end-user engagement. ISO 9241-210:2019, Human-Centred Design Processes for Interactive Systems [7], offers a useful foundation for adapting such requirements to older adults' needs. Strengthening these elements would expand the reach and relevance of AAL.

5 Directions for Future Work

This research examined older adults' perspectives on how effectively and ethically AAL systems may be implemented and used, supported by insights from care provision and practice. While this report focused on older adults due to the particular potential of AAL to benefit this population, other user groups should also be considered. For example, future work may explore how best to develop AAL solutions for younger adults and persons with disabilities.

During interviews, some care provider participants raised questions of cultural safety and sensitivity, topics rarely explored in the reviewed literature. This gap suggests a need for more research on the ethical implementation of AAL among racial and cultural minority groups to better reflect the multicultural reality of older adults in Canada and inform standards development.

This rapid review and empirical study also highlighted gaps in the preparedness of care providers to integrate AAL into their work. As discussed here, care providers will need to know how to use the technologies themselves and to help care recipients understand and use them. Future standards and guidelines should reflect this dual role and identify opportunities to support it through professional training and clearer guidance from manufacturers. This will ensure that health professionals have the necessary resources to integrate AAL into their practice.

It would also be valuable to further explore how technology developers and providers can be supported in developing ethical AAL. Among the ethical considerations discussed, accessibility, co-design, and stigmatization are particularly relevant, with stigmatization especially underexplored as an issue developers might address. Given recent advancements in AI and its evolving role in AAL technologies, future work should also examine the ethical implications of AI in older adult care and how it can be used responsibly.

Further, the sample of the empirical study was limited by time and resource constraints. All participating older adults were college- or university-educated, lived in specific urban geographical areas, and did not necessarily represent the ethnic, cultural, or socioeconomic diversity of the Canadian population. Subsequently, ethical concerns more salient for marginalized groups may therefore be underrepresented.

Finally, only a limited number of care provider disciplines participated, despite efforts in the literature search to capture a broad range. Thus, this research should be viewed as an early exploratory step in developing best practices. Additional targeted work is necessary to ensure that standards and guidelines reflect real-world use cases. Future studies may benefit from specifically recruiting participants with lower education levels, individuals from marginalized groups, and people living in a wider range of environments. And further research with family caregivers and person-based care disciplines is also recommended.

6 Conclusions

This report aimed to synthesize the perspectives of older adults from the published literature, grey literature, and consultation in Canada to inform best practices for implementing AAL systems. The research project systematically identified relevant perspectives by surveying existing grey literature for standards and guidelines with explicit ethical considerations. Key ethical considerations included privacy, accessibility, social inclusion and exclusion, autonomy, co-design, safety and security, and stigmatization and alienation, which were explored through fictional use cases.

The recommendations for standards-based solutions summarized ways to support older adults in living independently for longer with varying levels of ability. They outline approaches to prioritizing ethical implementation, improving accessibility, and better preparing care providers for AAL-enabled care. Continued research in AAL will be essential to help ensure that AAL products and standards remain relevant for older adults and care providers and reflect the diversity of lived experience and professional practice.

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