

A Review and Assessment of Advanced In-Home Activity-Monitoring Systems for Older Adults

Aging and Adult Services Division

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A Review and Assessment of Advanced In-Home Activity- Monitoring Systems for Older Adults

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We have also benefitted immensely from the support of our science consultant at the University of Minnesota, Dr. Joseph Gaugler, who guided us toward relevant research, helped us identify potential key informants, and consulted with us on a range of issues that relate to the function, use and acceptability of currently available technology.

Finally, we are grateful to have excellent colleagues at Wilder Research who helped us to sort through the wide range of current studies, organize content, and develop this report.

Executive summary

Key findings

In 2017, the Minnesota Legislature appropriated \$40,000 for a grant to a local research organization to create a report on Advanced In-Home Activity-Monitoring Systems (AIHAMS).

On October 3, 2017, the Department of Human Services awarded \$40,000 through a competitive Request for Proposals process to Wilder Research for FY 2018. In compliance with the terms of the authorizing legislation, Wilder Research is:

“...a local research organization with expertise in identifying current and potential support systems and examining the capacity of those systems to meet the needs of the growing population of elderly persons to conduct a comprehensive assessment of current literature, past research, and an environmental scan of the field related to advanced in-home activity-monitoring systems for elderly persons. The commissioner must report the results of the assessment by January 15, 2018, to the legislative committees and divisions with jurisdiction over health and human services policy and finance. This is a onetime appropriation.”

Wilder Research’s review shows that Minnesota is already moving quickly to identify ways in which advanced in-home activity-monitoring systems (hereto forward referred to as AIHAMS) can be used to bolster opportunities for aging in place. Efforts have been underway for more than five years to apply this technology through the Live Well at Home grants to service providers, the federally-approved remote monitoring services available across the disability home and community based waivers, and through Senior LinkAge Line® service protocols for fielding consumer questions. The following is a summary of key findings identified through this review.

- There is a steep growth in new monitoring and sensing technologies and applications of AIHAMS that support older adults in their homes. The growth of this field has been stimulated by 1) the unprecedented growth of the older adult population around the world, 2) the high cost of institutional- and facility-based care, and 3) the advent and everyday use of monitoring and sensing technology through the development of smartphones, GPS technology, and other wireless communication systems.

- Individuals and families in Minnesota have begun using various technologies to support aging-in-place for older adults. Currently, there is incomplete data on the breadth and scope of AIHAMS technology use in Minnesota, and most experts note that its use is still somewhat limited. However, several State of Minnesota-funded projects have made access to some of this technology possible.
- Technologies in use by family caregivers now include fall alert devices (mainly activated by the wearer), motion and position detectors (for security or wander prevention) and sensors attached to locations like beds, stoves, toilets, lighting, and medication dispensers. However, newer and more integrated AIHAMS are being developed and marketed now that are able to interpret functional changes over time, sense gait changes that may signal future falls, learn usual patterns of behavior, facilitate communication with family members, integrate information from other devices, and alert caregivers to possible problems. Because of rapid developments in both the sophistication of the devices as well as the integrating platforms, older technology can become outdated quickly.
- Commercial interest in product development and promotion is strong. Much of what is being promoted to support family caregivers has not been tested in any rigorous way that establishes clear and beneficial outcomes for device users and their caregivers, although there is considerable anecdotal testimony describing benefits. Companies like Best Buy, Inpenda, and Lowe's, among others, are vying for a share of the consumer market related to integrated AIHAMS technology. Much can be learned during the next few years by observing how the technology is received by older adults and family members, and how it influences future decision making regarding the use of these and similar applications.
- There are multiple criteria now being used to assess the impact and value of AIHAMS technology. Typical criteria used for establishing benefit related to the use of advanced monitoring devices include (but are not limited to):
 - Accurate detection of changes in the health status or function of the person being monitored
 - Increasing length of stay at home
 - Reducing ER or hospital admissions or readmissions
 - Detection of health changes prior to a precipitous decline or crisis
 - Reduced caregiver stress or increased caregiver confidence
 - Enhanced quality of life

- The evidence base for establishing benefits derived from AIHAMS technology is modest, but growing. Although few technologies have been tested in rigorous clinical trials, those that have been tested show some promise of benefit. Evidence of benefit is best for the use of passive technology intended to detect changes in functional status, movement, medication compliance, or enhance safety. Evidence for establishing a net benefit to caregivers is currently weak but growing as studies expand and become more rigorous.
- There is concern regarding privacy and unauthorized access to health information based on wireless transmission of data. Experts suggest that no system is completely foolproof in this regard. Many community-based service providers are cautious about the potential invasiveness of technology and its use in private spaces like bathrooms and bedrooms. Home and community-based disability waiver services have parameters that describe allowable use. An example of these parameters is included in the “Current Reimbursement” section of this report. Consumers, too, are cautious of what information might be accessible based on technology installed in their homes. In addition, the practical and legal basis for the use of AIHAMS technology by caregivers whose care recipients are in facility-based settings is a subject of recent interest and controversy.

Issues to consider

The following considerations are worthy of attention as the work to harness the value of AIHAMS technology continues.

1. Are we keeping the work person-centered? Are we doing all that is necessary to clearly understand the views and interests of older adults and their caregivers as we seek to support the use of various AIHAMS in the home?
2. Will county and state service systems be able to provide the customized assessments, supports, and follow-up necessary to effectively serve the demand that is likely to be encountered as the population of low-income older adults continues to grow, and as AIHAMS technology becomes more effective and reliable.
3. Will the broadband infrastructure of our state support applications of AIHAMS in more rural areas of Minnesota where it could be especially useful, but where it is more costly to provide services in the home, simply because of geography and the presence of fewer service providers?
4. Can the perspective, knowledge, and service capacity of the home and community-based service providers across the state be effectively marshalled in a way that can support the growth of AIHAMS strategies?

5. Can AIHAMS technology be made more useful to older adult “solos” – those without support networks like families and friends? If so, what arrangements would be required to engage health care providers, promote monitoring by trusted intermediaries, and support the use of health care decision-makers and advanced directives?
6. Do we have adequate opportunities for collaboration and communication across state service divisions related to the investigation, application and use of AIHAMS technology? Will current policies and protocols be adequate to ensure that staff members are aware of relevant work outside of their own divisions and able to stay abreast of relevant technology innovations as they emerge?
7. How well do current and emerging AIHAMS technologies work, what additional research is needed to have a credible evidence base, and how will the State determine which AIHAMS technologies should be discussed and considered for wider use to support a rapidly growing aging population?
8. How do the experiences, expectations, and needs of older adults in communities of color vary from those in the dominant culture communities? What will need to be done to address diverse needs? Is there capacity to reach these older adults in a variety of languages?
9. How will we provide affordable technology applications to older adults who already have limited access to technology due to their low-income status?

Recommendations

This review of recent research, relevant products, market analysis, expert opinion, and current practice regarding AIHAMS technology has raised a range of potential issues and opportunities. Given the purpose of this work – to inform policymakers of the current landscape regarding this technology and identify areas in which action may be useful – we offer the following recommendations.

- **Raise awareness and build knowledge.** There is general agreement that more work is needed to help older adults learn about and understand the AIHAMS available to support aging-in-place. The technology available is not well understood, its application for use in homes to support family members who care for an older adult is often not recognized, and more could be done to increase awareness among older adults and their families about the potential of this technology for supporting the care of older adults. Wilder recommends a public information and awareness campaign (similar to the one recently conducted for caregivers in Minnesota) to help older adults and their caregivers connect independence and autonomy with the potential benefits of AIHAMS and related technology. It is further recommended that this campaign provide easy access to information for family members through a telephone call or website visit.

- **Customize support and offer follow-up assistance.** Multiple experts emphasized the need to individualize planning for the use of AIHAMS technology by older adults and family caregivers, and assure that person-centered choices can occur. Experts also emphasize the need to provide an adequate amount of training and follow-up once the technology is deployed. Initiatives that do this have maintained a high retention rate among both users and family caregivers. This will be an essential strategy in further promoting the use of AIHAMS among health-compromised older adults and their families. Additionally, attention to the diverse needs and expectations of older adults and families, including those in rural, low-income, and ethnically and racially diverse communities, will be an important consideration.
- **Build on projects with a track record.** The Minnesota Department of Human Services, with funding from the Minnesota legislature, has supported the use of AIHAMS, including efforts to link the technology to assistive devices, for at least five years. This has primarily occurred through independent demonstration projects with home and community-based service providers through Live Well at Home grants supported by the Aging and Adult Services division. In addition, the Minnesota Department of Administration operates a federally funded program called System of Technology to Achieve Results (or STAR) to help people with disabilities and age-related functional needs gain access to assistive technology.

The Aging Services Division and the Minnesota Board on Aging are well positioned to capitalize on the knowledge base created by these and other projects to increase the number of older adults who can be served with appropriate AIHAMS technology. It is worth exploring how these efforts can be amplified and how the Senior LinkAge Line® might play a greater role in connecting callers to potential on-ramps for technology-related services.

- **Invest in new demonstration projects.** Service providers, researchers, and commercial interests are clearly interested in expanding the range of technology available to assist older adults and their caregivers. The state should consider establishing criteria for funding demonstration projects in this area with strong evaluation components. Similar efforts in Missouri are now reaping rewards in both home care and assisted living settings, and one of the leaders of these projects (M. J. Rantz, personal communication, November 16, 2017) has offered to provide in-person consultation to Minnesota lawmakers.

- **Continue to invest in rural broadband.** Rural communities in Minnesota could be among the most likely to benefit from the application of AIHAMS technologies. This may be critically important where people are isolated from friends or relatives, or live a significant distance from available health or home service providers. Most AIHAMS technology requires access to high-speed internet, and alerts to families or service providers may be interrupted or delayed by inadequate internet speeds. Continuing investment in rural broadband has many potential benefits for the state, not the least of which may be in supporting the needs of frail and functionally declining older adults.

- **Conduct an assessment of facility-based applications of advanced activity-monitoring system.** Recent high visibility reporting of conditions encountered by older adults and their families in Minnesota's skilled nursing and assisted living facilities has made it clear that it is difficult to effectively monitor the circumstances of the more than 85,000 adults currently cared for in these facilities. What role might advanced activity-monitoring technology serve in supporting older adults who can no longer be cared for at home? Learning what is now being done in some facilities through monitoring and sensing technology, and what may be possible in the future, could be extremely helpful as demand for services grows, as the demographic data suggests. It will also be important to establish the practical and legal basis for the use of advanced activity-monitoring technology by caregivers whose care recipients are in facility-based settings.

- **Develop an ongoing system for gathering information from both caregivers and care recipients who have experience using state and county-funded AIHAMS technology.** In order to learn more about how best to move forward to empower family caregivers using this technology, it would be useful to gather routine feedback from those who are using or contemplating using advanced in-home activity-monitoring devices. There is currently no well-developed and reliable feedback mechanism to learn from the experiences of family caregivers who have chosen to adopt this technology, nor is there a process in place to assess long-term benefit outside of controlled studies conducted by academic institutions.

Legislation

The authorizing legislation supporting the production of this report is described below.

Session Law 2017, Article 18 Appropriations Section 1. Health and Human Services Appropriations, Subd 27. Grant Programs; Aging and Adult Services Grants

(b) **Advanced In-Home Activity-Monitoring Systems.** \$40,000 in fiscal year 2018 is for a grant to a local research organization with expertise in identifying current and potential support systems and examining the capacity of those systems to meet the needs of the growing population of elderly persons to conduct a comprehensive assessment of current literature, past research, and an environmental scan of the field related to advanced in-home activity-monitoring systems for elderly persons. The commissioner must report the results of the assessment by January 15, 2018, to the legislative committees and divisions with jurisdiction over health and human services policy and finance. This is a onetime appropriation.

Introduction

Background

During the 2017 Minnesota Legislative Session, the State of Minnesota allocated \$40,000 in one-time funds to the Department of Human Services (DHS) to contract with a local research organization to scan the environment of AIHAMS technology, review professional literature, and identify and examine relevant state-funded projects in order to develop a more comprehensive understanding of the rapidly changing AIHAMS technology that may help older adults remain at home and avoid the need for premature institutional care. It is presumed that these technologies will become increasingly important as the state's population of older adults increases (more than doubling by 2030), and as the growing number with chronic health conditions or disabilities makes greater demands on service systems throughout the state. Wilder Research was selected to conduct the review and prepare a report for the legislature regarding findings and recommendations by January 15, 2018.

The last two decades have produced a wide range of innovations in AIHAMS technology — often combined with electronically connected assistive devices — intended to provide information to both family and professional caregivers regarding the health and well-being of older adults who remain in their homes despite frailty, disability, illness, or other health limiting conditions. It is safe to say that the rapid adoption of digital and hand-held technology, especially smartphones, along with a wide range of related applications (including wearable monitoring devices), has created a virtual explosion in the range of choices available to the public. A recent market-watch publication has shown a surge of venture capital being invested in the creation of a range of new technology, including AIHAMS devices. Funding has supported the application of available technology, product innovation, and greater market analysis and market penetration strategies (Orlov, 2017). Given the range and diversity of this technology, it is often difficult for potential users to identify the best applications and strategies for effectively supporting the older adults for whom they care.

MN2030, the joint initiative between the Minnesota Board on Aging (MBA) and DHS seeks to challenge policy makers and the general public to create innovations and take action in order to support older adults to live fulfilling lives. This initiative builds on earlier work documented in reports by DHS, *Reshaping Long-Term Care in Minnesota* (2001), and the Minnesota Department of Health, *Updating Minnesota's Blueprint for Public Health* (2010).

One of the primary strategies in the MN2030 report advised further investment in technology that could help older adults remain independent. The Live Well at Home grant program has responded by funding home and community-based service programs, including those that implement remote activity monitoring, medication monitoring, and engagement technologies. A recent report, *Technology and Home Modifications to Help Older Minnesotans Live Well at Home* (Minnesota Board on Aging, 2017), highlights some of the current technologies and innovations available to older adults and further urges continued attention to opportunities for growth.

This report seeks to provide an up-to-date review and classification of in-home monitoring technology, assess current applications supported by the State of Minnesota's Department of Human Services, review current issues arising from its use, and examine evidence of product usefulness, acceptability, and benefit.

Definitions

The professional literature related to technology that supports older adults to remain at home and avoid the need for premature and costly institutional care uses several terms interchangeably. Ambient Assisted Living (AAL) is currently the most widely recognized, broad term, and refers to the global, emerging technology that combines products and services to support older adults who wish to live independently in the community, as well as to the informal caregivers who assist them. AAL encompasses a variety of applications that can be implemented to evaluate, detect, monitor, prevent, and respond to medical conditions and circumstances, and assess safety, as well as promote quality of life and well-being for older adults.

Other related terms include telehealth, telecare, electronic assistive technology, smart home technology, and tele-monitoring. Telehealth primarily refers to remote telecommunications technology specifically connected to health-related information and health care providers, and may involve remote health visits, remote physiological monitoring by professionals, and the response to patient data by trained health professionals. Telecare typically refers to a range of equipment, devices and sensors, used by informal caregivers to support the needs of family members or friends. Electronic assistive technology typically refers to applications that provide assistance in the home and community through strategies other than passive monitoring. Smart home technology generally refers to residential installations in which appliances, lighting, heating, air conditioning, TVs, computers, entertainment audio & video systems, security, and camera systems can communicate with one another and can be controlled remotely. Tele-monitoring is a more general term that means any information technology used to monitor patients at a distance.

In the authorizing legislation for this report, the State of Minnesota has used the term Advanced In-Home Activity-Monitoring Systems (AIHAMS) in its description of the applied technologies and related policies that support older adults and caregivers. This term encompasses telehealth, but is more narrowly focused than AAL; it is closely related to telecare in its involvement with informal caregivers. Although AIHAMS technologies may include aspects of telehealth, its focus is the range of strategies specifically intended for the use and benefit of family caregivers and their care recipients, as well as for the use of home and community-based service agencies that help families to identify, assess, and implement these technologies with the goal of ensuring greater safety and well-being for the care recipient. It is this term — Advanced In-Home Activity-Monitoring Systems or AIHAMS — that is the focus of this report.

Classifying advanced in-home activity-monitoring technology

The rapid expansion of the AIHAMS technology field has led a number of researchers to create classification systems for organizing and describing the range of advanced in-home activity-monitoring devices available in the market place. Figure 1 describes an organizing set of categories that are now being used by multiple researchers to describe the current range of technology available to support older adults at home. (Demiris, 2015; Demiris and Hensel, 2008)

Given the alignment of the scope of this review and the classification scheme offered below, the Demiris, et al. (2015) classification scheme, with minor variations, will be used as the organizing framework for this report to illustrate the range of available in-home monitoring and sensing technology.

Another classification scheme developed by Schulz, et al. (2015; Figure 2) has a broader scope that describes the wide range of intersections between available and emerging technology and the potential needs of an aging population. This model may help readers to envision the broader applicability and expanded range of functions to which these and related technologies might be applied.

1. Smart-home functionalities and implications for caregiving

Functionality	Definition	Implications and caregiving
Physiological monitoring	Collecting and processing physiological measurements such as vital signs of pulse, respiration, temperature, bladder and bowel output, etc.	Providing summary data sets describing physiological status to inform care coordination, preparation of meals, and symptom management
Functional monitoring	Collecting and processing functional measurements such as general activity level, motion, gait, meal intake, and other activities-of-daily-living	Informing potential interventions to reduce environmental elements that pose a fall risk, determining need for assistance with personal care and daily activities
Safety monitoring	Collecting and processing measurements that detect environmental hazards such as fire or gas leak. Safety assistance includes functions such as automatic turning on/off bathroom lights when getting out of bed, facilitating safety by reducing trips and falls. Location technologies including global-positioning system (GPS)-based tracking aimed at safety also fit into this type	Providing peace of mind for caregivers
Security monitoring and assistance	Enables measurements that detect human threats such as intruders. Assistance includes responses to identified threats	Provides peace of mind for caregivers and enables them to adjust their schedule if loved one needs to be briefly unattended
Social interaction monitoring and assistance	Collecting and processing of data pertaining to frequency of social interactions such as phone calls, visitors, and participation in activities. Social interaction assistance includes technologies that facilitate social interaction such as video-based components that support video-mediated communication with friends and loved ones, virtual participation in group activities, etc.	Providing virtual presence for remote/distant caregivers, informing interventions to increase social interactions and facilitating the engagement of other family members and friends who can participate in group discussions and activities
Cognitive and sensory assistance	This feature supports automated or self-initiated reminders and other cognitive aids such as medication reminders and management tools, lost key locators, etc., for users with identified memory deficits. Cognitive assistance applications also include task instruction technologies such as verbal instructions in using an appliance. Sensory assistance includes technologies that aid users with sensory deficits such as for sight, hearing, and touch	Assist caregiver with medication administration, coordination of tasks, and assistance with instrumental activities of daily living

Note. Reprinted from "Information Technology to Support Aging: Implications for Caregiving," by George Demiris in *Family Caregiving in the New Normal*, edited by Joseph E. Gaugler and Robert L. Kane, p. 215. Copyright by Elsevier, 2015.

2. Technology applications to important life domains

Technology functions	Life domains				
	Physical and mental health	Mobility	Social connectedness	Safety	Everyday activities and leisure
Monitoring/measurement (person, environment)	Physiological functioning (e.g., heart rate, blood pressure, and oxymetry), affect, health behaviors	Speed and variability of gait, distance covered, vestibular functioning, driving behavior, daily exercise	Frequency and duration of mobile and fixed communication device uses; frequency and duration of time in direct communication with other humans; frequency and time spent in social settings	Frequency of falls, location, driving ability	Frequency, accuracy, and speed of daily task performance; frequency and duration of leisure activities
Diagnosis, screening	Clinical conditions, risk status for clinical conditions	Risk for falling; ambulatory ability, adequacy of daily physical exercise	Social isolation, social integration	Emergency situation, being lost, at risk for driving accidents	Critical cognitive functioning, critical ADL/IADL status
Treatment, intervention (compensation, prevention, enhancement)	Remote behavioral treatment, chronic disease management, prevention and wellness interventions, clinical decision support	Guidance assistance, risk mitigation (e.g., risk of falling), encouragement and support for exercise	Enhanced social integration, connectivity through computers/communication technologies	Emergency response systems, computerized driving assistance, alert systems	Task assistance or training, entertainment, education

Note. Reprinted from "Advancing the Aging and Technology Agenda in Gerontology," by Richard Schulz, et al., 2015, *The Gerontologist*, 55, Issue 5, p. 727, by permission of Oxford University Press.

Discussion of technology

Introduction

This section of the report provides examples of technology that are covered within each of the following domain categories.

- Biological and physiological
- Function and motion
- Safety and security
- Social interaction
- Cognitive monitoring
- Integrated monitoring and assessment platforms

In examining this information, the reader should note the following:

- Examples illustrate typical products and include references to technology discussed in other sections of the report. The naming of specific devices and manufacturers should not be construed as an endorsement of any specific product. Products and manufacturers are named only for illustration.
- The product lists included here are not comprehensive and the domains themselves may overlap and include devices or applications that may be appropriate within multiple domains.
- Anyone being monitored by a device in which information is being sent to someone other than the care recipient should be able to give and withdraw consent for the use of the device(s), and have choice in the type of device(s) implemented.
- The categories used below represent a slight modification of those proposed by Demiris (2015), as described in Figure 1, primarily in the combining of safety and security categories.
- These tables are presented in more detailed form in Appendix D.

Biological and physiological

Remote patient monitoring and telemedicine

The use of advanced biological and physiological monitoring devices by health care providers has a long history in Minnesota and elsewhere. This is undoubtedly related to the fact that many important devices have been invented and manufactured here. The University of Minnesota, along with small medical engineering companies, together with large corporations like Medtronic, 3M, and Boston Scientific, among others, have created or acquired products that are able to take reliable biometric readings that can be transmitted from a patient's residence and remotely assessed by health care providers.

This technology is well established in the telehealth world and has now been adopted by most of the larger home health care agencies in the United States. But it is only more recently that these devices are finding their way into the world of home and community-based service providers and family caregivers. In part, this has occurred because of the expanded availability of these devices in the consumer market, including devices like fitness trackers, smart watches, smartphones, and other wearable and relatively inexpensive products that can monitor one or more physiological functions. Figure 3 identifies two examples of these products now being used by caregivers to monitor key biological indicators that may show increased risks or health hazards for homebound older adults.

3. Examples of biological or physiological monitoring technology

Product (manufacturer)	Technology details	Service subscription	Requirements Smartphone	Wireless internet	Information monitoring
Blood pressure monitor (Blip Care)	<p>Wireless monitor</p> <p>Reminders to take readings</p> <p>Data sent and stored automatically</p> <p>Tracks data from PC, tablet, smartphone</p> <p>Remote monitoring</p>	Yes	Yes	Yes	Can be forwarded to health care provider or family member
Glucose-monitoring system (iHealth Smart)	<p>Wireless monitor</p> <p>Pocket-sized device connects to smart phone</p> <p>Quick results, accurate readings</p> <p>Tracks results via app</p> <p>Reminders for readings and insulin</p>	Yes	Yes	Yes	Automatic connection via cloud Results can be exported to file

Function and motion

The AIHAMS technology used to assess function, motion and related activity is a critical and fast developing component of the applications thought to be useful for improving the potential for individuals to age in place. Some of these applications are used in telemedicine for ongoing monitoring of gait, movement, and other aspects of daily functioning. For a family caregiver, one or more sensors might be installed in the home of an at-risk older adult to see if he or she has gotten out of bed, used the toilet, or been physically active during the day. A good example of devices in this category are those like LOK8U, which use global positioning systems (GPS) to track the location of older adults with memory loss who may be at risk of wandering to unsafe locations. Examples of these and other devices are shown in Figure 4.

4. Examples of function and motion sensors, passive detection applications

Product (manufacturer)	Technology details	Service subscription	Requirements		Information monitoring
			Smartphone	Wireless internet	
Wander prevention alert watch (LOK8U Freedom)	Locator device Monitors location Location sent via email/text Water-resistant	Yes	Yes	Yes	Family members/ personal contacts
Auto activated mobile medical alert (Live Life Alarms LLC)	Personal mobile alarm Assistance call function (including 911 and personal contacts) GPS location sent via text Fall detection Waterproof	Yes	For receivers of emergency call	No	No
Wireless Wander Door Alarm (Safeguard)	Wireless alarm system Door or window sensor Wireless receiver/alarm carried by the caregiver	No	No	No	Caregivers Staff in facility
Toilet Seat Sensor Pad Alarm (Easier Living Everyday Independence)	Motion sensor Seat sensor alarm when person gets up unattended Reduces risk of falls and injury; increases privacy	No	No	No	Attendant nearby

Safety and security

The use of monitoring applications to support the safety and security of older adults has grown in popularity and accessibility with the advent and advancement of smartphone and tablet technologies. Included in this category of AIHAMS are live video streaming, motion sensors, remote home comfort and utilities control, medical alert devices, and GPS observation. Remote caregivers, in particular, can be reassured by monitoring that allows for real time video of the care recipients' activities and movements, as well as custom notifications about alterations in daily patterns that may signal a change in the status of the care recipient. Real-time alerts for falls or other medical issues can boost security and well-being. Providing additional supports for older adults who live independently or with chronic conditions that impair their functioning may also contribute to their overall sense of security. Applications related to safety and security may assist in monitoring visitors to the home entrance via video streaming, as well as remote control of lighting, locks and thermostats. In cases of cognitive impairment and the risks associated with wandering behaviors and other vulnerabilities, GPS monitoring may provide additional peace of mind to caregivers who are able to verify the physical locations of the care recipients.

Figure 5 provides further details about some of the products available now for use by caregivers to monitor the safety and well-being of care recipients.

5. Examples of safety and security monitoring technologies

Product (manufacturer)	Technology details	Service subscription	Requirements		Information monitoring
			Smartphone	Wireless internet	
Indoor Camera (Alarm.com)	Live streaming video Smartphone or tablet Includes night vision	Yes	Yes	Yes	Caregiver
Video Door Bell (Sky Bell Ring)	Smart video doorbell See/hear/speak to visitor at door from any location Triggered by motion sensor	Yes	Yes	Yes	Resident
Assured Living (Best Buy)	Customized sensor based notification Patterns in care recipients' activities Voice automation controls lights, locks, room temp Reminders for daily tasks, medications	Yes	Yes	Yes	Custom alerts sent to family/caregivers

5. Examples of safety and security monitoring technologies

Product (manufacturer)	Technology details	Service subscription	Requirements		Information monitoring
			Smartphone	Wireless internet	
Smart Thermostat (Sensi)	Wi-Fi intuitive app Remotely control and schedule home comfort Sync w/Alexa for voice control adjustments	Yes	Yes	Yes	No
24/7 medical alert (Belle and Belle+) (MN DHS approved Waiver provider for Personal Emergency Response System (PERS))	Emergency alert pendant 911 back-up calling Fall detection In-home/out-of-home Water-resistant 24/7 monitoring	Yes	Yes	Yes	Caregivers can locate 24/7 on web or mobile app

Social interaction

As social isolation has been increasingly recognized as a health and mobility risk for older adults (Perissinotto, Stijacic & Covinsky, 2012; Luo, Hawkley, Waite & Cacioppo, 2012), technologies that allow older adults to stay connected to friends and family have grown increasingly popular. Older adults can access information or interact with others from their homes, even with barriers such as inclement weather conditions, mobility limitations, or caregivers or family who live at a distance. Caregivers can communicate via video calling with the older adult, or share videos or emails. Using a smartphone or tablet device also allows an older adult access to news in order to stay connected to current events or to applications that provide games or other internet browsing. Such devices may be configured to support those with vision or hearing loss. Caregivers also have the option of remotely monitoring activity on the device or completing updates to the applications.

Figure 6 provides additional information about current products available that older adults who may be limited by location or circumstance can use to facilitate social interactions.

6. Examples of social interaction monitoring technologies

Product (manufacturer)	Technology details	Service subscription	Requirements		Information monitoring
			Smartphone	Wireless internet	
Oscar Senior (App store/Google Play)	<p>Tablet app</p> <p>Stay connected via video/text/calling/photos</p> <p>Access to games/news/internet browsing</p> <p>Screen visibility for vision impairment</p> <p>Remote programming/monitoring by caregiver</p>	Yes	Yes	Yes	Family can monitor
Gerijoy (A Care Coach service)	<p>Caregiving companion tablet</p> <p>Avatar companion via human control</p> <p>24/7 caregiver support</p> <p>Care reminders</p> <p>Social connection via photos/music/voice</p> <p>Emergency contact phone numbers</p>	Yes	No	Yes	<p>Caregivers for home use</p> <p>Care providers in assisted living settings</p>
iN2L (Dignity Through Technology)	<p>Picture-based touch screen tablet</p> <p>Person-centered technology</p> <p>Access to games/email/internet browsing/photos/videos</p> <p>Therapeutic use</p>	Yes	No	Yes	Observation possible in facility setting

Cognitive monitoring

As rates of dementias have increased among older adults, technologies that may help with reminders for essential tasks have emerged as an important new technology that could assist older adults maintain their independence. Included in this category are customizable audio reminder devices that can be programmed to alert older adults when it is time to take medications, as well as to alert caregivers in the event of medication non-compliance. The use of many cognitive monitoring devices requires pairing with other assistive devices or services, such as a mobile phone or tablet device.

Figure 7 provides additional details about technologies that may help older adults with cognitive deficits maintain their independence.

7. Examples of cognitive assistance technologies

Product (manufacturer)	Technology details	Service subscription	Requirements		Information monitoring
			Smartphone	Wireless internet	
Personal voice reminder (Reminder Rosie)	Personalized voice controlled clock Customized/multiple reminders for meds/ appointments/daily tasks Works during power outages Hands-free operation	No	No	No	Supports caregiver
Medication tracking system (Pill Drill)	Pill tracker Medication reminder Tracks/verifies meds intake Tracks mood or pain Create/edit medication schedule via app	Yes	Yes	Yes	Health care provider Family/caregiver

Integrated monitoring and assessment platforms

The rapid development of AIHAMS equipment has necessitated a parallel development of systems that can both integrate and manage various types of technology. A smartphone is a familiar example of the type of integration that can occur when data from multiple applications is integrated and customized for an individual user.

Retailers like Lowe’s and Best Buy have entered the home support field with integrated systems that use sensors, cameras, and related devices intended to help care recipients and family members receive notification of various function or safety issues. Devices like Google Home and Amazon’s Alexa have the capacity to integrate various sensor functions including thermostats, lights, cameras, and other monitoring technology, both to receive commands to make adjustments in the environment—and to identify potential risks and threats.

Another U.S. company, Independa, based in San Diego, California, collaborates with LG to produce an integrated communications platform that works through a smart television set and allows two-way communications between family caregivers and older adult family members. This platform is also capable of integrating multiple devices from different manufacturers, including: sensors and physiological monitors; providing educational content via the television; supporting medication compliance with reminders; and providing family members with alerts by phone, email or text. Examples and descriptions of these platforms are shown in Figure 8.

The integration of information from multiple sources and the analysis of this information for use by professional caregivers is moving at an extraordinary pace. Figure 8 provides examples of integrated platforms designed for older adults and their family caregivers.

8. Examples of integrated monitoring and assessment technologies

Product (manufacturer)	Technology details	Service subscription	Requirements		Information monitoring
			Smartphone	Wireless internet	
All in one caregiver dashboard (Independa)	Smart TV “Angela” remote control Caregiver sends alerts via app to “Angela” for medicine/ appointment/tasks reminder Photo and video sharing Video chat Call button to contact family	Yes	Yes	Yes	Customize phone or computer with Independa app

8. Examples of integrated monitoring and assessment technologies (continued)

Product (manufacturer)	Technology details	Service subscription	Requirements		Information monitoring
			Smartphone	Wireless internet	
Smart home system (Iris Smart Hub by Lowes)	<p>Smart home security network</p> <p>Connects all compatible smart products through Iris app</p> <p>Turns lights on and off</p> <p>Burglar alarm alerts</p> <p>Live stream video</p>	Yes	Yes	Yes	Caregiver
Remote monitoring service (Healthsense, renamed Lively Home)	<p>Remote monitoring solution</p> <p>Unobtrusive sensors track and monitor daily activity</p> <p>Real time response to health concerns</p>	Yes	Yes	Yes	Alerts caregivers to changes in care recipient's normal routine
Large touchscreen (GrandCare Systems)	<p>Touchscreen interface</p> <p>Web-based communication via sensors in home for home health, senior living community, hospice</p> <p>Social interaction, med prompts, task reminders</p>	Yes	Yes	Yes	Through GrandCare website/online portal
Multifunction Wearables (Fitbit and Apple Watch)	<p>Wearable tracker</p> <p>Tracks activity, health, weight, food intake, sleep</p> <p>Sync info from device with phone or computer</p>	Yes	Yes	No	Online and mobile tools track data
Assured Living (Best Buy)	<p>Customized sensor based notification service</p> <p>Monitor patterns in activities</p> <p>Reminders for tasks, meds</p> <p>Voice automation controls lights, locks doors, room temperature</p>	Yes	Yes	Yes	By sensor through Amazon Echo Alert caregivers to changes in patterns

8. Examples of integrated monitoring and assessment technologies (continued)

Product (manufacturer)	Technology details	Service subscription	Requirements		Information monitoring
			Smartphone	Wireless internet	
Smart bed technology (BAM Labs is now SleepIQ LABS)	<p>Sensor technology</p> <p>Touch-free sensor under mattress</p> <p>Monitor heart/respiration rates, motion bed-presence</p> <p>Non-intrusive</p>	Yes	Yes	Yes	Health care providers monitor via computer or mobile devices
All in one caregiver dashboard (TheirCare - First Layer Health)	<p>Worldwide communication through television</p> <p>Works through existing remote control or mobile device</p> <p>Medication reminders</p>	Yes	Yes	Yes	Health care provider

Minnesota-based initiatives

State-funded programs and projects

Current remote activity monitoring study

Led by Dr. Joseph Gaugler, this 5-year demonstration, embedded experimental, mixed-methods evaluation project seeks to determine the efficacy of the eNeighbor remote activity monitoring technology (developed by Healthsense, see above) in improving outcomes among persons with Alzheimer’s disease and related dementias (ADRD) living in the community and their family caregivers. The eNeighbor technology platform includes a combination of remote sensors that are located in key areas of a person with ADRD’s home (e.g., bed, medicine cabinet or refrigerator doors, toilet, and living rooms). Such sensors can immediately communicate any function that is outside of an expected threshold for the person with ADRD to both a family caregiver and a care professional (e.g., nurse care manager). Data collection is ongoing and results have not yet been released for this study. See Appendix B for a full description.

STAR

A System of Technology to Achieve Results (STAR) is the state’s federally funded Assistive Technology (AT) Act program. It is administered by the Minnesota Department of Administration and helps Minnesotans of all ages with disabilities gain access to and acquire the assistive technology they need to live, learn, work, and play.

Program services include product demonstrations and device loans to help consumers, their families, and professionals make informed decisions regarding the use of in-home assistive technology. Other services include a device exchange that allows consumers to donate, sell, and buy previously owned equipment.

STAR also provides free information and assistance, publishes a quarterly newsletter, and shares the latest AT news on social media.

The Technology for Home project

The Technology for Home project within the DHS Disability Division tests whether teams of advanced practice professionals can help people with disabilities meet their goals that have remained unmet in the usual service delivery system. This state-funded grant initiative serves people with disabilities who use home and community-based services. Some services can be reimbursed by the Elderly Waiver (EW) program, which pays for the devices that program staff deem appropriate. Teams of advanced practice professional staff conduct person-centered, individual home assessments and determine unmet goals the person would like to consider. In the course of its 4.5 years of operations, Technology for Home has served approximately 1300 adults and children with disabilities with the following types of devices:

- **Reminder devices** (approximately 20% of their clients) are a relatively low-tech option similar to pagers that can encourage people, with a spoken or visual prompt, to take medicines or carry out other tasks. For those who already use a smartphone, applications are already available to set up reminders without the purchase of new equipment. The advantage of this reminder technology is that it typically does not require in-home Wi-Fi or Bluetooth technology.
- **Tile devices** (approximately 20% of clients), often purchased from big box technology stores or online, are small, detectable devices that can be attached to something that is used every day such as keys or phones, and can be activated by a base unit that helps individuals find something in their homes that they are looking for.
- **GPS monitoring devices for wandering** (approximately 10% of clients) alert family caregivers if an individual with mild to moderate dementia moves outside of a familiar or safe area. The advantage of some of these devices is that they have backup systems that work even when the individual is out of their own Wi-Fi range. The devices can be water-resistant, and alerts can be directed to go to whomever the care recipient has selected. The devices require a cellular network service.
- **Alerting devices** (approximately 5% of clients) include sensors on exterior doors, as well as in other locations in the home such as dim lighting at night. The devices are managed so that family caregivers are alerted only when something occurs that might be a threat to safety or health. Cameras are installed only when requested, due to concerns about people's privacy, and never in a bathroom or bedroom and within Medical Assistance parameters. Devices like Amazon's Alexa and Google Home can also be used for the same purpose, if such a device is already in use in the home. Staff must follow the federally approved DHS protocols regarding when and how such devices can be used, installed, and monitored.

- **Communications technologies** (approximately 10% of clients) include a variety of applications (including such familiar ones as Skype or FaceTime) which allow visual two-way communication with caregivers and care recipients. These devices are viewed as particularly useful to older adults in greater Minnesota, and may reassure caregivers about older adults who live on their own in rural areas. A nonprofit agency can provide low-cost computers to make this technology accessible for people with low incomes, but the applications do require a Wi-Fi or Ethernet internet connection.
- **Assistive devices** (approximately one client per month) are often attached to medication dispensers and provide alerts that are matched to individuals' schedules and needs. Family caregivers can be alerted if the medication is not dispensed. These reminder devices are paid for by Medical Assistance and require a Wi-Fi internet connection.

Work funded by recent Live Well at Home grants

Following the recommendations of the Long-Term Care Task Force, the Live Well at Home grant program has funded a variety of community grants focused on advancing the use of AIHAMS technology by and for older adults. Highlights of these grants include the following:

Augustana Learning Lab (2017)

Staff at Augustana Care launched the Learning Lab for Eldercare Technologies, which offers demonstrations of tools designed to help older adults stay safely in their homes. The lab features a wide range of devices and products that individuals, family members, and professional service providers can test before choosing to use. Devices include sensing and monitoring equipment, specialized lighting, and other assistive technology. Staff seek to stay abreast of the latest technologies and are working with Dr. Joseph Gaugler at the University of Minnesota to evaluate product implementation experiences with users.

St. Louis County (2016)

In a rural region of MN with limited internet access and many residents with little experience with technology, staff implemented the eNeighbor technology system to deliver a person-centered model of health and safety monitoring to low-income residents of a Section 202 HUD Housing unit. The health monitoring technology has supported a preventative health care model for older adults and caregivers, promoted independence, and enabled older adults to avoid moving to more restrictive care settings. Staff expected to secure reimbursements through Elderly Waiver assistive technology after the grant funding ended.

Catholic Charities of Southern MN (2017)

The program provides assistance for older adults in rural Southeast MN to live independently, through the use of activity monitoring and other evidence-based programs to support health and wellness. One goal is to test a product that may help predict who is at risk for falling and prevent falls, and assist in notifying caregivers in the event of a fall. The initiative is also intended to fill a gap in supports for caregivers. The Mayo Clinic is a partner in the collection and tracking of data collected through this initiative.

St. John Lutheran Home (2017)

Capitalizing on the familiarity with and common availability of televisions, including for low-income and rural older adults, the initiative implemented a television and mobile-based health care delivery system. The application is delivered and used directly over the TV network with the individual's remote control device. Individuals benefit from the simplified social connections with friends and family members, as well as from the access to health care providers for telehealth purposes.

The Lutheran Home Association (2015)

Staff at The Lutheran Home Association developed and tested an innovative model of dementia care solutions in their rural community. They piloted a variety of technology applications to support persons with dementia and their caregivers. They also created the Belle Plaine Dementia Awareness Alliance with a group of local business and community leaders, which provides outreach and education to improve health outcomes for community members living with Alzheimer's disease and related dementias. These efforts are intended to provide effective strategies for building a dementia capable community.

Other work in MN

Northfield Retirement Community (NRC)

A current pilot study is assessing caregiver burden and the potential for alleviating some of the burden on caregivers, as well as increasing caregivers' knowledge and confidence through the use of technology. By focusing on person-centered care, the staff are hopeful that people will be able to remain in their homes for longer. The GrandCare Systems technology uses a customized touchscreen application for members in each household.

Researchers are assessing the efficacy of the interventions with data collected at preset intervals from several sources, including the Burden Scale for Family Caregivers, participant satisfaction, ER utilization, falls, and frequency of hospitalizations.

The study began in June 2017; results are not yet available. Following the completion of the pilot, NRC staff expect to expand the reach of the intervention from couples living in an NRC facility to couples in the broader community.

Best Buy

In addition to the work of nonprofits, Best Buy, a major Minnesota-based corporation that markets home electronics and related services, has developed an initiative called Assured Living. As described in our product grids (Appendix D), Assured Living includes both products and services to create an integrated monitoring system in a care recipients' homes. The technology can provide notifications to designated caregivers when patterns of behavior are out of the ordinary since the system compares current patterns to past patterns and identifies those outside of normal ranges. In these instances, caregivers will receive an email or text message indicating that they should get in touch with the care recipient. Applications are customized for individual circumstances and may include bed sensors, motion sensors, medication dispensers with compliance aids, doorbells, and automated lighting. Staff follow up within one or two weeks of an installation to provide additional education and support as needed. It appears that the majority of applications so far have been with adult children who are caring for their aging parents.

Best Buy's entry into this market place with both products and services is a clear indication of how the market for this technology is being viewed in the for-profit world. Given the very recent launch of these services, experts consulted for this project report little experience with Assured Living.¹ While many are eager to see how families respond to this service, there are some concerns regarding the extent to which staff background and training will be a good fit with the customer base, given the complexity of health conditions likely to be encountered when developing customized product installations.

Current reimbursement

Elderly Waiver (EW) and Alternative Care (AC) funding cover long-term services and supports for low-income adults age 65 and older who require a level of care that is provided by a nursing home, but who choose to live in the community.² This funding currently provides access to both Personal Emergency Response Systems (PERS) and some types of AIHAMS technology for low-income older adults. However, by all estimates, the size of this low-income population will grow rapidly over the next decade and add significantly to the demands on this source of funding.

¹ Assured Living is currently available only in Minneapolis and Denver.

² EW is for older adults whose income qualifies them to receive Medical Assistance; AC is for older adults with low incomes and assets who are not eligible for Medical Assistance.

Included in current coverage is monitoring technology that is designed to keep older adults safe and support their independence.³ Specific guidelines define reimbursable technologies as either PERS or Monitoring Technology (MT). MT includes devices and services such as audio listening devices, cameras or video equipment, mobile on-person sensors or equipment, and sensors not on the person (e.g. GPS).

PERS includes a system typically worn as a pendant or bracelet that includes an alert or panic button the person can press in the event of a fall or other emergency. The program does not cover passive fall sensing devices. The total annual authorization for PERS is \$3,000 during a participant’s “waiver” year.

Covered under both the PERS and the MT services are the purchase costs of the equipment, including assessments to determine the most appropriate type, installation, maintenance and repairs, as well as monthly monitoring fees that may be associated with the use of the equipment. MT is most often authorized under the specialized equipment and supplies service. It can also be authorized under environmental accessibility adaptations (EAA) in cases where equipment installation requires physical structure modifications to the home.

The program can also cover some EAA, but typically excludes adaptations or improvements to the home that add to the total square footage of the home or that are unrelated to a participant’s disability. EAA are typically limited to a maximum of \$40,000 per year per waiver participant, except when a participant has an approved modification based on requesting additional square footage, the rate maximum does not apply. Additional details regarding rules governing these programs can be found in Appendix E.

Market rates for EW and AC funding limits for 2017 are provided in Figure 9.

9. Market rate funding limits for in-home monitoring technologies covered by EW and AC

Technology	Cost limit	Interval
PERS installation and test	\$500	Per occurrence
PERS service fee	\$110	Monthly
PERS equipment purchase	\$1500	Per occurrence
Specialized equipment and supplies	Up to an individual participant’s budget cap	Per item
EAA assessment	\$20,000	Annually
EAA installation	\$20,000	Annually

³ Allows a caregiver to see, hear or locate a person; be the most appropriate means to address assessed needs and goals; monitor the person in real time; increase independence, address a complex medical condition, reduce or minimize critical incidents, improve the quality of supports (MN Department of Human Services, 2017).

Initiatives outside Minnesota

The AIHAMS technology in assisting older adults to remain independent has also gained traction in other regions of the United States. The following examples of current work by one nationwide association and several institutions serve to illustrate some of the diverse range of work being completed to advance the connections between technology and improved care for older adults.

LeadingAge

LeadingAge is a nationwide association of nonprofit organizations that seeks to lead and transform the way in which issues are addressed for the aging population. The Center for Aging Services Technologies (CAST), a part of LeadingAge, “is leading the charge to expedite the development, evaluation, and adoption of emerging technologies that can improve the aging experience.” (<http://www.leadingage.org/center-aging-services-technologies>). Key activities include the following research and policy work highlights.

- Early in 2017, CAST completed case studies on social connectedness and technology with 11 providers. A summary report for providers includes an extensive list of lessons learned from the studies and includes topics related to planning and implementation, marketing and utilization, and training.
- As one of its policy priorities, CAST has advocated for programming aimed at helping low-income older adults access internet service so that they may use current technology applications. In March 2016, the Federal Communications Commission announced that it is updating its Lifeline program to provide low-income consumers with access to affordable internet service.
- In October 2017, CAST launched a resource tool that helps older adults, caregivers, and service providers select technology solutions to address older adults’ needs for social engagement. (Sanders, 2017)

The Center for Research and Education on Technology Enhancement (CREATE)

The Center for Research and Education on Technology Enhancement (CREATE) is a collaboration between the University of Miami, Florida State University, and Georgia Institute of Technology. (<http://create-center.org/>) The mission of the multidisciplinary work focuses on three broad areas: “1) Design strategies to help older adults use technology well, 2) How technology affects older adults’ health, quality of life, and independence, and 3) Older adults’ needs and preferences with respect to technology.” Currently, the main focus of the center involves a randomized trial study of a software program that supports older adults to access the internet in order to improve social connectedness and cognitive skills (Winerman, 2017).

Scripps Gerontology Center at Miami University in Ohio

Scripps Gerontology Center at Miami University in Ohio published a report in 2017 with recommendations related to using technology to assist older adults to live independently in the community for as long as possible (Mehdizadeh, Nelson, Applebaum & Straker, 2017). Policy experts believe that technology development could promote economic growth in the state, as well as benefit older adults. Researchers cautioned, however, that even with technological advances, technology cannot be expected to substitute for personal care of older adults by both paid and unpaid caregivers.

Current research regarding the application and use of advanced in-home activity-monitoring technology

Research designed to examine the application of AIHAMS technology to support at-risk older adults has grown exponentially during the past two decades. This is undoubtedly due to the fact that the vast majority of countries in the world are experiencing unprecedented growth of their aging population. In fact, according to revised 2017 UN estimates:

“...the number of persons aged 80 or over world-wide is projected to triple by 2050, from 137 million in 2017 to 425 million in 2050. By 2100 it is expected to increase to 909 million, nearly seven times its value in 2017” (United Nations, 2017).

Another driver of this growth in research interest has been a period of remarkable technological innovation that has put devices like smartphones, Global Positioning Systems, passive sensors and other advanced technology into the hands of consumers and created a virtual revolution in the way in which humans work and interact with each other.

Given this context, it is not surprising that there have been multiple reviews of research and related literature during this time period to try to organize, systematize, and summarize what is known. And inevitably, as technologies are updated, outmoded, and surpassed, earlier research becomes less relevant. With this in mind, we have selected a few of the most up-to-date reviews to summarize here.

Technology frameworks

In a recent review article by Al-Shaqi, Mourshed, and Rezgui (2016), the authors reviewed progress in what are now being called “ambient assisted living systems” designed to support independent living by older adults. Their review of 133 articles was organized in the following four categories:

- Activity modeling techniques
- Personal and environmental sensing and monitoring systems
- Home environment characteristics
- Recent research projects

Using the same categories described by Demiris and Hensel (2008) to organize the technological functions of ambient assisted living systems (page 9 of this report), the authors concluded that most frameworks for supporting independent living focused on activity monitoring to assess immediate risk, but fail to take advantage of opportunities:

“...for integrating environmental factors with analytics and decision making, in particular for long term care.” They also note that, “The potential for wearable devices and sensors, as well as distributed storage and access (e.g. cloud) are yet to be fully appreciated.” The authors also identify multiple challenges to fully benefiting from the use of wearable technology including, “...acceptability, durability, easiness, communication and power requirements.”

With regard to effectiveness, the authors state, “There is a distinct lack of strong supporting clinical evidence from the implemented technologies.” In addition, the review raises concerns regarding the lack of attention to social and cultural variations that will impact how different groups might respond to the technology, as well as the general issue of the acceptability and usability of the technology that make up ambient assisted living systems.

Assessing technology effectiveness

Another review, conducted by Reeder, et al. (2013) began with an examination of 1685 citations related to home-based consumer health technologies, specifically seeking research that could be framed as public health interventions to promote independent living. The review specifically excluded technology focused on specific diseases, wearable sensors, or remote health monitoring technology used in telehealth applications. Through this process, the authors concluded with the selection of 31 publications that met scientific criteria for review. The majority of studies included in the final review group were published in 2005 or later.

The review found that only 3 of the 31 studies could be classified as demonstrating an “effective” intervention based on a satisfactory controlled design. And of this group, only two of the studies sought to examine outcomes that included reduced hospital admissions, reduced length of rehabilitative stays, improved cognitive functioning, or increased number of days at home. The remaining studies were classified as “promising” (n=10) or “emerging” (n=21), indicating a weaker level of evidence based on study design, sample size and other related criteria.

These challenges are also reflected in other smart home technology, according to Tomita, Mann, Stanton, Tomita, and Sundar (2007). The authors tested an early version of X10 Active Home, an integrated platform of technology that integrates appliance modules, door sensors, motion sensors, lighting, and other devices through a home's existing electrical wiring⁴ and a computer. They found that in the 46-person treatment group, one-third stopped using all of the sensing technology by the end of the second year of the study. Moreover, they found that lack of familiarity with computers, connection issues, too-sensitive motion detectors, and other technical issues required regular attention and oversight of the systems. While some of these issues have undoubtedly been addressed in the 10 years since the publication of this study and others will likely be addressed as the population reaching old age becomes more technologically proficient, recent literature continues to emphasize the need for a,

“...thorough assessment of users' needs, abilities and contexts to ensure correct adjustment of the technology” (Berge, 2017).

With regard to evidence of benefit, Tomita, et al. (2007) go on to report that when they compared the matched comparison group to the treatment group after two years, they found small but significant improvements in cognitive function for the treatment group but no differences in other health or physical status measures. Much of this they attributed to the fact that all members of the control group were required to learn how to use a computer over the course of the study. Another detail of this study is important to note. Several younger seniors who were randomly assigned to the control condition dropped out of the study because they were disappointed that they would not get to use the technology, and several older seniors assigned to the treatment group dropped out because they had concerns about using the required equipment. It is likely that age differences will continue to influence an older persons' willingness to learn and use new technology. But it also seems likely that as Baby Boomers – who have significantly more experience with computers and related technology than the Greatest Generation – continue to age, there will be a growing acceptance of this type of smart home technology provided it is not prohibitively expensive, difficult to use, or intolerably compromising of an individual's privacy.

⁴ Today, of course, there are many other similar technology platforms that operate on wireless technology including systems sold by Best Buy, Lowe's, and Inpenda, among others. (See Figure 8.)

Another study reviewed by Reeder, et al. (2013), and described as “promising,” has been underway for nearly two decades at the University of Missouri. Building on work that began in the 1990s, and with state and federal support, researchers have designed a housing program, Tiger Place, that integrates information from an array of technology that includes a,

“...1) bed sensor (fits under the mattress with no active engagement by the resident) to monitor heart rate, respiratory rate, and nighttime bed restlessness; 2) motion sensors to monitor activity in rooms; and 3) Kinect depth images to automatically monitor walking and gait parameters and report falls in real time with alerts emailed to direct care staff” (Rantz, et al., 2015).

Furthermore, this entirely passive system uses algorithms to determine if health patterns appear different from those observed during the previous two-week period. One promising finding of the research is that they have been able to double the average length of stay for residents monitored in this way when compared to the length of stay for a comparison group.

It is important to note that the study takes place in a specially built facility which, although **not** a nursing home, has been constructed in a way that meets existing nursing home standards. Given this fact, it might seem unlikely that this type of comprehensive health home technology will be adapted for use in the same manner by family caregivers in the near future. However, in a recent phone conversation the author reported that the technology has been simplified, and is now being tested in 12 assisted living facilities and multiple home based settings. (M. J. Rantz, personal communication, November 16, 2017). Given this fact, it is likely that components of the technology will soon find their way into applications for families and caregivers.

Assessing acceptability

In another recent review focused on the acceptability of body-worn sensing devices (Bergmann and McGregor, 2011), the authors reviewed a total of 843 papers of which only 11 studies were deemed suitable for inclusion. A variety of different clinically relevant users, including older adults, were part of the review. Based on the studies reviewed, preferred devices would be,

“... compact, embedded and simple to operate and maintain. They should also not affect daily behavior.”

And as with other studies of monitoring and sensing devices, the authors cautioned that the use of such devices could not replace health care professionals. At the time the article was written, the reviewers concluded that these preferences were seldom taken into account by those who were designing wearable sensing devices. However, that does not appear to be the case today, given the range of options available in wearable sensing technology.

A market perspective

A final important source of information about the development and application of this technology can be found in market literature such as the recent overview of the current market for this technology prepared by market analyst, Laurie Orlov (2017). She begins by describing the market forces and demographics now driving innovation in this area, as well as the uncertain financial circumstances of many older adults. She goes on to describe the fact that tech-enabled home care startups alone received more than \$200 million of funding in 2016 and that caregiving applications and initiatives have multiplied, in her words, "...like weeds." However, she also offers the following cautions:

- Many users will find their devices too complex and in constant need of patches and upgrades
- Technologies will not be adopted unless they are well-supported and intuitive
- Upgrades will need to be more seamless than today
- Device vendors will have to create and use common standards for communication with caregivers and professional providers
- Training services will fall behind in confronting the rapid pace of change of devices
- Growing security threats, including geolocation hackers, will target the identity and safety of users
- Higher income consumers will come to realize that in-home bandwidth enables better caregiver supports, suggesting lower income consumers will be left out of applications requiring such technology
- The marketplace of products and services will continue to be fragmented; with ever-shifting cottage industries comprised largely of startups and challenged by...end user resistance

One final observation of this 2017 market report makes it clear that those who are creating and selling “aging in place technology” are paying close attention to what is happening among this demographic. In fact, the report indicates that caregivers of older adults can be seen as a largely untapped market that holds out promise as, “...a \$72 billion market opportunity by 2020.”

Cautions and opportunities identified in the market report were also raised in our key informant interviews conducted as part of this study and are reported in the section that follows.

Expert opinion regarding the application and use of advanced in-home activity-monitoring technology

Introduction

The review of recent research makes it clear that the evidence base supporting the use of AIHAMS technology is still a work in progress. In addition, knowledge among older adults regarding the availability, function, and capabilities of the technology, as well as the adoption of potentially beneficial technology, lags far behind the range of technology currently available and the new applications that become available almost daily. This section of the report summarizes the opinions and recommendations from 17 experts in the field (see Appendix A), including those who study the technology, those who help older adults and families to consider and potentially adopt the technology, and those who have directly observed various applications of the technology.

Results

Areas of progress in the development and use of monitoring technology

- Technology is improving at a rapid pace. There have been significant improvements since the early monitoring systems were developed and tested. Not surprisingly, newer technology typically works better than older technology.
- The State of Minnesota has funded projects designed to introduce people to AIHAMS technology and has achieved some success with both older adult and disabled populations, although total numbers served are still low. When services and applications are customized for users and there is sufficient follow-up and support, technology adoption can be successful.
- Commercial interests are moving quickly to appeal to the senior market with various types of monitoring and sensing technology. Some are selling integrated systems as well as services to support them.
- Monitoring systems are being tested for efficacy. Improvements are being made in systems as weaknesses are discovered. However, new and improved technology is often available before the testing of earlier technologies is complete.

Perceived barriers to the implementation and use of AIHAMS technology

- Interest in this technology varies by age and level of familiarity with smart devices. Older adults (those over 75 today) seem more reluctant to try or use the new technology than younger baby boomers who have already adapted to smartphones and wearable applications.
- Broadband infrastructure limits hinder application of this technology in rural areas of the state.
- Poor reliability of home computer networks and wireless connections impede the use of some types of technology.
- The high cost of monitoring devices, in-home computers, and internet access are likely to be a limiting factor for those with limited means.

Views regarding where the leading edge of AIHAMS technology is today

- Integrated passive sensing systems that can monitor multiple areas of health status including respiration, gait, activity level, and fall risk, among others, have improved substantially in recent years.
- Sensing technology is generally more acceptable than applications that involve video monitoring.
- In Japan, the use of robots in the home has progressed to the level that the government has intervened to identify specific areas in which robots can be used for monitoring and assisting, and areas that will be deemed off limits for sensing technology.
- Applications that build on technology that is already familiar (e.g., Amazon Echo, Google Home, and smartphones) may provide an advantage in increasing acceptability and use.
- Applications that address social isolation seem to be growing in popularity, especially in rural areas or when caregivers do not live nearby.

Views regarding areas of home-based care where monitoring technology is most likely to be useful

- Because of the problems that occur when medications are not taken following a prescribed protocol, monitoring devices attached to medication dispensing equipment may be one of the best values for use in the home. However, experts advise that the marketplace is still in flux, and that they have not fully solved the issues of whether or not medications are actually taken once dispensed, nor the problem of errors in the refilling of the devices. These problems are receiving attention now.
- Safety devices like automatic stove shut-offs that can sense when a stove is no longer in use can be valuable for those with mild cognitive impairment.
- Safety systems that provide older adults with greater peace of mind, like video doorbells and motion sensor systems, are attractive to more tech savvy older adults and caregivers. Although these devices do not provide caregivers with any information about the health and functional status of the older adults who use such systems, they do support independent living and safety
- Motion and function sensors may improve confidence in older adults and contribute to increased mobility.
- Integrated platforms that incorporate data from multiple sensors, imaging devices, or other monitoring equipment may provide the best prospect for identifying future health risks, based on the ability of these systems to compare current activity and function data to normal parameters on personal baseline data. These systems are being engineered to be more reliable and easy to use, including simplified messages for family caregivers that can be received on smartphones. But since these technologies gather and transmit data to others, privacy and choice issues must also be considered.

Areas of disagreement among professionals regarding the future home-based use of the technology

- Respondents disagreed on the extent to which passive sensing devices, like fall detection technology, had evolved to the point where they were less likely to produce false positives (e.g., an alert to a caregiver or provider that a fall had been detected, when in fact no fall had occurred).

- Respondents disagreed on how problematic false positive alerts were. While some respondents indicated that such messages (which occur with passive fall sensors and wander prevention technology) could be a significant distraction and annoyance for caregivers, others felt that caregivers would be able to tolerate some false positives as long as the technology did not fail to alert a caregiver to a serious problem.
- Respondents disagreed on the extent to which information produced by monitoring technology could be hacked, identities stolen, or health information compromised.

Monitoring and sensing systems are also being used in facility-based care

- Respondents described applications of advanced activity-monitoring and sensing technology in various care settings, including senior housing, assisted living, and skilled nursing facilities. In some cases, the technology was tested first in facilities before being used in homes.
- Bed sensors and non-video kinetic imaging can be used to detect functioning, movement, and fall risk within a facility. There is limited agreement on how much of this technology will be adopted and how much will be acceptable to residents and caregivers. Nonetheless, it is thought to hold promise for addressing anticipated future staffing issues.
- Concerns are being raised regarding how to regulate the use of advanced activity-monitoring and sensing equipment by family caregivers in facilities that are staffed by professional care providers and assistants.

Principles suggested to guide selection and use of AIHAMS technology in Minnesota

- Technology should only be deployed with the full consent of the person being monitored and/or family members.
- Technology applications should follow the guidelines associated with person-centered care⁵ and consider complex conditions.
- The technology recommended to family members served by state and county government agencies should be the least invasive and simplest to use, highly reliable, and appropriate for the needs that are identified.

⁵ Person-centered care “refers to an orientation to the delivery of health care and supportive services that considers an older adult’s needs, goals, preferences, cultural traditions, family situation, and values... Services and supports are delivered from the perspective of the individual receiving the care, and when appropriate, his or her family.” (Feinberg, 2012)

- Technology applications should only be used when there is assurance of sufficient training and ongoing technical support.

Cautions going forward with the application of AIHAMS

- The sheer range and diversity of AIHAMS technology is great and new developments occur often. Adoption and use of the technology by consumers will improve as guidance and follow-up expand.
- Commercial interests are vying for market share. However, most commercially available systems have not been tested for efficacy from a caregiver's point of view, nor have many been tested to determine how they will impact health outcomes for the care recipient. There is likely a role for both government and non-profit organizations to monitor developments in the marketplace and to guide older adults in their consideration of these various technologies.
- Reimbursements and financial assistance should be negotiated so that equipment costs and monthly fees for technology will remain accessible to lower-income individuals and families.

Implications for state planners and lawmakers

- Educate and inform the public about how AIHAMS technology might benefit those who seek to age in place.
- Consider regulations that make safety shut-off sensors mandatory on all new gas and electric ranges sold in the state or readily available to those who could benefit from them.
- Strengthen the rural broadband system to enable the use of AIHAMS technology in more rural areas of the state.
- Invest support in one or more state agencies or concentrate attention on this issue through an interagency collaboration. In general, ensure that the State of Minnesota stays abreast of the technology available, reviews potential new applications, and examines studies of effectiveness and consumer satisfaction, in order to make informed recommendations regarding policy and products.

- Most experts consulted for this report recognize that understanding and supporting some AIHAMS innovations could have significant value. In particular, they see that AIHAMS technology has the potential to ease the burden of care for a fast growing aging population and provide significant, long-term savings for families and health systems. However, they also recognize the up-front investment that will be required to develop the knowledge and background necessary to do this work wisely and effectively.

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Appendix A—Key experts interviewed*

Mark Anderson, Knute Nelson

Paul Bernstein, Consultant, Gadget Guy

Catherine Blonigen, Lutheran Social Services

Sharon Blume, Lutheran Home Association

Konnie Evans, Knute Nelson

Dr. Joseph Gaugler, University of Minnesota, School of Nursing

Sara Hage, Pioneer Care

Jennifer Halberg, Catholic Charities of Southern MN

Shelley Holden, Northfield Retirement Community

Kate Ingalls-Maloney, Augustana Learning Lab

Daphne Karpan, Consultant

Professor Marilyn Rantz, Tiger Place, MO School of Nursing

Sue Redepenning, Director, Live Life Therapy Solutions, a grant contractor for MN DHS
Technology for Home

Kian Saneii, Founder & CEO, Independa, Inc.

Paul Wessel, St. John's Lutheran Home

Chad Wojchik, Senior LinkAge Line®

* The name of one key expert has been withheld

Appendix B—Remote Activity Monitoring Study, Dr. Joseph Gaugler

Sensor-based technologies that operate remotely and are non-invasive could assist family caregivers monitor the daily function of persons with Alzheimer’s Disease or a Related Dementia (ADRD). The eNeighbor technology platform includes a combination of remote sensors that are located in key areas of a person with ADRD’s home (e.g., bed, medicine cabinet or refrigerator doors, toilet, and living rooms). Such sensors can immediately communicate any function that is outside of an expected threshold for the person with ADRD to both a family caregiver and a care professional (e.g., nurse care manager). The goal of the remote health monitoring technology such as eNeighbor is to prevent negative health transitions such as falls or wandering events, and thus provides a more proactive intervention model than many clinical protocols that are currently delivered to family caregivers of persons with ADRD. The Lutheran Home Association, a non-profit long-term care provider located in Belle Plaine, Minnesota, has deployed eNeighbor in residential and home settings the past 5 years.

The objective of this 5-year demonstration project is to build on the work of The Lutheran Home Association and conduct an embedded experimental mixed methods evaluation to determine the efficacy of the eNeighbor technology in improving outcomes among persons with ADRD living in the community and their family caregivers. The Specific Aims are as follows:

- To compare 100 ADRD caregivers randomly assigned to an attention control with 100 ADRD caregivers who utilize eNeighbor over an 18-month period to determine if the use of the remote sensor technology results in a) significant ($p < .05$) increases in caregiver self-efficacy and sense of competence, b) significant decreases in caregiver distress (subjective stress, depressive symptoms), c) significant delays of or reductions in negative health transitions (falls, wandering events) and service utilization (residential care placement, hospitalizations) for persons with ADRD; and d) greater cost-effectiveness.
- To determine through “embedded” qualitative data collection components how eNeighbor is successfully utilized and why this health monitoring technology benefits persons with ADRD and their family caregivers.

- To engage stakeholders on a quarterly basis throughout this 5-year demonstration project in order to enhance the utility and stakeholder-relevance of health monitoring technology for families who care for persons with ADRD. We anticipate that the successful completion of the project aims will position the eNeighbor as an innovative, stakeholder-centric service that offers robust support for family caregivers of persons with ADRD in the community.

Appendix C—Methodology

In order to complete this report, Wilder Research was contracted to complete the following tasks:

- A review and summary of how and when this technology is being used
- A description of how and when monitoring technology may be linked to other assistive devices in the home, including safety devices, in-home lighting, telephones and computers, and medication management tools
- A description of how intermediary agencies (e.g. home and community-based services or health care providers) work with care recipients and families in the identification and application of monitoring strategies
- The creation or use of a basic taxonomy that is able to classify, describe, and define the types and potential applications of in-home monitoring strategies including the range and scope of the technology, and its uses, benefits, and limitations

To accomplish these tasks, Wilder Research completed the following research activities:

- A review and summary of current literature and research about AIHAMS technologies
- Use of a classificatory scheme (a modification of one recently suggested in the research literature) to define and describe a sample of existing products and service platforms
- A review and summary of current MN state-funded efforts to identify, implement, and assess the impact of AIHAMS technologies
- Telephone interviews with experts in the field of technology development and implementation, as well as with providers familiar with the experiences of end-users of the technologies

Appendix D—Products (Note that representation here does not imply any recommendation by the MN DHS)

Examples of biological or physiological monitoring technology

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements		Information monitoring	Product claims, Testimonials, and News articles
				Smartphone	Wireless internet		
Blood pressure monitor (Blip Care)	<p>Wireless monitor</p> <p>Reminders to take readings</p> <p>Data sent and stored automatically</p> <p>Track data from PC, tablet, smartphone</p> <p>Remote monitoring</p>	\$129	Yes	Yes	Yes	Can be forwarded to health care provider	<p>Blip Wi-Fi Bp has 510(k) OTC clearance from FDA and is CE marked.</p> <p>First Wi-Fi based Blood Pressure Monitor to be cleared by the FDA</p>
Wireless gluco-monitoring system (iHealth Smart)	<p>Wireless monitoring system</p> <p>Pocket-sized device connects to smart phone</p> <p>Quick results, accurate readings</p> <p>Tracks results via app</p> <p>Reminders for readings and insulin</p>	\$29.99	Yes	Yes	Yes	<p>Automatic connection via cloud</p> <p>Results can be exported to file</p>	FDA Approved and CE Certified

Examples of biological or physiological monitoring technology (continued)

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements		Information monitoring	Product claims, Testimonials, and News articles
				Smartphone	Wireless internet		
Wireless pulse oximeter (iHealth Air)	<p>Wireless device</p> <p>Measures blood oxygen level, pulse rate, perfusion index</p> <p>Portable, clips to finger</p> <p>Track results via app</p>	\$69.99	Yes	Yes	Yes	<p>Automatic connection via cloud</p> <p>Share info with health care providers/ caregivers</p>	Clinically tested and HIPAA compliant.
BodyGuardian remote monitoring system (Preventice Services)	<p>Wireless body sensor</p> <p>Monitors heart</p> <p>Prescribed by a doctor</p>	Paid through insurance, including Medicare	Not applicable	Yes	Yes	Data sent via cloud; accessed by health care providers	Patient testimonials

Examples of function and motion sensors and other passive detection applications

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements		Information monitoring	Product claims, Testimonials, and News articles
				Smartphone	Wireless internet		
Wander prevention alert watch (LOK8U Freedom)	Locator device Monitors location sent via email/text Water-resistant	\$29.95/month	Yes	Yes	Yes	Alert family members and others user chooses	Consumer reviews: http://www.lok8u.com/reviews/
Auto activated mobile medical alert (Live Life Alarms LLC.)	Personal mobile alarm Assistance call function (including 911 and personal contacts) GPS location sent via text Fall detection Waterproof	\$497.00	Yes	For receivers of emergency call	No	No	Swiss GPS German design reddot2015 winner Choice Magazine Winner 2017
Automatic stove turn-off with adjustable timer (CookStop)	Motion sensor timer Programmable timer and shut-off device Fire prevention	\$325	No	No	No	Caregiver help required to program	Product evaluation http://www.cookstop.com/files/125057646.pdf Consumer reviews
Wireless Wander Door Alarm (Safeguard)	Wireless alarm system Door or window sensor Wireless receiver/alarm carried by the caregiver	\$40.90	No	No	No	Caregivers Staff in facility	Consumer reviews

Examples of function and motion sensors and other passive detection applications (continued)

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements			Product claims, Testimonials, and News articles
				Smartphone	Wireless internet	Information monitoring	
Toilet seat sensor pad alarm (Easier Living Everyday Independence)	<p>Motion sensor</p> <p>Seat sensor alarm when person gets up unattended</p> <p>Reduces risks of falls and injury; increases privacy</p>	\$43.75	No	No	No	Attendant nearby	Not available
Wearable watch (Kanega Watch UnaliWear) (Available later in 2017)	<p>Voice controlled watch</p> <p>Connects to emergency assistance even when person can't speak</p> <p>Fall detection</p> <p>Voice activated directions</p> <p>Medication reminders</p> <p>Guide home assistance</p>		No	No	No	Connection to emergency operator	<p>Press:</p> <p>http://www.unaliwear.com/press/</p> <p>http://www.unaliwear.com/unaliwear-user-experience-test/</p>
Tempo™ Wearable watch (CarePredict)	<p>Wireless daily routine tracker</p> <p>Wrist sensor jewelry</p> <p>Senses daily living patterns and activities</p> <p>Real-time alerts</p> <p>Web-based dashboards</p>	Not available to consumers	Yes	No	Yes (via cloud)	Real-time communication with operators of senior living communities, home care, and caregivers	<p>News:</p> <p>https://www.carepredict.com/press/</p> <p>Industry research</p>

Examples of function and motion sensors and other passive detection applications (continued)

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements		Information monitoring	Product claims, Testimonials, and News articles
				Smartphone	Wireless internet		
BeClose (WH Interactive, LLC.) (technology partner w/Alarm.com)	Wireless daily routine tracker Wireless motion and weight sensors No cameras Remote caregivers alerted by phone, text, email	\$399-\$699	Yes	No	No	For caregivers via secure webpage	Press Release Piloted studies Better Business Bureau accreditation (A+)
Motion sensor pager (Smart Caregiver™)	Wander alarm motion sensor system Motion sensor reports movements within an infrared field Pager alarm	\$42.83	No	No	No	Caregivers	

Examples of safety and security monitoring

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements Smartphone	Wireless internet	Information monitoring	Product claims, Testimonials, and News articles
Indoor camera (Alarm.com)	Live streaming video (Smartphone or tablet) Includes night vision	\$85 - \$180	Yes	Yes	Yes	Caregiver	Consumer reviews
Video door bell (Sky Bell HD)	Smart video doorbell See/hear/speak to visitor at door from any location Triggered by motion sensor	\$199	Yes	Yes	Yes	Resident	Consumer reviews
Assured Living (Best Buy)	Customized sensor based notification Patterns in care recipients' activities Voice automation controls lights, locks, room temp Reminders for daily tasks, medications	\$389.96 \$29.99/month	Yes	Yes	Yes	Custom alerts sent to family/changes	News articles: https://www.bloomber.com/news/articles/2017-10-04/best-buy-bets-on-adults-remotely-monitoring-their-aging-parents

Examples of safety and security monitoring (continued)

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements		Information monitoring	Product claims, Testimonials, and News articles
				Smartphone	Wireless internet		
Smart thermostat (Sensi by Emerson)	<p>Wi-Fi intuitive app</p> <p>Remotely control and schedule home comfort</p> <p>Synced w/Alexa for voice control adjustments</p>	\$129.99	Yes	Yes	Yes	No	<p>Press releases: http://www.businesswire.com/news/home/20170117005039/en/Emerson%E2%80%99s-Sensi%E2%84%A2-Thermostat-Ranks-Highest-J.D.-Power</p> <p>January 2017</p>
Kelvin talking thermostat (SmartHome)	<p>Speech recognition technology</p> <p>Voice interactive for temperature adjustment and information</p>	\$129.95	No	No	No	No	<p>Consumer reviews: https://www.thegreenghead.com/2008/11/kevin-voice-activated-talking-thermostat.php</p>
Medical Alert System (Medical Guardian)	<p>Wearable medical alert button</p> <p>Wireless signal to base station with 2-way speaker</p> <p>Landline alert to monitoring center</p>	\$29.95-\$49.95/month	Yes	No	Yes	Devices connected to certified operators	

Examples of safety and security monitoring (continued)

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements		Information monitoring	Product claims, Testimonials, and News articles
				Smartphone	Wireless internet		
Fall button (MobileHelp)	<p>Medical alert emergency systems</p> <p>In-home and out-of-home fall detection</p> <p>Range of options: neck pendant, wrist button, mobile base</p>	\$10-\$41.95/month	Landline	Yes AT&T for patented GPS technology	No	24/7 emergency monitoring service	<p>The first FDA-registered mobile medical alert system</p> <p>Reviews: https://www.mobilehelp.com/resources-information/reviews/</p> <p>News and press releases: https://www.mobilehelp.com/about-mobilehelp/newsroom/mobilehelp-in-the-news.shtml</p>
24/7 medical alert (Belle and Belle+)	<p>Emergency alert pendant</p> <p>911 back-up calling</p> <p>Fall detection</p> <p>In-home/out-of-home</p> <p>Water-resistant</p> <p>24/7 monitoring</p>	\$39.95 to \$49.95/month	Cell phone service	Yes	Yes	Caregivers can locate 24/7 on web or mobile app	MN Department of Human Services approved Waiver provider (P.E.R.S.)

Examples of social interaction monitoring

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements		Information monitoring	Product claims, Testimonials, and News articles
				Smartphone	Wireless internet		
Oscar Senior (App store/Google Play)	<p>Tablet application</p> <p>Stay connected via video/text/calling/photos</p> <p>Access to games/news/internet browsing</p> <p>Screen visibility for vision impairment</p> <p>Remote programming/monitoring by caregiver</p>	\$4.99/month-\$18.99/month	Yes	Yes	Yes	Family can monitor	Designed with users, families and people from home health care agencies to meet real needs of seniors
Claris Companion (Claris Companion)	<p>Tablet</p> <p>Stay via email/text/photos/videos/video calling</p> <p>Remote monitoring of med/treatment/appointment compliance</p>	\$29/month	Yes	Yes	Yes	Caregivers receive alerts	Customer stories News articles
Gerijoy (A Care Coach service)	<p>Caregiving companion tablet</p> <p>Avatar companion via human control</p> <p>24/7 caregiver support</p> <p>Care reminders</p> <p>Social connection via photos/music/voice</p> <p>Emergency contact phone numbers</p>	\$249/month	Yes	No	Yes	Caregivers for home use Care providers in assisted living settings	Case studies

Examples of social interaction monitoring (continued)

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements		Information monitoring	Product claims, Testimonials, and News articles
				Smartphone	Wireless internet		
Telikin	Family computer Touchscreen device for video chat, photo sharing, email	\$699- \$1,299	Yes	No	Yes	No	Consumer reviews: http://www.telikin.com/
TelyHD	High definition Skype video calls Via HDMI compatible TV or via HDMI port		Yes	No	Yes	No	Press releases: http://www.tely.com/about/press-releases/
iN2L (Dignity Through Technology)	Picture-based touch screen tablet Person-centered technology Access to games/email/internet browsing/photos/videos Therapeutic use Home or senior living facility	\$300/home & \$49/month	Yes	No	Yes	Observation in senior facility	Testimonials: http://in2l.com/ideas-insights/testimonials/ Research: Univ of Washington, 1/2016 Univ of Toledo, 2013 Aging in PlaceTechnology Watch, 10/2017

Examples of cognitive monitoring (often paired with assistive devices or services)

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements		Information monitoring	Product claims, Testimonials, and News articles
				Smartphone	Wireless internet		
Personal voice reminder (Reminder Rosie)	<p>Personalized voice controlled clock</p> <p>Customized/multiple reminders for meds/appointments/daily tasks</p> <p>Works during power outages</p> <p>Hands-free operation</p>	\$119.95	No	No	No	Supports caregiver	<p>Testimonials: http://www.reminder-rosie.com/customers/</p> <p>Press release May 2017: Helps Patients with Memory Loss Achieve 80% Medication Compliance in Home Care Agency Pilot Study</p>
No-fuss pill box (Tricella)	<p>Pill box</p> <p>Notifications for missed or wrong pills</p> <p>Tracks compliance</p> <p>Syncs with phone</p>	\$74.99	Yes	Yes	Yes	Notifications to family members; can send reminders	
Medication tracking system (Pill Drill)	<p>Pill tracker</p> <p>Medication reminder</p> <p>Tracks/verifies meds intake</p> <p>Tracks mood or pain</p> <p>Create/edit medication schedule via app</p>	\$199.00	Yes	Yes	Yes	Health care provider Family/caregiver	<p>Awards: https://www.pilldrill.com/awards</p> <p>Testimonials: https://www.pilldrill.com/testimonials</p> <p>News: https://www.pilldrill.com/news</p>

Examples of cognitive monitoring (often paired with assistive devices or services) (continued)

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements		Information monitoring	Product claims, Testimonials, and News articles
				Smartphone	Wireless internet		
Medication dispensing system (TabSafe)	Medication management system Meds dispensed on a schedule Visual and audible reminders Refillable at pharmacy	< \$100	Yes	No	Yes	Pharmacist Family Caregiver	Award Testimonials: https://www.tabsafe.com/product/testimonials/
Hearing loss technology (TV Ears, Inc.)	Voice clarifying wireless TV headset Volume control through headset Reduced interference from room noise	\$129.95 analog	No	No	No	No	

Examples of integrating platforms, systems or applications that integrate two or more monitoring or sensing devices

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements		Information monitoring	Product claims, Testimonials, and News articles
				Smartphone	Wireless internet		
All in one caregiver dashboard (Independa) (In partnership with LG and Samsung)	<p>Smart TV “Angela” remote control</p> <p>Caregiver sends alerts via app to “Angela” for medicine/appointment/tasks reminder</p> <p>Photo and video sharing</p> <p>Video chat</p> <p>Call button to contact family</p>	\$396.95	Yes	Yes	Yes	<p>Family gets updates</p> <p>Customize phone or computer with Independa app</p>	<p>News: https://independa.com/about/pr/#.We5epXZryM8</p> <p>Facebook</p>
Smart home system (Iris Smart Hub by Lowes)	<p>Smart home security network</p> <p>Connects all compatible smart products through Iris app</p> <p>Turns lights on and off</p> <p>Burglar alarm alerts</p> <p>Live stream video</p>	<p>\$69.99</p> <p>\$9.99- \$14.99/month</p>	Yes	Yes	Yes	Caregiver	https://www.irisbylowes.com/blog/

Examples of integrating platforms, systems or applications that integrate two or more monitoring or sensing devices (continued)

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements		Information monitoring	Product claims, Testimonials, and News articles
				Smartphone	Wireless internet		
Remote monitoring service (Healthsense, renamed Lively Home)	<p>Remote monitoring solution</p> <p>Unobtrusive sensors track and monitor daily activity</p> <p>Real time response to health concerns</p>	Call for cost	Yes	Yes	Yes	Alerts caregivers to changes in care recipient's normal routine	<p>Testimonials: http://healthsense.com/about-healthsense/testimonials</p> <p>Study: Remote Monitoring at Home Brings Lower Costs and Better Outcomes</p>
Large touchscreen (GrandCare Systems)	<p>Multi-purpose system with touchscreen interface</p> <p>Web-based communication via sensors in home for home health, senior living community, hospice</p> <p>Social interaction, med prompts, task reminders</p>	Call for consultation	Yes	Yes	Yes	Through GrandCare website/online portal	<p>Awards & testimonials: https://www.grandcare.com/resources/awards-testimonials/</p>

Examples of integrating platforms, systems or applications that integrate two or more monitoring or sensing devices (continued)

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements		Information monitoring	Product claims, Testimonials, and News articles
				Smartphone	Wireless internet		
Multifunction Wearables (Fitbit and Apple Watch)	Wearable tracker Tracks activity, health, weight, food intake, sleep Sync info from device with phone or computer	\$129.95 – \$399.00	Yes	Yes	Yes	Online and mobile tools track data	Fitbit: www.fitbit.com/whyfitbit Apple: https://www.apple.com/watch/
Fitbit Tracker Ultra (Fitbit)	Wireless activity & sleep tracker Tracks activity, health, weight, food intake, sleep Sync info from device with phone or computer	\$99.95	Yes	Yes	Yes	Online and mobile tools track data	Customer reviews News articles https://www.fitbit.com/lp/competitor
Assured Living (Best Buy)	Customized sensor based notification service Monitor patterns in activities Reminders for tasks, meds Voice automation controls lights, locks doors, room temperature	\$389.96 \$29.99/month	Yes	Yes	Yes	By sensor through Amazon Echo Alert caregivers to changes in patterns	News Articles: https://www.bloomberq.com/news/articles/2017-10-04/best-buy-bets-on-adults-remotely-monitoring-their-aging-parents https://www.mprnews.org/story/2017/07/27/best-buy-bets-on-tech-for-monitoring-elderly-parents

Examples of integrating platforms, systems or applications that integrate two or more monitoring or sensing devices (continued)

Product (manufacturer)	Technology details	Base cost	Service subscription	Requirements		Information monitoring	Product claims, Testimonials, and News articles
				Smartphone	Wireless internet		
Smart bed technology (BAM Labs is now SleepIQ LABS)	<p>Sensor technology</p> <p>Touch-free sensor under mattress</p> <p>Monitor heart/ respiration rates, motion bed-presence</p> <p>Non-intrusive</p>	Purchase through Sleep Number	Yes	Yes	Yes	Health care providers monitor via computer or mobile devices	<p>Press releases: http://bamlabs.com/blog-full-width/press-releases/</p> <p>Media resources: http://bamlabs.com/media-resources/</p> <p>News: http://bamlabs.com/blog-full-width/bamnews/</p> <p>Journal of Aging - peer-reviewed clinical study</p>
All in one caregiver dashboard (TheirCare - First Layer Health)	<p>Worldwide communication through television provider</p> <p>Works through existing remote control or mobile device</p> <p>Medication reminders</p>	Unavailable	Yes	Yes	Yes	Yes	

Appendix E

Specific Guidelines for Reimbursable Technology under Elderly Waiver and Alternative Care Grants

Specific guidelines define reimbursable technologies as either Personal Emergency Response Systems (PERS) or Monitoring Technology (MT). MT includes devices and services such as audio listening devices, cameras or video equipment, mobile on-person sensors or equipment, and sensors not on the person (e.g. GPS).

The federally approved **DHS Monitoring Technology/BI Waiver Plan** is described below:

Service Definition (Scope):

Environmental accessibility adaptations are physical adaptations to the participant's home or primary vehicle, required by the participant's community support plan, that are necessary to ensure the health and safety of the participant or enable the participant to function with greater independence. Examples of adaptations include the installation of ramps and grab-bars, widening of doorways, modification of bathroom facilities, installation of specialized electric and plumbing systems that are necessary to accommodate the medical equipment and supplies, or monitoring or surveillance systems* including cameras, motion detectors, GPS trackers, home security systems, and door and window alarms. The service also covers the necessary assessments to determine the most appropriate adaptation or equipment. The service may also cover installation, maintenance and repairs of environmental modifications and equipment. Repairs may only be covered when they are cost-effective given the condition of the item and compared to replacement of the item.

For purposes of the waiver, home refers to the participant's primary place of residence (i.e., not vacation homes). Exceptions to the requirement that home modifications be limited to the participant's primary place of residence, may be authorized by the case manager when the following criteria are met and documented in the participant's community support plan. The accessibility adaptation:

1. will enable active involvement of the participant with family members; and
2. is portable and can be used in a number of settings unless there is documentation that portable methods are not appropriate; and

3. is cost-effective compared to other services that would be provided in an environment that is inaccessible.

If, for any unforeseen reason, the individual does not enroll in the waiver (e.g., due to death or a significant change in condition), the local agency may bill for environmental accessibility adaptation as a Medicaid administrative cost.

*(a) Any agency or individual who creates, collects, records, maintains, stores, or discloses any individually identifiable participant data, whether in an electronic or any other format, must comply with the privacy and security provisions of applicable privacy laws and regulations, including:

- (1) the federal Health Insurance Portability and Accountability Act of 1996 (HIPAA), Public Law 104-1; and the HIPAA Privacy Rule, Code of Federal Regulations, title 45, part 160, and subparts A and E of part 164; and
- (2) the Minnesota Government Data Practices Act as codified in chapter 13.
 - (b) The agency or individual shall be monitored for compliance with the following provisions:
 - (1) The agency or individual must control access to data on participants according to the definitions of public and private data on individuals under section 13.02; classification of the data on individuals as private under section 13.46, subdivision 2; and control over the collection, storage, use, access, protection, and contracting related to data according to section 13.05, in which the agency or individual is assigned the duties of a government entity;
 - (2) The agency or individual must provide each participant with a notice that meets the requirements under section 13.04, in which the agency or individual is assigned the duties of the government entity, and that meets the requirements of Code of Federal Regulations, title 45, part 164.52. The notice shall describe the purpose for collection of the data, and to whom and why it may be disclosed pursuant to law. The notice must inform the participant that the agency or individual uses electronic monitoring and, if applicable, that recording technology is used;
 - (3) In accordance with Minn. Stat. § 245A.11, Subd. 7a (f) “a foster care recipient may not be removed from a program under this subdivision for failure to consent to electronic monitoring.” If an existing resident does not consent to electronic monitoring, the application for an alternative overnight supervision technology license will not be approved. If the participant does not consent, the case manager and the support planning team are responsible to ensure that the participant’s needs are met by alternative means.
 - (4) The use of environmental accessibility adaptations funding for monitoring technology requires an informed consent process. To ensure an informed consent process, the Case Manager and the participant or legal guardian must collaborate and determine:

- a) how the monitoring technology will be used;
- a) how their needs will be met if they choose not to use monitoring technology;
- b) possible risks created by the use of the technology;
- c) who will have access to the data collected and how their personal information will be protected; and
- d) their right to refuse, stop, or suspend the use of monitoring technology at any time.
- e) The participant's Community Support Plan must describe how the use of monitoring technology:
 - a) is the least restrictive option and the person's preferred method to meet an assessed need;
 - b) achieves an identified goal or outcome; and
 - c) addresses health, potential individual risks and safety planning.
- (5) Consent is not required for door and window alarms that do not record data, when used to supplement the supervision provided by an on-site caregiver.
- (6) Monitoring cameras must not be installed in bathrooms; and will only be permitted in bedrooms for complex medical needs or other extreme circumstances as approved by the Department. Department approval is not required when parents are monitoring minor children using cameras in bedrooms for purposes of health and safety. Electronic monitoring cameras must not be concealed from the participant;
- (7) Equipment that is bodily invasive, concealed cameras, and auto door or window locks are not allowed.
- (8) The State must review support plans of waiver participants with a proposed need for cameras in their bedroom. Support planning teams may consist of individuals with expertise in areas appropriate to meet the individual's needs.
- (9) Electronic video and audio recordings of participants shall be stored for five days unless: (i) a participant or legal representative requests that the recording be held longer based on a specific report of alleged maltreatment; or (ii) the recording captures an incident or event of alleged maltreatment under section 626.556 or 626.557 or a crime under chapter 609. When requested by a participant or when a recording captures an incident or event of alleged maltreatment or a crime, the recordings must be maintained in a secured area for no longer than 30 days to give the investigating agency an opportunity to make a copy of the recording. The investigating agency will maintain the electronic video or audio recordings as required in section 626.557, subdivision 12b.

Specify applicable (if any) limits on the amount, frequency, or duration of this service:

Environmental accessibility adaptations excludes adaptations or improvements to the home that add to the total square footage of the home or that are not of direct and specific benefit to the participant due to his/her disability, such as carpeting, roof repair, central air conditioning, kitchen and laundry appliances, swimming pools, etc.

Environmental Accessibility Adaptations are limited to a maximum of \$40,000 per year per waiver participant. When a participant has an approved modification based on requesting additional square footage, the rate maximum does not apply.

Adaptations that add to the total square footage of the home may be covered when it is necessary to build a new or modify an existing bathroom when all of the following criteria are met:

- The accessibility adaptation is necessary to accommodate a wheelchair.
- The accessibility adaptation is to an unlicensed private residence of the individual and is owned by the individual or a family member.
- The annual waiver and home care costs for the individual, including the cost of the environmental accessibility adaptations, does not exceed the overall waiver and home care costs (minus the cost of the adaptations) projected for the individual in the succeeding 12 month period following the adaptation.
- At least two comparison bids were received.
- An evaluation by an expert in the field of home modifications must be completed to determine whether the accessibility adaptation is necessary based on the health and safety needs identified in the participant’s community support plan. The expert must have no financial interest in the delivery of the accessibility adaptation.
- The accessibility adaptation is reasonable given the value and size of the home and is limited to materials that are the least costly and of reasonable standards.

The lead agency will determine whether the above criteria are met and will submit all documentation to the department for the final determination.

The Minnesota Department of Human Services Community-Based Services Manual provides the following guidelines on technology usage:

Page posted: 11/8/13	Page reviewed: 6/7/17	Page updated: 6/7/17
Legal authority	<u>Federally approved BI, CAC, CADI, DD and EW waiver plans, Alternative Care (AC) program (Minn. Stat. §256B.0913)</u>	
Definition	Monitoring technology supervision: The use of equipment to oversee, monitor and supervise someone who receives waiver/AC services. It can help keep people safe and support independence. The	

	<p>equipment used may include alarms, sensors, cameras and other devices.</p> <p>Affected participant: A person who, as a roommate or significant other who lives with the person and is not a caregiver, may have their personally identifiable information viewed or recorded by the monitoring technology.</p>
Applicability	<p>This policy applies to both new and existing monitoring technology equipment and supervision funded under one of the following home and community-based services (HCBS) programs:</p> <ul style="list-style-type: none"> • <u>Alternative Care (AC) program</u> • <u>Brain Injury (BI) Waiver</u> • <u>Community Alternative Care (CAC) Waiver</u> • <u>Community Alternatives for Disability Inclusion (CADI) Waiver</u> • <u>Developmental Disabilities (DD) Waiver</u> • <u>Elderly Waiver (EW).</u> <p>For information about the services under which monitoring technology is covered, see the following sections on this page:</p> <ul style="list-style-type: none"> • <u>Coverage under the BI, CAC, CADI and DD waivers</u> • <u>Coverage under the AC program and EW.</u>
Requirements	<p>Monitoring technology equipment usage and supervision must meet the following four requirements:</p> <ol style="list-style-type: none"> 1. Allow a caregiver to see, hear or locate a person 2. Be the most appropriate means (and the person’s preferred method) to address assessed need(s) and goal(s) 3. Monitor the person in real time 4. Achieve one of the following: <ul style="list-style-type: none"> • Increase independence • Address a complex medical condition or other extreme circumstance • Reduce or minimize critical incidents • Improve the quality of supports.
Examples	<p>Monitoring technology equipment might include:</p> <ul style="list-style-type: none"> • Audio listening devices • Cameras and video equipment (e.g., baby video monitors) • Mobile, on-person equipment (e.g., body sensors, GPS) • Sensors not on the person (e.g., motion sensors, door and window alarms). <p>Monitoring-technology usage can include the equipment as well as remote-based staff paid to provide oversight and support of a person.</p>

<p>Prohibited/not included</p>	<p>Monitoring technology cannot be for the convenience of the provider. Additionally, the following are prohibited:</p> <ul style="list-style-type: none"> • Auto-door and window locks • Cameras located in bathrooms • Concealed cameras • Equipment that is bodily invasive. <p>Monitoring technology usage does not include:</p> <ul style="list-style-type: none"> • <u>Personal Emergency Response Systems (PERS) for people on the BI, CAC, CADI, and DD waivers</u> that only have the function to summon assistance in an emergency-only situation • <u>PERS for people on the AC program and EW</u> that only have the function to summon assistance in an emergency-only situation • <u>Telemedicine</u> • Technology used by the provider agency or family member to monitor staff activities • Technology services paid for directly or indirectly through another service or payment source.
<p>Storage</p>	<p>The license holder or primary caregiver must store electronic video and audio recordings of participants for five days unless a participant or legal representative requests the recording be held longer based on:</p> <ul style="list-style-type: none"> • A specific report of alleged maltreatment • The recording captures an incident or event of alleged maltreatment. <p>In that case, the recordings must be maintained in a secured area for 30 days to give the investigating agency an opportunity to make a copy of the recording.</p> <p>HIPAA requirements</p> <p>All video, audio or other personally identifiable information must be treated consistently with HIPAA regulations.</p>

<p>Service and support plan requirements</p>	<p>The use of all monitoring technology must meet the following three requirements:</p> <ul style="list-style-type: none"> • Achieve an identified goal or outcome • Address health, potential individual risks and safety planning • Be the least restrictive option and the person’s preferred method to meet an assessed need. <p>The lead agency must update the person's support plan to describe how the use of the monitoring technology meets these three requirements.</p> <p>Camera/video usage in bedroom</p> <p>The use of a camera or video equipment in the person’s bedroom must meet the above three requirements and address a complex medical need or other extreme circumstance.</p> <p>The lead agency must update the person’s support plan to describe how the use of the camera or video equipment meets these four requirements. For more information about camera and video equipment use in the bedroom, see the <u>DHS approval</u> section.</p>
<p>Lead agency approval and ongoing review</p>	<p>The lead agency approves and oversees the use of all monitoring technology. When camera or video equipment is located in the person’s bedroom, <u>DHS must also approve</u>. The case manager collaborates with the person and his/her team to make sure monitoring technology is appropriate. Monitoring technology cannot be used without informed consent.</p> <p>Applicability</p> <p>The policy applies to both:</p> <ul style="list-style-type: none"> • On-going monitoring of people who receive waiver/AC services using monitoring technology • Monitoring technology equipment currently in use and previously purchased with waiver/AC funds. <p>Informed consent process</p> <p>As part of the informed-consent process, the lead agency must complete and keep a copy of each of the following in the person’s file:</p> <ol style="list-style-type: none"> 1. <u>Participant Consent for Use of Monitoring Technology, DHS-6789B (PDF)</u> 2. <u>Affected Participant Consent for the Use of Monitoring Technology form, DHS-6789C (PDF)</u>, if applicable (for a definition of affected participant, see <u>definition section</u>) 3. The updated support plan.

<p>Lead agency approval and ongoing review (continued)</p>	<p>Participant participation We recognize there will be times when the person's guardian may need to be heavily involved in this process. However, the participant, regardless of age, should be involved in the informed-consent and planning process as much as possible.</p> <p>When consent is not required Participants and affected participants do not have to give consent for door and window alarms that do not record personally identifiable data when used:</p> <ul style="list-style-type: none"> • To supplement the supervision provided by an on-site caregiver and address critical health and safety needs as documented in the support plan • By non-residential providers as part of normal business operations. <p>Ongoing review The lead agency must review annually. That review includes documentation in the support plan of:</p> <ul style="list-style-type: none"> • The monitoring technology that has been used • Progress toward achieving identified goal. <p>The lead agency must review as soon as possible if there is a(n):</p> <ul style="list-style-type: none"> • Change in guardianship or legal representative responsible for informed consent • Decrease in the participant's level of control over the monitoring technology • Increase in the number of critical incidents while using monitoring technology • Substantial change to in where, when or the amount of time that monitoring technology is used.
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<p>DHS approval of camera/video usage in bedroom</p>	<p>The lead agency must seek approval from DHS for all uses of cameras or video equipment in a person’s bedroom.</p> <p>Initial approval process</p> <p>To initiate a request for DHS approval, the case manager should complete and submit the <u>Monitoring Technology Approval Request, DHS-6789A</u>. It will require you to attach:</p> <ol style="list-style-type: none"> 1. <u>Participant Consent for the Use of Monitoring Technology, DHS-6789B (PDF)</u> 2. If applicable, <u>Affected Participant Consent for the Use of Monitoring Technology, DHS-6789C (PDF)</u> 3. The updated support plan (with clear language about how it is necessary to address complex medical needs or other extreme circumstances, as well as the other support plan requirements described in the <u>service and support plan requirements section</u>). <p>Exception</p> <p>DHS approval is not required when parents use cameras/video equipment in the bedroom to monitor minor children for health and safety purposes. The lead agency reviews these scenarios.</p> <p>DHS reauthorization</p> <p>Unless the lead agency requests a new review, DHS does not have to reauthorize the use of cameras/video equipment in bedrooms unless there is a(n):</p> <ul style="list-style-type: none"> • Change in guardianship or legal representative responsible for informed consent • Decrease in the participant’s level of control over the use of monitoring technology in bedroom • Increase in the number of critical incidents while using monitoring technology • Substantial change to in where, when, or the amount of time that monitoring technology is used.
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<p>Coverage under the BI, CAC, CADI and DD waivers</p>	<p>Environmental accessibility adaptations For the BI, CAC, CADI and DD waivers, the <u>environmental accessibility adaptations (EAA)</u> service covers approved monitoring technology equipment that is not shared (i.e., it would follow the person if/when they move). EAA includes the assessments necessary to determine the most appropriate equipment, and installation, maintenance and repairs of the equipment.</p> <p>Repairs EAA covers repairs only when they are cost-effective compared to the price to replace the item.</p> <p>Shared equipment Equipment that is shared as part of a foster care or supported living service arrangement is compensated within the framework for those services (under the “client programming and supports” component value). The lead agency may not authorize the equipment separately under EAA.</p> <p>24-hour emergency assistance service For the BI, CAC, CADI and DD waivers, the <u>24-hour emergency assistance</u> service covers on-going monitoring to support a person using the technology if he/she meets both of the following criteria:</p> <ul style="list-style-type: none"> • Live in his/her own home (i.e., not in a group residential setting, such as corporate foster care) • Went through the applicable monitoring technology approval process.
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<p>Coverage under the AC program and EW</p>	<p>Specialized equipment and supplies For the AC program and EW, the <u>specialized supplies and equipment service</u> covers approved monitoring technology equipment and monthly fees including:</p> <ul style="list-style-type: none"> • Individual evaluation or assessment to determine the most appropriate equipment • Installation when modifications to the physical structure of the home is not required • Maintenance and repairs, when they are cost-effective compared to the price to replace the item. • Monitoring service costs • Purchase or rental fees. <p>Environmental accessibility adaptations For the AC program and EW, the lead agency should authorize installation of monitoring technology equipment under the <u>environmental accessibility adaptations (EAA)</u> service when the equipment installation requires modifications to the physical structure of the home that are not easily removed.</p> <p>Items authorized under EAA should use the EAA HCPC codes and follow the EAA authorization limits.</p> <p>EAA includes:</p> <ul style="list-style-type: none"> • Installation • Maintenance • Necessary assessments to determine the most appropriate equipment • Repairs of the equipment.
<p>Additional resources</p>	<p><u>CBSM – 24-hour emergency assistance</u> <u>CBSM – Environmental accessibility adaptations (EAA)</u> <u>MHCP – EW and AC – Environmental accessibility adaptations (EAA)</u> <u>MHCP – EW and AC – Specialized equipment and supplies (SES)</u></p>