



REPORT TO THE PRESIDENT
Independence, Technology, and
Connection in Older Age

Executive Office of the President
President's Council of Advisors on
Science and Technology

March 2016





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The President's Council of Advisors on Science and Technology (PCAST) is an advisory group of the Nation's leading scientists and engineers, appointed by the President to augment the science and technology advice available to him from inside the White House and from cabinet departments and other Federal agencies. PCAST is consulted about, and often makes policy recommendations concerning, the full range of issues where understandings from the domains of science, technology, and innovation bear potentially on the policy choices before the President.

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President Barack Obama
The White House
Washington, DC 20502

Dear Mr. President:

We are pleased to send you this PCAST report on *Independence, Technology, and Connection in Older Age*. It is the second and final installment of PCAST's work on the topic of technology for graceful aging. The first was our letter report to you in October 2015 on technologies for hearing assistance.

The average age of the American population is increasing, and Americans want to continue to have active and productive lives as they age. The older adult population is diverse, made up of individuals with different economic circumstances, living situations, geographic locations, and language backgrounds, but predictable changes occur as people age.

Technology has played an important role in increasing life expectancy, but it also has an important role to play in increasing the quality of life, by maximizing Americans' ability to function in their later years.

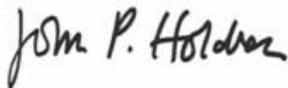
Last year marked the 50th anniversary of Medicare, Medicaid, and the Older Americans Act. At the 2015 White House Conference on Aging, discussions and new ideas inspired the direction of aging policy for the next decade.

Building on these ideas, PCAST looks in this second report at three areas where older adults experience change: social engagement and connectivity, cognitive function, and physical ability. PCAST investigated technologies that promote individuals' continued independence and productivity as these changes happen.

The report includes four cross-cutting recommendations that span a wide range of technologies and eight targeted recommendations concerning specific applications to improve mobility, cognitive function, and social engagement. Internet access, telehealth, monitoring technology, emergency preparedness systems, and intentional design are some of the technologies that will support healthy aging for all Americans. The report focuses on near-term Federal actions to advance these possibilities.

Older adults can bring the experiences and knowledge of their lifetimes to be vital, contributing, and productive members of society. Implementing these recommendations will help that happen, by ensuring that Americans now and in the future remain independent and connected as they age.

Sincerely,



John P. Holdren
Co-Chair



Eric S. Lander
Co-Chair



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Executive Summary and Recommendations

The U.S. population is getting older, and Americans are living longer, on average, than they ever have before. As they age, people are healthier and more active than the generations before them and have fewer functional limitations such as difficulty walking or blindness. Studies show that people are happier on average as they advance into their later decades and enjoy high levels of accumulated knowledge and experience.

Getting older is a time of social, emotional, mental, and physical change. Retirement might change how a person interacts socially every day, affecting a person's mood and well-being. Cognitive aging—the normal process of cognitive change as a person gets older—can begin, or a permanent change in physical function may arise. Technology offers a path for people who are navigating these changes potentially to prevent or minimize the risks associated with them and to enhance people's ability to live their lives fully. We, the President's Council of Advisors on Science and Technology (PCAST), sought to identify technologies and policies that will maximize the independence, productivity, and engagement of Americans in their later years.

Study Scope

Advances in technology hold great promise for adding to the lives of older adults. Our study focused on four key changes older Americans often experience: hearing loss; loss of social engagement and connectivity; cognitive change; and physical change. PCAST issued a letter report on technologies for hearing assistance in October 2015. The current report is the second and final report of the study and addresses the three remaining areas. In light of the many promising technologies that exist, this report is selective rather than comprehensive. It considers technologies important to the key areas, rather than specific diseases and situations, and it focuses on technologies that could have an effect broadly and in the near future. Chapter 1 introduces the three areas and cross-cutting themes. Chapter 2 describes technologies for social connectivity and emotional health. Technologies to address changes in mental ability are discussed in Chapter 3. Chapter 4 describes technologies to address changes in physical ability.

Although this report is split into chapters, the concepts are inter-related. For example, lack of mobility can affect social engagement that can affect cognitive decline. This means that these areas cannot be addressed successfully independently; rather, a systematic approach is needed for to increase independence. This observation underlies our strong recommendation that the Federal Government create a standing cross-departmental, multi-agency council with responsibility and meaningful authority to address all these issues.

Social Connectivity and Emotional Health (Chapter 2)

Three common ways older adults engage with the world include social participation, employment and volunteerism, and accessing information and resources. Interacting with family and community groups and being active in organizations can increase a person's health and reduce the risk of disability or

death, and technology can assist with promoting such engagements. Social participation can be enhanced through social media, interactive online games and collaboration tools, or websites that introduce people to others with common interests. People may find new employment and volunteer activities with online job training and volunteer-networking websites, or they may increase or maintain their productivity and skills by taking advantage of universal design elements of software or by teleworking. A number of websites give people access to curated information targeted for older audiences and to government services.

In 2013, over half of older adults reported using the Internet—mostly to buy things, email, or seek out information such as the news. Those who are not accessing the Internet cite a lack of interest or need, perceived level of difficulty, and inability to access the technology. There are large socioeconomic differences in populations who use the Internet and have access to and can afford broadband connection and those who do not. In addition, one factor that can be especially important to older adults is the need for training on how to set up and use information technology and the Internet. PCAST recommends Federal actions to expand affordable access to broadband in the homes of seniors and to provide support for training. Internet access at home should not be a luxury for those who can afford it; it has become like the telephone—a utility necessary to function in the modern world. Internet access and use underlie many of the technologies in this report.

In addition to helping with daily needs, older adults' connections to their families and communities are never more important than during emergencies. Superstorm Sandy descended on New York City in 2012 and showed how vulnerable older adults can be when the power goes out and cell towers are down. Mobility and cognitive impairments can inhibit people from getting the help they need, and those who are not tech-savvy may not find alternative sources of information during an emergency. We recommend that technology for current and future emergency communication systems be developed with the needs and capabilities of older adults in mind.

Changes in Cognitive Ability (Chapter 3)

In addition to changes in social connectivity and emotional well-being people may experience as they age, older adults are likely to experience mental or cognitive changes. Cognitive aging happens to most humans as they age and may affect a person's attention span, memory, and speed of processing. This phenomenon is separate from specific diseases like dementia. Monitoring systems are one set of technologies that can help a person remain independent longer as he or she experiences cognitive change. By unobtrusively recording the level of activity or whether a senior falls, monitoring can inform a trusted caretaker about the well-being of an adult with cognitive limitations without needing that adult to leave home. PCAST believes the National Institutes of Standards and Technology (NIST) should take an active role in addressing the privacy, security, and validity of monitoring technologies.

Because of changes in mental ability, older adults also can be targets of financial fraud. Whether victims are people who have spent their lives saving for retirement or older adults with little savings and working to make ends meet, fraud can be devastating. Financial exploitation of older adults is massively underreported, in part because of shame or the older adult's fear that their independence will be taken away. PCAST believes that technologies common in the credit-card industry should be readily available in the banking industry to detect fraud in bank and deposit accounts and that steps should be taken to

ensure that—when desired by seniors—trusted caregivers can have appropriate levels of information about older adults’ financial activity or health.

The third set of technologies relevant to changes in mental ability are cognitive enhancement or cognitive assistive systems. “Brain games” purported to increase a person’s cognitive ability are an enticing prospect for a person experiencing unwelcome cognitive decline. Many of these technologies have not been scientifically proven. The Federal Government has an important role to play in protecting consumers from paying for training services that advertise promises of increased cognitive skills that are not proven.

Changes in Physical Ability (Chapter 4)

Changes in physical function present some of the visible chronic changes an older adult might experience with age, but they are also changes that can be readily met with technological intervention. The foundation of ensuring that older adults or anyone with declining mobility can age in place is the design and updating of homes and other buildings with appropriate accommodations for universal access. The Department of Health and Human Services and the Department of Housing and Urban Development have important roles to play in stimulating the public and private sectors to adopt minimum design standards that will maximize people’s ability to age in their homes. Diseases like arthritis also can impede a person’s ability to manipulate objects in the home or in hospital and care settings and to take care of himself or herself on a daily basis. Changes to manual dexterity can make opening food packaging or using can openers or scissors an unbearable task. Guidelines for product design friendly to older adults can ensure that meal packaging does not require additional tools or significant hand strength to open them. The Consumer Product Safety Commission is the critical Federal lead in ensuring the safety of older adults in this space.

Wheelchairs, walkers, and scooters are vital technologies that can compensate for mobility loss and are a critical part of maintaining or restoring a person’s ability to move about the home, community, and beyond. Wheelchair users over decades have experienced changes in the durability, cost, and features of wheelchairs. These changes are driven in part by Medicare payment policy. Given advances in materials, electronics, manufacturing, and more, improved features such as weight, strength, battery life, and comfort in wheelchairs should be within reach of consumers. The Veterans Administration and the Centers for Medicare and Medicaid Services should lead a multi-agency task force with industry and users to create a roadmap for improved wheelchairs within the next decade.

For those people with limited physical function, Internet access provides an increasingly popular avenue for ensuring patients obtain necessary medical care from home. Telehealth, the process of providing or obtaining health care by telephone, videoconference, email, monitoring technologies, or web interfaces, provides many services. Hospitals are running pilot programs to understand how telehealth can help ensure follow up care is complete. Mental health professionals are able to provide services to remote patients. Health-insurance subscribers can call nurse help lines to check if their symptoms require medical attention. Broadband access at home provides the basis for video conferencing and web links to care providers, and changes to reimbursement policies from the Centers for Medicare and Medicaid will help older adults get needed services at home.

Recommendations in Summary

Cross-Cutting Recommendations

Recommendation 1: Integrating Federal Action

Optimizing Federal support for independent aging requires coordinated action in health, housing, transportation, communications, energy, education, environment, and public safety.

1. The Office of Science and Technology Policy (OSTP) should create a one-year Task Force of the National Science and Technology Council that will identify technologies vital to an aging population, focused on enhancing work between agencies.
2. The Department of Health and Human Services (HHS) should support a standing private-public council, with private-sector leaders from industry, academia, and advocacy organizations to advise on sector-wide ways to advance technology in the service of improving quality of life for older people.

Recommendation 2: Engagement and Social Connectivity

Access to Internet communications is essential to health, social engagement, and well-being.

1. The HHS Administration for Community Living (ACL) and the National Telecommunications & Information Administration (NTIA) at the Department of Commerce (DOC) should create a national plan to ensure all older people have broadband Internet access.
2. The Federal Communications Commission (FCC) should ensure that older adults are included, as are school children, in all negotiated agreements for Federal telecommunications approvals.
3. FCC and NTIA should create a plan, including a matching program with private support, to support training centers in accessible distance for all older people.

Recommendation 3: Monitoring Technology for Frail and Vulnerable Elders

Monitoring holds great promise for predicting problems and enhancing safety of people at risk, and the Federal government could promote the needed frameworks and standards to encourage innovation and access to this service.

1. The National Institute of Standards and Technology (NIST), in collaboration with the private sector, should develop guidelines for marketing and instructional materials to ensure that consumers understand the operational requirements, benefits, and risks of various monitoring technologies.
2. NIST, in collaboration with the private sector, should develop guidance to identify privacy and security risks in a way that does not pose undue barriers to innovation and adoption.

Recommendation 4: Research is Needed to Spur Further Innovation

The National Institutes of Health (NIH), HHS Agency for Healthcare Research & Quality (AHRQ), the National Science Foundation (NSF), the Veterans Health Administration (VHA), the Department of

Defense (DOD), and the Defense Advanced Research Projects Agency (DARPA) should support interdisciplinary and translational research including robotics, advanced mobility technologies, communications technology with special emphasis on emergency situations, cognitive training, and home monitoring.

Issue-Specific Recommendations

Recommendation 5: Education and Training in Online Technologies

The Administration should support ongoing reauthorization of the Older Americans Act and build on the provisions in Section 415 to ensure access to online services and protection from scams and fraud, tailored to the learning needs of older adults. Corporation for National & Community Services (CNCS) should expand Senior Corps to include older people with literacy and skills in technology use.

Recommendation 6: Emergency Response and Communications

Older people are especially vulnerable in disaster and emergency situations.

1. The Federal Emergency Management Agency (FEMA) at the Department of Homeland Security (DHS) should advance national strategies to create effective communications systems that reach isolated and vulnerable older people.
2. Within HHS, the Office of the Assistant Secretary for Preparedness and Response (ASPR), the Office of the National Coordinator for Health Information Technology (ONC), and the Centers for Medicare & Medicaid Services (CMS) should promote more rapid interoperability of medical information to ensure timely access whenever and wherever a patient may appear.
3. FEMA, ASPR, and CMS should advance policies that make medical device interfaces more consistent and interoperable to ensure timely access to people who depend on these devices.

Recommendation 7: Financial Services

The Federal Government should encourage the banking and financial services sector to offer monitoring services to protect assets from fraud and exploitation.

1. Signatories to the 2013 Interagency Guidance on Privacy Laws and Reporting Financial Abuse of Older Adults should accelerate expectations of banks to offer a range of available protective services.
2. The Executive Office of the President should convene State governors to ensure that reports of suspicious activity are reported to relevant adult protective services agencies.

Recommendation 8: Cognitive Training

The Federal Trade Commission (FTC) should continue to enforce regulatory review and guidelines for commercial cognitive training products.

Recommendation 9: Improve Regulation and Payment to Reflect Innovation in Telehealth

HHS should convene the Federation of State Medical Boards and the National Governors Association to accelerate reciprocal state licensure policies. CMS should use the full capacity of the Innovation Center to advance payment policies that support innovation in telehealth.

Recommendation 10: Home Design to Sustain Independence

HHS should work with the Department of Housing and Urban Development (HUD) to streamline and strengthen regulations and payment policies that govern home accessibility standards in order to promote uniform standards allowing efficient use and changes in technological support systems. This is especially important for retirement communities.

Recommendation 11: Improving Product Design for Older Adults' Needs

The Consumer Product Safety Commission (CPSC) should work with AARP and other relevant groups to accelerate better design guidelines for senior-friendly packaging, especially of technology and essential products like food and medical supplies.

Recommendation 12: Future Role of Assistive and Robotic Technologies

Advances have been made in wheelchairs and other mobility-necessary technologies, but Medicare payment policies inhibit access and market innovation.

1. CMS should examine current payment policies and implement changes that allow people to buy higher-functioning products with some Government support.
2. A multiagency and industry task force led by VHA, DOD, DARPA, and HHS should recommend a ten-year roadmap for improving wheelchair functional capabilities.



1. Introduction and Cross-Cutting Issues

The United States is an aging society, and most Americans can look forward to living longer lives than ever before. The average child born in 2013 can expect to live until 79 years of age, which is almost a decade longer than children born in 1960.¹ As a result of the rapid increase in life expectancy, 46 million Americans—about 15 percent of the total US population—were over the age of 65 in 2014 (Figure 1).²

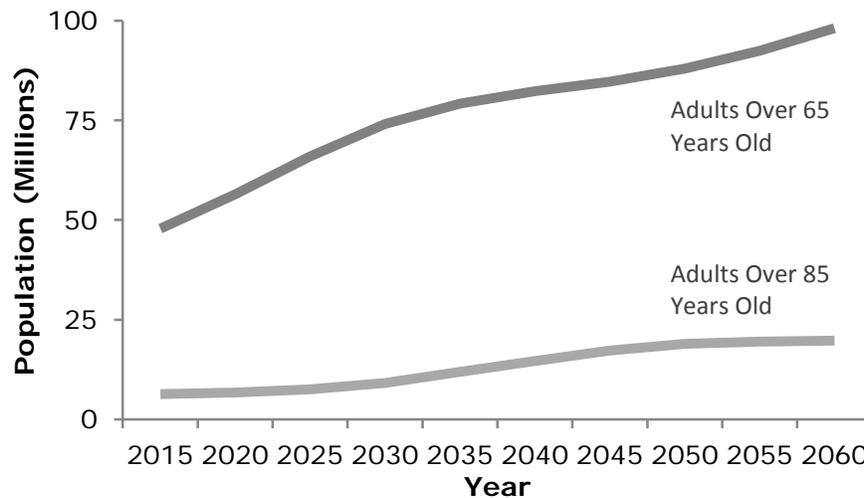


Figure 1. Projections of the number of U.S. older adults.³

Increasing life expectancy has also been coupled with healthier aging. Many people can expect to remain active well into their eighth and ninth decades of life. In fact, the number of older Americans dealing with functional limitations, like difficulty walking or blindness, steadily declined each year during the twentieth century.⁴ There have been broader improvements in the health of older adults, with more

¹ Xu, J., Murphy, S.L., Kochanek, K.D., Bastian, B.A., "Deaths: Final Data for 2013," *National Vital Statistics Reports*, 64(2): 1-118, 2016.

² Annual Estimates of the Resident Population for Selected Age Groups by Sex for the United States, States, Counties, and Puerto Rico Commonwealth and Municipios: April 1, 2010 to July 1, 2014.

Source: U.S. Census Bureau, Population Division, Release Date: June 2015.

³ See: www.census.gov/population/projections/data/national/2014.html.

⁴ Cosa, D.L., "Changing chronic disease rates and long-term declines in functional limitation among older men," *Demography*, 39(1): 119-137, 2002; and Cutler, D. and Wise, D., eds. "Health at Older Ages: The Causes and Consequences of Declining Disability among the Elderly", University of Chicago Press, 2009. See: papers.nber.org/books/cutl08-1papers.nber.org/books/cutl08-1.

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reporting excellent or very good health status (over 40 percent), declining numbers of hip fractures, and fewer preventable hospitalizations.⁵

People do face predictable changes as they get older. Some are challenging. These can include chronic diseases, depression, and difficulty completing routine activities without joint pain.⁶ Two-thirds of older adults have multiple chronic conditions, such as arthritis, diabetes, cardiovascular conditions, or depression.^{7,8} Chronic conditions and other health needs can lead to functional limitations. The Congressional Budget Office estimates that one-third of people over age 65, and two-thirds of people over age 85, have some functional limitation now.⁹

Caregivers are critical throughout the course of Americans' lives, and they can play an important role for older adults. One study estimated that two-thirds of people turning 65 will need some type of support for functional limitations during their lifetime, with an average need of three years of long-term services and supports.¹⁰ Other research suggests that future older adults may struggle with more chronic diseases and disabilities due to obesity and other risk factors (Figure 2).¹¹ Providing supportive services for older adults with functional challenges will affect how families, States, and the Federal Government use their resources.¹²

Many older adults would like to age in place, remaining in the home and community that they have lived in for years. An AARP survey estimates that almost 90 percent of older adults would like to stay in their homes for as long as possible.¹³ In some areas of the country, older adults are aging in place at such a scale that "naturally occurring retirement communities" have formed. In addition to improving people's quality of life, keeping people healthy in their homes can reduce Medicare and Medicaid expenditures.

⁵ UnitedHealth Foundation, "America's Health Rankings: Senior Report. 2015 Edition." See: www.americashealthrankings.org/senior.

⁶ *ibid.*

⁷ Centers for Medicare and Medicaid Services, "Chronic conditions among Medicare beneficiaries, Chartbook, 2012 edition," 2012. See: www.cms.gov/research-statistics-data-and-systems/statistics-trends-and-reports/chronic-conditions/downloads/2012chartbook.pdf.

⁸ Centers for Disease Control and Prevention (CDC), "The state of aging and health in America 2013," Atlanta, GA: Centers for Disease Control and Prevention, US Department of Health and Human Services, 2013. See: www.cdc.gov/aging/pdf/state-aging-health-in-america-2013.pdf.

⁹ Hagen, S., "Rising demand for long-term services and supports for elderly people," Washington, DC: Congressional Budget Office, 2013. See: www.cbo.gov/sites/default/files/113th-congress-2013-2014/reports/44363-LTC.pdf.

¹⁰ Kemper, P., Komisar, H.L., Alecxih, L., "Long-Term Care Over an Uncertain Future: What Can Current Retirees Expect?" *Inquiry*, 42: 335–350, 2005.

¹¹ Gaudette, E., Tysinger, B., Cassil, A., Goldman, D., "Health and Health Care of Medicare Beneficiaries in 2030," *Forum for Health Economics and Policy*, 18(2): 75-96, 2015.

¹² Hagen, S., "Rising demand for long-term services and supports for elderly people," Washington, DC: Congressional Budget Office, 2013. See: www.cbo.gov/sites/default/files/113th-congress-2013-2014/reports/44363-LTC.pdf

¹³ Farber, N., Shinkle, D., Lynott, J., Fox-Grage, W., Harrell, R., "Aging in place: A state survey of livability policies and practices," AARP, 190, 2011.

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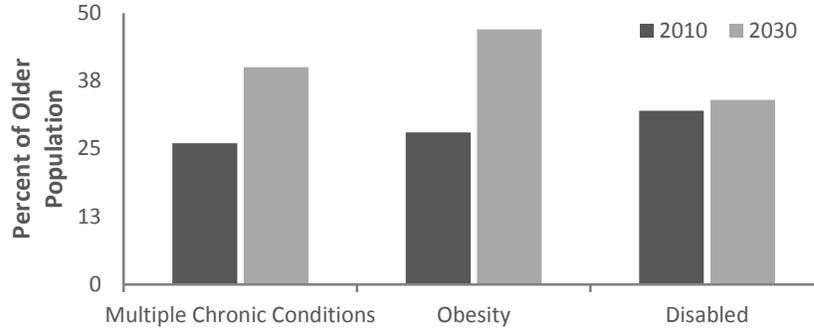


Figure 2. Potential future health challenges for older adults (projections from 2010 to 2030).¹⁴

To remain in the community, older adults may need specific supportive services and assistance. Some people may need support to manage chronic conditions and health ailments; others may need help with specific activities—such as managing money—even though they can manage all other aspects of their life. Some may need assistance with basic activities such as eating, bathing, and using the bathroom; others may only need help with instrumental activities such as managing medications, preparing meals, and shopping; and still others may just need support to be active broadly in social activities and hobbies.¹⁵

When a large portion of the community is older, local services can be overwhelmed, especially when such services are limited; there are older houses that need extensive maintenance, and few younger adults are nearby that can provide additional support.¹⁶ In these situations, technology may provide the necessary services that allow individuals to stay in the community, and some technologies may perform tasks that previously required a health care professional.¹⁷ Technology can also be useful for many other situations facing older adults.

Study Overview

Given the potential of technology to change how people live, work, and interact, the President’s Council of Advisors on Science and Technology (PCAST) undertook a study of technologies that could support older adults. Through a working group composed of PCAST members and national experts in multiple fields, it gathered information on the range of technologies available now or with the potential for

¹⁴ Gaudette, E., Tysinger, B., Cassil, B., Goldman D., “Health and Healthcare of Medicare Beneficiaries in 2030,” *Forum for Health Economics & Policy*, 18(2): 75-96, 2015.

¹⁵ Lawton, M. P., and Brody, E. M., “Assessment of older people: Self-maintaining and instrumental activities of daily living,” *Gerontologist*, 9: 179-186, 1969; also see: www.apa.org/science/about/psa/2004/02/rogers.aspx.

¹⁶ See: www.wsj.com/articles/communities-struggle-to-care-for-elderly-alone-at-home-1443193481.

¹⁷ Mynatt, E., Borrelli, A., Czaja, S., Iturriaga, E., Kaye, J., Nilsen, W., Siewiorek, D., Stankovic, J., “Trans-NIH/Interagency Workshop on the Use and Development of Assistive Technology for the Aging Population and People with Chronic Disabilities,” Computing Community Consortium, 1-15, 2015, See: cra.org/ccc/wp-content/uploads/sites/2/2015/06/CCC-AiP-White-Paper.pdf.

¹⁷ “Report to Congress: Aging Services Technology Study,” 2012. See: aspe.hhs.gov/basic-report/report-congress-aging-services-technology-study.

future development. The study identified technologies that address multiple goals for older adults: supporting independence; providing new opportunities for socialization, engagement, and education; assisting in self-management of chronic diseases; improving quality of life; expanding access to health care, preventive services, and wellness activities; ensuring safety and security, maintaining or reducing costs to individuals and society; and others.

Promising technologies are not being used for many reasons, including a paucity of structured programs for seniors themselves to acquire technology skills, lack of awareness by consumers, usability problems, physical and cognitive challenges to use the technology, or limited training for healthcare professionals.¹⁸ The study examined the barriers and challenges preventing the spread of potentially useful technologies. PCAST is recommending strategies to spur faster development and adoption of effective technologies.

The scope of the report is limited in two ways. First, the report considers common functional changes that occur to older adults, but not specific diseases. The chapters in the report each address a major dimension of change for many older adults: social engagement and connectivity, cognitive decline, and physical mobility. Second, the report does not make recommendations on every technology that could be useful for these problems—indeed, the study found hundreds of technologies that could be applicable. Rather, the recommendations are limited to those technologies with the greatest potential for short-term impact and where Federal action could have the greatest effect. By limiting its scope in this way, PCAST sought to make this report actionable in the short term.

Potential of Technology

Technology can help older adults stay active and independent as they age; it can increase social engagement and activities that add to a person's sense of purpose. Technologies also benefit caregivers who assist older adults with activities like taking care of routine health care needs and other daily living tasks. Caregivers are critical in technology adoption and use. Technology can support older adults wanting or needing to remain in the workforce, and many new technologies are emerging for a wide range of uses.^{19,20} One Federal database, AbleData (sponsored by the National Institute on Disability, Independent Living, and Rehabilitation Research), has inventoried over 24,000 assistive technology products, including prosthetics, therapeutic aids, and other tools for assisting with activities of daily living.²¹ Another more focused database, Technology for Long-Term Care, has identified over 1,200 technology products for people in long-term care settings.²²

¹⁸ Institute of Medicine and National Research Council, "Fostering independence, participation, and healthy aging through technology: Workshop summary," The National Academies Press, 2013; See: aspe.hhs.gov/basic-report/report-congress-aging-services-technology-study; also see: www.pewInternet.org/2014/04/03/older-adults-and-technology-use.

¹⁹ "Report to Congress: Aging Services Technology Study, 2012; see: aspe.hhs.gov/basic-report/report-congress-aging-services-technology-study.

²⁰ See: www.leadingage.org/SubSection.aspx?id=525.

²¹ See: www.abledata.com.

²² See: www.techforltc.org.

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A few examples illustrate technology's usefulness. Smartphone apps can allow a person to monitor fine motor control, which might be helpful for a patient with Parkinson's disease or multiple sclerosis.²³ Remote monitoring, wearables, and sensors can help seniors age in place while ensuring their safety and maintaining their health.²⁴ Basic home modifications can prolong independence and minimize the risk of falls. Predictive analytics and non-intrusive monitoring can protect older adults against financial scams or fraud. Technology, along with other changes, could also help slow (or prevent) the onset of disability.²⁵ Online "time banks" can allow seniors to donate services now in order to access help from others when they need it.²⁶ This is not to say that complex technology is always the solution—many times the answer may be relatively simple technology that can assist in common situations.²⁷

Technological advances can also be helpful to older Americans who want, or need, to continue working. Many older adults desire to continue to work, mentor, or be entrepreneurial.²⁸ The labor force participation for older adults has increased, rising from 13 to 17 percent during 2000-2010. This growth is expected to continue, with projections by the Bureau of Labor Statistics that the number of individuals in the workforce over the age of 65 will increase by over 80 percent between 2010 and 2020.²⁹ Online tools can help older adults to participate in the sharing economy,³⁰ and other technologies can help seniors work remotely. This would benefit society more broadly as those working people continue to expand the economy and pay taxes on their income. At the same time, older workers can have trouble finding any job, with some organizations unwilling to hire older workers,³¹ and other workers not finding the type of work that fits their capabilities, flexible work hours, or part-time work.³²

Many seniors rely on caregivers to assist them with their routine health care needs and other activities of daily living. Caregivers are critical in ensuring that technology succeeds; they also need technology to

²³ Daneault, J.F., Carignan, B., Codère, C.É., Sadikot, A.F., Duval, C., "Using a smart phone as a standalone platform for detection and monitoring of pathological tremors," *Frontiers in Human Neuroscience*, 6(357): 1-12, 2013. See: www.ncbi.nlm.nih.gov/pmc/articles/PMC3548411.

²⁴ See: www.huffingtonpost.com/paul-h-irving/aging-in-place_b_8056900.html.

²⁵ Institute of Medicine and National Research Council, "Fostering independence, participation, and healthy aging through technology: Workshop summary," The National Academies Press, 2013.

²⁶ linkAges TimeBank, David Druker Center for Health Systems, Palo Alto Medical Foundation, See: timebank.linkages.org.

²⁷ Institute of Medicine and National Research Council, "Fostering independence, participation, and healthy aging through technology: Workshop summary," The National Academies Press, 2013.

²⁸ Irving, P., and Chatterjee, A., "The Longevity Economy: From The Elderly, A New Source Of Economic Growth" *Forbes*, 2013, See: www.milkeninstitute.org/publications/view/687.

²⁹ Toossi, M., "Labor force projections to 2020: a more slowly growing workforce," *Monthly Labor Review*, 135: 43-64, 2012, See: www.bls.gov/opub/mlr/2012/01/art3full.pdf.

³⁰ See: www.nytimes.com/2015/09/26/your-money/the-sharing-economy-attracts-older-adults.html.

³¹ Heidkamp, M., Mabe, W., DeGraaf, B., "The Public Workforce System: Serving Older Job Seekers and the Disability Implications of an Aging Workforce," *NTAR Leadership Center*, 2012, See: www.dol.gov/odep/pdf/NTAR_Public_Workforce_System_Report_Final.pdf.

³² Irving, P., "Self-empowerment in Later Life as a Response to Ageism," *Generations*, 39(1): 72, 2015, See: www.milkeninstitute.org/publications/view/714.

help them meet their responsibilities. The needs of caregivers must also be taken into account in the design of technology systems.

Cross-Cutting Themes

As PCAST explored the different areas in this study, it uncovered several cross-cutting themes: heterogeneity of the older-adult population; the foundational role of Internet connectivity; monitoring within homes and communities; the need for more research; and technology standards. These are important considerations for implementing the specific recommendations found in later chapters.

The first important theme is that older adults in the United States are heterogeneous. The population of older Americans includes people in all economic circumstances and income levels; people who live in urban, rural, and suburban communities; people of all racial, ethnic, and language backgrounds; and people with different levels of physical and cognitive functioning. There are also significant differences in the uses of technology among seniors. Some older adults use technology extensively (especially younger, highly-educated, affluent seniors) and have smartphones, tablets, and online communication tools such as Skype or FaceTime to connect with family members, while others have limited engagement with technology or do not use information technology at all.³³ Multiple solutions will be needed to support older adults based on their capabilities and access to technology.

This diversity affects the recommendations throughout this report and suggests that one-size-fits-all solutions are unlikely to be effective; rather, different solutions and technologies may be needed based on the different needs of the particular individual and his specific capabilities. Versatile technologies that can be used by a wide range of older adults are likely to be the most effective.

The lessons from user-centered design approaches and universal design are applicable. Significant knowledge, much of it held by industry, already exists on how to design technology and user interfaces to make them most useful for all people (regardless of their age). This work can be extended to older adults by paying particular attention to how vision, memory, and dexterity of different people affect ways in which they interact with technology.

Another important theme is the foundational role of Internet connectivity. The Internet can allow older adults to interact with others to reduce social isolation, can provide new connections to health professionals through telehealth services, and can offer opportunities for intellectual stimulation. Unfortunately, many older adults do not use the Internet, although that number is rising quickly—from 14 percent in 2000, to 45 percent in 2010, to almost 60 percent in 2014.^{34,35} As noted in the next chapter, there are multiple reasons why older adults do not have access to broadband or any Internet connection—cost can be a barrier for those on fixed incomes, many rural areas still lack broadband connections, and there are few centers that teach older adults how to use and navigate online.

³³Pew Research Center, “Older Adults and Technology Use,” 2014, www.pewInternet.org/2014/04/03/older-adults-and-technology-use.

³⁴ U.S. Census Bureau, “65+ in the United States: 2010,” U.S. Government Printing Office, P23-212, 2014.

³⁵ Smith, A., “Older Adults and Technology Use,” *Pew Research Center*, 1-26, 2014, See: www.pewinternet.org/files/2014/04/PIP_Seniors-and-Tech-Use_040314.pdf.

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Related to this heterogeneity of older adults is the wide range of Federal agencies and programs that have grown to provide needed services. Each agency operates under a different mission relevant to successful aging. Health care services focus on medical needs while housing services emphasize independent living environments and veterans' services strive for continued participation in the community. While these services meet important specific needs, opportunities are lost for cross-agency support for aging adults, especially when integrated models of support could achieve greater support at lower costs. The aging of the population, in the United States and in countries around the world, calls for a more specific and thorough-going focus of government on the specific challenges and opportunities presented by longer lives. This reality affects national policy not only in health care, but in housing, transportation, communications, energy, and education as well as environmental and public safety on both the national and local level. The Office of Science and Technology Policy could play an important role in setting common goals for the agencies, and an independent academic and private-sector advisory group would be useful for sharing knowledge and experience for all sectors.

A third cross-cutting theme is the growing role of monitoring within homes and communities, which has been facilitated by new devices and fast Internet connections. Without remote monitoring technology, people have to be in a specialized facility (like a nursing home) to have their health monitored continuously. The advantage of monitoring is that its information can alert a family member, caregiver, or health professional to take immediate action if there is a fall or other problem. Studies have shown that remote monitoring can improve quality of life and reduce health care usage, for example by preventing hospitalizations.³⁶

These monitoring opportunities can be used to great benefit for reminders, predictions and possible prevention of events such as falls, threats to financial security, identification of problems with normal activities of daily living, or discovering vulnerable people in emergencies. Further innovation is needed to account for the diversity of situations where monitoring will be used (especially given the differences in each person's home and differences in each person's functioning), to improve ease of use for older adults, and to ease the burden of maintaining the technology.³⁷

Monitoring technologies also come with concerns about privacy, which vary.³⁸ Some people do not want any information shared about themselves, while others are willing to provide information about themselves via monitoring devices if it allows them to live with dignity and independence. As the

³⁶ Goldwater, J. and Harris, Y., "Using technology to enhance the aging experience: a market analysis of existing technologies," *Ageing International*, 36(1): 5-28, 2011.

³⁷ Mynatt, E., Borrelli, A., Czaja, S., Iturriaga, E., Kaye, J., Nilsen, W., Siewiorek, D., Stankovic, J., "Trans-NIH/Interagency Workshop on the Use and Development of Assistive Technology for the Aging Population and People with Chronic Disabilities," Computing Community Consortium, 1-15, 2015, See: cra.org/ccc/wp-content/uploads/sites/2/2015/06/CCC-AiP-White-Paper.pdf.

³⁸ "Report to Congress: Aging Services Technology Study, 2012. See: aspe.hhs.gov/basic-report/report-congress-aging-services-technology-study; and Mynatt, E., Borrelli, A., Czaja, S., Iturriaga, E., Kaye, J., Nilsen, W., Siewiorek, D., Stankovic, J., "Trans-NIH/Interagency Workshop on the Use and Development of Assistive Technology for the Aging Population and People with Chronic Disabilities," Computing Community Consortium, 1-15, 2015, See: cra.org/ccc/wp-content/uploads/sites/2/2015/06/CCC-AiP-White-Paper.pdf.

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technology matures, policies will need to be in place that specify how information is shared and promote confidence that monitoring technology supports dignity and independence.

The fourth theme is the need for more interdisciplinary and translational research into technologies that can support an aging population. Such research areas include home robotics, advanced mobility technologies and next-generation technologies for wheelchairs, communications technology (especially during emergencies) cognitive training and coaching, and home monitoring technologies.

The final theme is the importance of standards, as effective use of many technologies is stymied by limited standards. For example, many hearing aids are unable to communicate with people's cellular phones. Similarly, technologies need to be interoperable in order to exchange information, such as between remote devices and healthcare providers. There are further challenges in having information flow between long-term care facilities and other health care settings, such as hospitals or outpatient clinics.³⁹

The three key areas of the study and the cross-cutting themes led us to the four recommendations that underlie the technologies discussed subsequently in the report.

³⁹ Institute of Medicine and National Research Council, "Fostering independence, participation, and healthy aging through technology: Workshop summary," The National Academies Press, 2013.

Cross-Cutting Recommendations

Recommendation 1: Integrating Federal Action

Optimizing Federal support for independent aging requires coordinated action in health, housing, transportation, communications, energy, education, environment, and public safety.

1. The Office of Science and Technology Policy (OSTP) should create a one-year Task Force of the National Science and Technology Council that will identify technologies vital to an aging population, focused on enhancing work between agencies.
2. The Department of Health and Human Services (HHS) should support a standing private/public Council, with private-sector leaders from industry, academia, and advocacy organizations to advise on sector-wide ways to advance technology in the service of improving quality of life for older people.

Recommendation 2: Engagement and Social Connectivity

Access to Internet communications is essential to health, social engagement, and well-being.

1. The HHS Administration for Community Living (ACL) and the National Telecommunications & Information Administration (NTIA) at the Department of Commerce (DOC) should create a national plan to ensure all older people have broadband Internet access.
2. The Federal Communications Commission (FCC) should ensure that older adults are included, as are school children, in all negotiated agreements for Federal telecommunications approvals.
3. FCC and NTIA should create a plan, including a matching program with private support, to support training centers in accessible distance for all older people.

Recommendation 3: Monitoring Technology for Frail and Vulnerable Elders

Monitoring holds great promise for predicting problems and enhancing safety of people at risk, and the Federal Government could promote the needed frameworks and standards to encourage innovation and access to this service.

1. The National Institute of Standards and Technology (NIST), in collaboration with the private sector, should develop guidelines for marketing and instructional materials to ensure that consumers understand the operational requirements, benefits, and risks of various monitoring technologies.
2. NIST, in collaboration with the private sector, should develop guidance to identify privacy and security risks in a way that does not pose undue barriers to innovation and adoption.

Recommendation 4: Research is Needed to Spur Further Innovation

The National Institutes of Health (NIH), HHS Agency for Healthcare Research & Quality (AHRQ), the National Science Foundation (NSF), the Veterans Health Administration (VHA), the Department of Defense (DOD), and the Defense Advanced Research Projects Agency (DARPA) should support interdisciplinary and translational research including robotics, advanced mobility technologies, communications technology with special emphasis on emergency situations, cognitive training, and home monitoring.



2. Technologies for Social Connectivity and Emotional Health

Evidence indicates that engagement in family, community, and organizations helps to promote health and reduce the risk of mortality in later life.⁴⁰ Advances in several fields of technology in the 21st century have significantly changed and expanded how people interact with information, each other, and the greater world around them; in some cases, new technologies have replaced traditional methods of engagement completely.

Improving Engagement through Technology

Technology can assist Americans in reaching the engagement goals for older adults identified by the World Health Organization: social participation, employment and volunteerism, and access to information and resources.⁴¹

Social Participation

Social participation is strongly linked to improved physical and mental health⁴² and delayed cognitive decline.⁴³ Social participation often varies throughout life, with the most important changes occurring at common major events, such as retirement or losing a significant other or family member.⁴⁴ Although social isolation and loneliness may be linked to factors relating to the individual, a number of environmental factors can contribute to isolation, such as the absence of formal and informal social support structures or whether buildings and streets allow older adults with physical limitations to navigate them. Social isolation may exacerbate depression among older adults. This is a challenge given the number of older adults struggling with depression. Older men are at special risk of suicide.⁴⁵

Technologies can help Americans live fully in their later years. In cases where adults have physical barriers to leaving their homes or traveling, social-networking technologies can facilitate and increase

⁴⁰ Choi, N.G., Dinitto, D.M., "Internet use among older adults: association with health needs, psychological capital, and social capital," *Journal of Medical Internet Research*, 15(5): 97, 2013.

⁴¹ World Health Organization, "Global Age-Friendly Cities: A Guide," Geneva, 1-76, 2007; See: www.nyam.org/agefriendlynyc/docs/WHO_Global_Age_friendly_Cities_A_Guide.pdf.

⁴² Higgs, P., Nazroo, J., Hyde, M., "The relationship between health and social participation: Results from the English Longitudinal Study of Ageing (ELSA)," *Gerontologist*, 44: 288, 2004.

⁴³ Lovden, M., Ghisletta, P., Lindenberger, U., "Social participation attenuates decline in perceptual speed in old and very old age," *Psychology and Aging*, 20(3): 423-434, 2005.

⁴⁴ Alpass, F., Towers, A., Stephens, C., Fitzgerald, E., Stevenson, B., Davey, J., "Independence, well-being, and social participation in an aging population," *Annals of the New York Academy of Sciences*, 1114: 241-250, 2007.

⁴⁵ Centers for Disease Control and Prevention and National Association of Chronic Disease Directors., "The State of Mental Health and Aging in America Issue Brief 1: What Do the Data Tell Us?," *National Association of Chronic Disease Directors*, 2008, See: www.cdc.gov/aging/pdf/mental_health.pdf.

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access to social-support systems. Social networking use among Internet users ages 50 and older nearly doubled, from 22 percent to 42 percent between 2009 and 2010. In addition, 47 percent of Internet users ages 50–64 and 26 percent of users 65+ now use social networking sites.⁴⁶ Technologies to facilitate social participation include:

- Social media (Facebook, Twitter, Pinterest, Instagram)
- Virtual communities (Selfhelp Community Services)
- Real-time video conferencing/calling (Skype, FaceTime, Google Voice)
- Interactive applications and games (collaboration tools, social gaming, religious services)
- In-person facilitation technologies (Stitch, companionship websites, dating sites, Meetup)
- Social support applications (online spiritual care, Vincles, CareLinx, Honor)
- Blogging and Internet-forum platforms (Wordpress)

A number of technologies also being developed assist in creating a social support system for the smaller contingent of older adults who may be homebound or socially isolated. In Barcelona, Spain, the Vincles project uses an application to connect older adults, caregivers, health care providers, and social services through an online and mobile platform.⁴⁷ The application helps to create “circles of trust” among all of the people in an older person’s life (e.g., neighbors, service providers, and family members nearby and far away) that the older person can call upon when necessary. The Vincles project has leveraged both public and private funding from the city of Barcelona and the Bloomberg Philanthropies.⁴⁸ In the United States, applications like *Honor* are also attempting to change how older adults participate in their own care.⁴⁹ Customers can request home health aides, transportation, and housekeeping services, as well as companionship and check-up services to increase social engagement and prevent loneliness. Both caregivers and the older adults themselves can rate the services provided to them and customize how future caregiving is provided.

Employment & Volunteerism

Employment and civic participation among older adults have been closely linked to improved quality of life, reduced cognitive decline, and reduced risk of mental health decline such as depression.^{50,51,52} The benefits of prolonged employment and participation are often associated with greater sense of self-

⁴⁶ Smith, A., “Older Adults and Technology Use,” *Pew Research Center*, 1-26, 2014, See: www.pewinternet.org/files/2014/04/PIP_Seniors-and-Tech-Use_040314.pdf.

⁴⁷ Chesser, A., Burke, A., Reyes, J., Rohrberg, T., “Navigating the digital divide: a systematic review of eHealth literacy in underserved populations in the United States,” *Informatics for Health and Social Care*, 41(1): 1-19, 2015.

⁴⁸ BCN Smart City, “Vincles BCN,” Accessed March 14, 2016, smartcity.bcn.cat/en/vincles-bcn.html.

⁴⁹ Honor, “Home Care like You’re There,” Accessed March 14, 2016, www.joinhonor.com.

⁵⁰ Moen, P., Dempster-McClain, D., Williams, R.M., “Successful aging: A life-course perspective on womens multiple roles and health,” *The American Journal of Sociology*, 97(6): 1612-1638, 1992.

⁵¹ Hao, Y.N., “Productive activities and psychological well-being among older adults,” *Journals of Gerontology*, 63(2): S64-S72, 2008.

⁵² Adelman, P.K., “Multiple Roles and Psychological Well-Being in a National Sample of Older Adults,” *Journals of Gerontology*, 49(6): S277-S285, 1994.

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identity and purpose, as well as larger and more diverse social networks.^{53,54} Prolonged employment can also improve financial security and delay reliance on social insurance programs.⁵⁵ Phased retirement, job sharing, paid sick leave, flexible work schedules and locations, and other family- and life-course friendly workplace policies are needed to enable older people to remain in the workforce;⁵⁶ however, technology can also facilitate or inhibit continued employment.

The process of finding opportunities for work and volunteerism has radically shifted in the last decade, with recruitment, job listings and applications, and personal networking opportunities often only accessible online. In addition, technology has become essential to most industries and workplaces and continues to catalyze changes to business and workplace practices. Among older adult Internet users, 21 percent used the job-search and networking site LinkedIn.⁵⁷ This represents an eight percent increase from 2013 and is one of the most significant increases in utilization among all age groups. As these technologies are further developed for use by job-seekers and job-recruiters alike, many older adults will need to learn how to use these technologies to advance their careers.

Technologies to access employment or volunteer opportunities and resources include:

- Accessing professional development and training opportunities (Lynda.com)
- Online job boards and volunteer boards (Monster, Craigslist, Idealist, NYC Service)
- Reviews of industry, salary potential, and employer qualities (GlassDoor)
- Professional networking sites (LinkedIn)
- Increased capacity for staying engaged with work remotely through a suite of productivity tools tailored for professionals working from home or local co-working spaces (Office 365, Google Apps, GoToMeeting)

New technologies can allow older adults to leverage their skills, either for paid work as service providers or as volunteers. For example, older adults could volunteer their expertise via online mentoring programs, older adults who enjoy crafting could sell their products via online shops, and retired individuals could generate income on an as-needed basis providing transportation or technical assistance using service-based smartphone applications such as Uber or TaskRabbit. In addition, older

⁵³ Hao, Y.N., "Productive activities and psychological well-being among older adults," *Journals of Gerontology*, 63(2): S64-S72, 2008.

⁵⁴ Calvo, E., "Does Working Longer Make People Healthier and Happier?" *Munich Personal RePEc Archive* 5606, University Library of Munich, 2006.

⁵⁵ Johnson, R., "Should People Work Longer, and Will They? Fact Sheets on Population Aging," *The Retirement Policy Center*, 1-7, 2007.

⁵⁶ Finkelstein, R., Roher, S., Owusu, S., "Age-Smart Employer NYC: A Compendium of Strategies and Practices," *The New York Academy of Medicine*, 2013, See: www.agesmartemployer.org/wp-content/uploads/2015/01/ASE_Compendium.pdf.

⁵⁷ Duggan, M., Ellison, N., Lampe, C., Lenhart, A., Madden, M., "Demographics of Key Social Networking Platforms," *Pew Research Center*, 1-17, 2015, See: www.pewInternet.org/2015/01/09/demographics-of-key-social-networking-platforms-2.

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adults can take advantage of crowd-funding sites to fund projects in their local communities or support local organizations. Technologies could promote opportunities in the following areas:

- Mentoring (ICouldBe.org)
- Volunteering (Volunteermatch.org, AARP's CreateTheGood.org/Volunteer-Search)
- Access to and provision of goods/services through the sharing economy (Timebanks USA, Village to Village Network, Uber, TaskRabbit, LiftHero, Craigslist, AirBnB)
- Online storefronts (Etsy, Squarespace, Ebay)
- Fundraising and capital building (Kickstarter, GoFundMe, IndieGoGo)

Information & Resources

Older adults require access to information such as news, weather, traffic, home maintenance, personal finance, and recreation and culture to maintain their independence.^{58,59} Older adults frequently consume traditional forms of mass media,⁶⁰ however, much of the information they need has migrated online, including information about benefit and entitlement programs, banking and retirement savings records, affordable housing listings, patient portals, electronic health records, and access to health insurance. Web-based resources are taking a lead role for managing consumer health and well-being. As more resources become completely digitized, older adults who do not have an Internet connection must rely on formal and informal networks to access vital information. Even when they have access, older people with low digital literacy may have more difficulty understanding content presented online.⁶¹ Inaccurate comprehension of health- and emergency preparedness-related information can pose a significant threat to health and safety.

If older people are connected and trained to use new technologies that generate more relevant, timely, personalized and location-based information, they will be able to meet their needs faster, more efficiently, and, in many instances, without leaving their homes. This is beneficial for those who are homebound due to physical or cognitive impairment or who are transportation disadvantaged. Technologies can facilitate access to information in the following areas:

- Housing information (Craigslist, affordable housing listings/lotteries, NYC Housing Connect)
- Arts/culture and event information (discounts, schedules, NYC-Arts Cultural Guides for Seniors)
- Education and training opportunities (Massive Open Online Courses [MOOCs], EdX, agefriendlycollege.org, Lynda.com)
- Information about benefit and entitlement eligibility (accessnyc.gov)

⁵⁸ Walker, J., Herbitter, C., "Aging in the shadows: social isolation among seniors in New York City United Neighborhood Houses of New York," *UNH Special Report*, 2005. See: www.unhny.org/LiteratureRetrieve.aspx?ID=95124.

⁵⁹ Williamson, K., "Older Adults: Information, Communication and Telecommunications," PhD thesis. Melbourne: RMIT, 1995.

⁶⁰ Simmons Market Research Bureau, "The 1996 Study of Media and Markets," Simmons Market Research Bureau, 1997.

⁶¹ Farnsworth, M., "Differences in perceived difficulty in print and online patient education materials," *The Permanente Journal*, 18(4): 45-50, 2014.

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- Information about finances and regulations (online tax filing such as Tax E-File with H & R Block, access to stock and financial records from home such as E*Trade)
- Information about local businesses, services, and products, including reputability and safety (Yelp, Angie’s List, Amazon)
- Healthcare services and information (ZocDoc, WebMD, Telehealth Services)
- Online fitness and nutrition services (Daily Burn, WeightWatchers)

Technology Utilization and Adoption

In 2013, 65 percent of older adults lived in homes with computers, and over half of all older adults reported using the Internet.⁶² Older adults are using the Internet for a variety of purposes, primarily email, information-seeking, or purchasing products.⁶³ Older people most frequently looked for health-related information, news, and government websites, trends that are similar among younger Internet users. This is not surprising, given that the majority of older people live and manage their health care needs independently.

It is important to note that even with increasing utilization rates, a sizable contingent of those age 65 and over either cannot access or do not wish to engage with some or any technological devices or services (Figure 3).⁶⁴ Across all generations, the major reasons for not adopting new technologies are lack of interest, perceived high costs, perceived level of difficulty, and inability to access those technologies. Fear or privacy and security concerns have been found to be most prevalent among older people.⁶⁵

Older populations are less likely to have broadband at home than younger populations, as illustrated by Figure 4. There is further disparity among older adults. Younger, higher-income, and more highly-educated older adults are more likely to use the Internet and broadband.⁶⁶ Of older adults with an annual household income of \$75,000 or more, 90 percent reported going online and 82 percent reported having broadband at home. In addition, 87 percent of older adults with college degrees reported going online. Seventy-six percent of them adopted broadband at home. This sharply contrasts with the utilization rates of low-income older people and those who did not attend college. Of older adults earning less than \$30,000 annually, only 39 percent reported going online and 25 percent reported having broadband at home.⁶⁷ There are also differences by race in access. Black and Hispanic

⁶² File, T., Ryan, C., “Computer and Internet Use in the United States: 2013,” *American Community Survey Reports*, ACS-28, U.S. Census Bureau, 2014, See: www.census.gov/content/dam/Census/library/publications/2014/acs/acs-28.pdf.

⁶³ Zickuhr, K., “Generations 2010,” Pew Research Center, 2010. See: www.pewInternet.org/2010/12/16/generations-2010.

⁶⁴ National Telecommunications & Information Administration, “Digital Nation Data Explorer,” 2015, See: www.ntia.doc.gov/other-publication/2015/digital-nation-data-explorer.

⁶⁵ Mason, O.J., Stevenson, C., Freedman, F., “Ever-present threats from information technology: the Cyber-Paranoia and Fear Scale,” *Frontiers in Psychology*, 5: 1298, 2014.

⁶⁶ Smith, A., “Older Adults and Technology Use,” Pew Research Center, 1-26, 2014, See: www.pewinternet.org/files/2014/04/PIP_Seniors-and-Tech-Use_040314.pdf.

⁶⁷ *ibid*

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older adults have significantly less access to a high-speed Internet connection than their White or Asian counterparts.⁶⁸

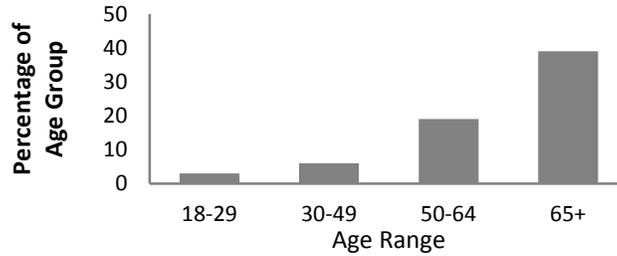


Figure 3. Percentage of adults not accessing the Internet.⁶⁹

Broadband Internet availability varies substantially between urban and rural areas of the United States. Urban areas have much higher availability of broadband Internet services than rural areas (99.6 percent have availability in urban areas vs. 82 percent in rural areas).⁷⁰ This divide in access is most prominent in Southwestern states (particularly Arizona), Northwestern states (such as Montana, Idaho, and Wyoming), and U.S. Territories and tribal lands.⁷¹ At the same time, over 95 percent of the rural population has mobile Internet technologies, such as smartphones, available to them.⁷² Many older adults in rural areas of the Southwest, Northwest, and U.S. Territories cannot access the Internet because adoption of mobile technologies has been slower among older adults.

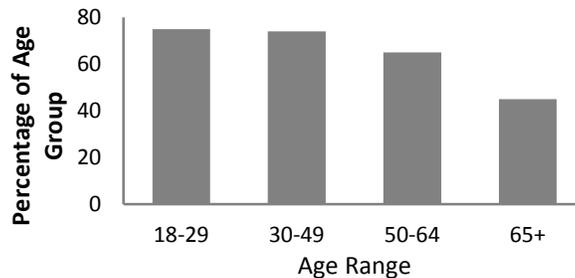


Figure 4. Percentage of adults with broadband access.⁷²

⁶⁸ File, T., Ryan, C., "Computer and Internet Use in the United States: 2013," *American Community Survey Reports*, ACS-28, U.S. Census Bureau, 2014, See: www.census.gov/content/dam/Census/library/publications/2014/acs/acs-28.pdf.

⁶⁹ Anderson, M., Perrin, A., "15% of Americans don't use the internet. Who are they?" *Pew Research Center*, 2015, See: www.pewresearch.org/fact-tank/2015/07/28/15-of-americans-dont-use-the-Internet-who-are-they.

⁷⁰ Kruger, L.G., Gilroy, A.A., "Broadband Internet Access and the Digital Divide: Federal Assistance Programs," *Congressional Research Service Report*, RL30719, 2013 See: www.fas.org/sgp/crs/misc/RL30719.pdf.

⁷¹ National Telecommunications and Information Administration, and Federal Communications Commission, "Broadband Statistics Report: Broadband Availability in Urban vs. Rural Areas," 1-12, 2015 www.broadbandmap.gov/download/Broadband%20Availability%20in%20Rural%20vs%20Urban%20Areas.pdf.

⁷² Horrigan, J., Duggan, M., "Home broadband 2015," *Pew Research Center*, 1-32, 2015, See: www.pewInternet.org/files/2015/12/Broadband-adoption-full.pdf.

Federal Actions to Improve Connectivity

Improving affordability, accessibility, training, and usability of technology for older people is critical for increasing usage. The Federal Government can take several steps to improve these factors.

A major impediment to Internet access for seniors is cost, including the cost of data consumption and basic connectivity. Accessing broadband Internet through cellular data networks will be a new cost for many older adults. While low- and no-cost options for older adults currently exist to provide cellular calling services, there are no such programs for wireless Internet or broadband.⁷³

In addition, access to Internet connectivity may be worse in rural areas where broadband installation is difficult and expensive. This can further decrease engagement among those older adults who are already physically isolated from others. While wireless and mobile Internet technologies are improving and can help ameliorate some of these issues, certain rural areas also have little or no cell-phone coverage.^{74,75} Low-income urban areas may also have low levels of connectivity or very slow connectivity, limiting access to free or affordable Internet.⁷⁶

As Internet technologies including websites and apps become more sophisticated, they also require more data and faster connections to run content. For example, streaming online videos requires a much faster connection and more data usage than accessing a text-based email. High-speed broadband is also required for many new health IT programs that can improve health and health care delivery.⁷⁶

Free WiFi access in community-based organizations, religious institutions, senior centers, senior housing, and libraries has the potential to increase connectivity among older people. Outdoor, publicly available WiFi hotspots and kiosks, such as those currently being installed in place of payphones in New York City, can also help to get older people online, if they are user-friendly and responsive to a range in functional capacity; however, a precondition of outdoor WiFi access is the ability to successfully navigate the built environment, which requires safe streets, accessible pedestrian plazas, and adequate seating for older people.

As described in a recent National Technology and Information Administration (NTIA) report, several existing Federal initiatives aim to improve Internet usage through, *e.g.*, infrastructure, training, or public computer access.⁷⁷ For example, the United States Department of Agriculture (USDA) Rural Utility Service operates two loan programs and one grant program focused on broadband infrastructure, as well as another grant program for distance learning and telemedicine. All these programs are explicitly

⁷³ Choi, N.G., Dinitto, D.M., "Internet use among older adults: association with health needs, psychological capital, and social capital," *Journal of Medical Internet Research*, 15(5): e97, 2013.

⁷⁴ Bjarin, B., "Living in the Last Mile: How to Improve Rural Internet Access" *Time Magazine*, 2013, See: techland.time.com/2013/10/14/living-in-the-last-mile-how-to-improve-rural-Internet-access/.

⁷⁵ Dailey, D., Bryne, A., Powell, A., Karaganis, J., Chung, J., "Broadband Adoption in Low-Income Communities," *Social Science Research Council*, 2010. See: webarchive.ssrc.org/broadband_adoption.pdf.

⁷⁶ The Office of the National Coordinator for Health Information Technology, Office of the Secretary Department of Health and Human Services. "Federal Health IT Strategic Plan 2015 – 2020," 2014, See: www.healthit.gov/sites/default/files/federal-healthIT-strategic-plan-2014.pdf.

⁷⁷ National Telecommunications & Information Administration, "BroadbandUSA: Guide to Federal Funding of Broadband Projects," *Department of Commerce*, 2015.

focused on improving broadband access in rural areas. The Federal Communications Commission (FCC) oversees the Lifeline program, which offers discounts for mobile and landline phone service. This program can provide Internet access to those receiving the mobile-phone discount. More could be done to coordinate these existing initiatives and meet the specific needs of older adults.

The Department of Housing and Urban Development (HUD) has started the ConnectHome program to improve broadband access for residents of HUD-assisted housing. The main focus of this program is children, so seniors who live with children (such as grandchildren) may benefit, but older adults are not the target of the program's efforts. In addition, HUD recently required that all HUD-funded housing that is newly-constructed or is a substantial rehabilitation project of an existing building is required to have broadband connectivity. This requirement can have a large impact, since 1.4 million households aged 62 and over benefited from rental assistance from HUD in 2011 (out of the 3.9 million households that were eligible). In 2013, roughly 263,000 older renters were provided Section 202 units and 483,000 were given housing choice vouchers.⁷⁸

Education & Training

While older adults often express the desire to use new technologies such as computers, tablets, e-readers, and smartphones, many have difficulties learning to use technology without assistance. To use social media, job-searching sites, and other online resources, seniors must know how to use the Internet and connected devices. Statistics demonstrate the extent of the need. In one survey, only 18 percent of older adults reported feeling comfortable learning to use new devices such as smartphones or tablets on their own, and three-quarters indicated that they would need someone to help walk them through the process.⁷⁹ Among older adults currently online, over half said they would need assistance to use new social networking sites to connect with friends or family.⁷⁹ Experience in the field has shown that many seniors are willing to learn and will adopt new technologies if provided structured and high-quality technology training in a supportive setting (Box 1).

Training in technology is especially important for older adults seeking employment, since the number of jobs that require knowledge of technology is increasing. At the same time, many employers have neglected to train older employees on newer technologies,⁸⁰ which creates a skills gap for many older workers. Even for older people who are technologically literate, training must be ongoing as systems and programs are frequently updated.⁸¹ Where training does exist, it is often delivered through a

⁷⁸ Section 202 housing is supportive affordable housing specifically established for very low-income elderly that is built by nonprofit organizations using HUD capital funding; however, the Section 202 house program has received no new funding in a number of years resulting in no new housing. (See Crosscutting Recommendation 2 in the Introduction.)

⁷⁹ Smith, A., "Older Adults and Technology Use," *Pew Research Center*, 1-26, 2014, See: www.pewinternet.org/files/2014/04/PIP_Seniors-and-Tech-Use_040314.pdf.

⁸⁰ Finkelstein, R., Roher, S., Owusu, S., "Age-Smart Employer NYC: A Compendium of Strategies and Practices," *The New York Academies of Medicine*, 1-68, 2013, See: http://www.ilc-alliance.org/images/uploads/publication-pdfs/Age_Smart_Employer_-_Compendium_of_Policies_and_Practices_-_The_New_York_Academy_of_Medicine.pdf.

⁸¹ Mermin, B.T., Johnson, R.W., Tower, E., "Will employers want aging boomers?" *The Retirement Policy Program Discussion Paper* 08-04, 1-57, 2008. www.urban.org/uploadedPDF/411705_aging_boomers.pdf.

webinar format that may not match the learning styles of many older adults, making job training less effective.

Box 1. Older Adults Technology Services, Inc. (OATS)

Since 2004, the nonprofit organization OATS (www.oats.org) has partnered with elected officials, government agencies, corporations, educational institutions, and community organizations to establish “broadband adoption ecosystems” designed especially for older adults. OATS serves urban settings such as New York City and Washington, DC and rural areas such as South Dakota and New York State’s Adirondack region. OATS advocates that technology use is relevant and valuable in a senior’s life, and it has successfully helped tens of thousands of seniors get online already.

OATS has developed a unique model that proactively targets and engages seniors; provides access, training, and support specifically tailored to the needs of seniors; and builds a membership community of active learners who are seeking to understand and use technology. It does so at no cost to the senior to ensure that finances are not a barrier. Once trained, the seniors involved with OATS use technology to expand their social connections, improve their health, enhance their economic prospects, and enrich their lives through creative and educational pursuits.

The nonprofit’s Senior Planet Exploration Centers are technology-themed community centers that offer free training courses, seminars, and more year-round. Smaller Senior Planet tech labs are established in neighboring communities or in the region. Intensive free training courses are delivered by professional multilingual instructors

In addition, Senior Planet mobile labs also transport tablets and other portable devices to community events and to seniors living in underserved areas. It runs an award-winning website, SeniorPlanet.org, which celebrates technology, digital culture, and “Aging with Attitude.” Senior Planet U. offers a series of free online learning modules that allow seniors anywhere to learn how to use technology to improve their lives. OATS engineers also provide strategic consulting, program planning, and program implementation services to public and private institutions

In addition to its work on expanding access, HUD is seeking to improve training through the HUD Service Coordinator Program. This program, part of HUD’s Multifamily Housing (MFH) Portfolio, funds the hiring or contracting of service coordinators for assisted housing for the elderly and persons with disabilities. These service coordinators are trained based on the specific training guidelines, including a set of training principles to help older adults get online.

The Federal Government can create more opportunities for older people to access education and training on the use of information and communications technologies through broadband adoption programs and other initiatives with education/training provisions, such as Section 415 of the Older Americans Act. Training should include access to essential online-only services and protection from scams and fraud and should be tailored to the learning styles of older people. The Corporation for National & Community Services (CNCS) should build on its existing employment and volunteer programs, such as Senior Corps, by recruiting older people who are technologically literate to serve older people in need of assistance.

Recommendation 5: Education and Training in Online Technologies

The Administration should support ongoing reauthorization of the Older Americans Act and build on the provisions on Section 415 to ensure access to online services and protection from scams and fraud, tailored to the learning needs of older adults. Corporation for National & Community Services (CNCS) should expand Senior Corps to include older people with literacy and skills in technology use.

Including Older Americans in Emergency Disaster Planning

Older adults may be more vulnerable in disasters than younger people due to mobility and cognitive impairments, chronic health conditions, diminished sensory awareness, social isolation, or financial limitations.^{82,83,84} As a result, older people have been disproportionately affected by recent catastrophic events (Box 2). Technology has great potential to maintain the health and well-being of older people during disasters, maximize scarce resources, and reduce emergency department usage; however, some of the most promising new initiatives have not adequately addressed the needs and communication modalities of older people. There is also evidence that older adults may be more psychologically resilient in the face of disaster than younger people and should therefore be mobilized to assist in response and recovery efforts.^{82,85}

Older technologies are rapidly being replaced by newer ones that may not have all of the same features and capabilities required by an older population. In addition, older people may be unaware of how changes to technology may affect their health, safety, and communication capabilities during emergencies. For example, in the transition from landline to mobile phone technologies or Internet-based phone services, several emergency functions of traditional copper landlines are lost. Copper wire lines route calls to the correct 911 center automatically (based on location) and include the caller's name, residence, and exact location. If the speaker is confused/unable to speak, the landline's location appears on a map and help can be dispatched. In addition, copper wire landlines are powered by the central phone service, making them much more likely to work in bad-weather conditions. In contrast, satellite-based Internet services can have outages during storms, and cell towers are vulnerable to losing

⁸² Acierno, R., Ruggiero, K., Kilpatrick, D., Resnick, HS., Galea, S., "Risk and Protective Factors for Psychopathology Among Older versus Younger Adults After the 2004 Florida Hurricanes," *The American Journal of Geriatric Psychiatry*, 14(12): 1051-1059, 2006.

⁸³ Fernandez, L.S., Byard, D., Lin, C., Benson, S., Barbara, JA., "Frail elderly as disaster victims: emergency management strategies," *Prehospital and Disaster Medicine*, 17(2):67-74, 2002.

⁸⁴ Evans, J., "Mapping the vulnerability of older persons to disasters," *International Journal of Older People Nursing*, 5(1): 63-70, 2010.

⁸⁵ Thompson, M., Norris, F., Hanacek, B., "Age differences in the psychological consequences of Hurricane Hugo," *Psychology and Aging*, 8(4): 606-616, 1993.

power in natural disasters.⁸⁶ The phone transition is bringing clear benefits to many, but these are challenges that need to be addressed to ensure older adults and all people remain safe.

Box 2. Older Adults during Superstorm Sandy

During Superstorm Sandy, older people's reliance on landlines and lack of redundant communications impeded their ability to maintain situational awareness, access information, and connect to formal and informal support systems.⁸⁸ Older adults were more likely to use landlines (between 12-18 percentage points higher than their younger counterparts) and less likely to report an additional form of communication, such as cell phones, email, or social media.⁸⁸ In many neighborhoods, however, cell phones were more likely to work than landlines.⁸⁹ Older people who did have cell phones sometimes did not understand how to use them to access assistance or could not access redundant power sources to charge them.⁹⁰ Because it is difficult to predict what forms of communication will work in an emergency, having more options creates better odds of connection.⁸⁸

Red Hook, Brooklyn, which has a large concentration of older people residing in public housing in poverty, was one of the most significantly affected communities. This neighborhood is geographically isolated and digitally underserved. Prior to the storm, The Red Hook Initiative, a community-based youth-empowerment organization, partnered with the Open Technology Institute to create a community wireless network (Red Hook WiFi) to provide free Internet access, local applications and services, and digital literacy training. When the neighborhood lost power for over a month after Superstorm Sandy, Federal Emergency Management Agency set up a satellite link on the roof of the Red Hook Initiative and a commotion router on the roof of a local business to leverage this network and target connectivity where residents and responders were most in need. In their 2013 report on the Red Hook WIFI initiative, the Open Technology Institute recommends pre-positioning wireless network equipment and increasing technological literacy in underserved communities prior to a disaster to expedite the deployment of connectivity, targeted outreach, and essential resources following a disaster.⁹¹

Redundant power sources are critical for older people who are dependent on durable medical equipment such as oxygen concentrators, motorized scooters, and dialysis units, as well those who take refrigerated medication and those who require an elevator to leave home. Because there are no dedicated funding streams for generators in low-income senior housing or public housing where many older people with chronic conditions reside, and because private homes rarely have generators, older people often visit the emergency room for access to charging stations for durable medical equipment. Newly available data from the Centers for Medicare and Medicaid Services (CMS) can help identify electricity- or oxygen-concentrator-dependent people at the zip code level along with the regions that most require high-tech, renewable power/battery charging stations.⁸⁷ Senior housing, senior centers, community centers, nursing homes, and libraries are ideal venues to house this technology.

⁸⁶ Dharma, D., Amelia, B., Powell, A., Joe, K., Jaewon, "Broadband adoption in low-income communities," *Social Science Research Center*, 1-103, 2010, See: webarchive.ssrc.org/broadband_adoption.pdf.

⁸⁷ Expert interview with Nicole Lurie, Assistant Secretary for Preparedness and Response, U.S. Public Health Service, 2015.

Independence, Technology, and Connection in Older Age

The Federal Emergency Management Agency (FEMA) has recognized the unique challenges for those with disabilities or functional limitations, regardless of age, during an emergency. Since 2010, it has operated the Office of Disability Integration and Coordination to consider how to improve emergency management for all people regardless of their functional capabilities. This office brought together previous activities at the Agency for Disability Inclusion, and it ensures that Disability Integration Advisors are included in the national command teams coordinating responses to major disasters.^{88,89,90,91}

FEMA should advance national strategies to create interoperable and more effective emergency communications systems in which the needs and capabilities of older people are included in evidence-based standards for existing and future wireline and wireless voice, data, image, and video technologies.

The Assistant Secretary for Preparedness and Response, Office of the National Coordinator for Health IT, and CMS should promote more rapid access to relevant data and interoperability of electronic health records to make possible the identification of vulnerable people and relevant medical information and resources in emergency situations.⁹² The Food and Drug Administration has an important role to play in this as well. This recommendation builds on the 2011 PCAST report on health information technology and the 2014 PCAST report on systems engineering in health care.

⁸⁸ NORC Center for Public Affairs Research and the Associated Press, "Communication during disaster response and recovery," 1-5, 2013. See:

www.apnorc.org/PDFs/Resilience%20in%20Superstorm%20Sandy/Communications_Final.pdf.

⁸⁹ New York City Housing Authority. Emergency Preparedness Resident Survey, Unpublished Data. 2013.

⁹⁰ Goldman, L., Finkelstein, R., Schafer, P., Pugh, T., "Resilient Communities: Empowering Older Adults in Disasters and Daily Life," The New York Academy of Medicine, 2014. www.nyam.org/publications/publication/resilient-communities-empowering-older-adults-in.

⁹¹ Open Technology Institute and The New America Foundation. "Case Study: Red Hook Initiative WiFi & Tidepools," 2013. commotionwireless.net/files/rhiwifi_tidepools_casestudy.pdf.

⁹² The President's Council of Advisors of Science and Technology, *Report to the President: Realizing the Full Potential of Health Information Technology to Improve Healthcare for Americans: The Path Forward*, 2010, www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-health-it-report.pdf; *Report to the President: Better Health Care and Lower Costs: Accelerating Improvement through Systems Engineering*, 2014, www.whitehouse.gov/sites/default/files/microsites/ostp/PCAST/pcast_systems_engineering_in_healthcare_-_may_2014.pdf.

Recommendation 6: Emergency Response and Communications

Older people are especially vulnerable in disaster and emergency situations.

1. The Federal Emergency Management Agency (FEMA) at the Department of Homeland Security (DHS) should advance national strategies to create effective communications systems that reach isolated and vulnerable older people.
2. Within HHS, the Office of the Assistant Secretary for Preparedness and Response (ASPR), the Office of the National Coordinator for Health Information Technology (ONC), and the Centers for Medicare & Medicaid Services (CMS) should promote more rapid interoperability of medical information to ensure timely access whenever and wherever a patient may appear.
3. FEMA, ASPR, and CMS should advance policies that make medical device interfaces more consistent and interoperable to ensure timely access to people who depend on these devices.



3. Technologies to Address Changes in Cognitive Ability

The opportunity for the Federal Government to facilitate the development and adoption of technology that supports the mental abilities and cognitive health of older Americans comes at an auspicious time. The 2015 White House Conference on Aging had a specific theme of improving older adults' cognitive health; the Centers for Disease Control (CDC) continues its public health initiative to promote healthy brain aging;⁹³ and Medicare's Annual Wellness Visit requires the detection of any cognitive impairment.⁹⁴ In addition, there are specific national plans to understand, treat, and prevent diseases that impair older adults' cognition, the most common being Alzheimer's disease, and to better meet the needs of the millions of Americans currently living with these diseases.⁹⁵

Each of these policy initiatives responds to the challenge of an aging population in which older Americans commonly report problems with cognitive function.⁹⁶ The changes in cognition may be due to cognitive aging, a process inherent in humans as they age, or due to a specific disease like Alzheimer's disease or dementia, which are prevalent, costly, and cause notable suffering.^{97,98,99,100} Regardless of

⁹³ The Center for Disease Control and Prevention: "The CDC Healthy Brain Initiative: The Public Health Road Map for State and National Partnerships, 2013-2018," pg. 51. www.cdc.gov/aging/pdf/2013-healthy-brain-initiative.pdf.

⁹⁴ Centers for Medicare and Medicaid, The Medicare Learning Network. "The ABCs of Providing the Annual Wellness Visit." 2012. www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/downloads/AWV_chart_ICN905706.pdf

⁹⁵ Office of the Assistant Secretary for Planning and Evaluation, "National Plan to Address Alzheimer's Disease: 2015 Update," United States Department of Health and Human Services; 2015. aspe.hhs.gov/national-plan-address-alzheimer%E2%80%99s-disease-2015-update.

⁹⁶ Centers for Disease Control and Prevention, Behavioral Risk Factor Surveillance Survey (BRFSS) of adults 60 years, See: www.cdc.gov/brfss; "Self-reported increased confusion or memory loss and associated functional difficulties among adults aged ≥60 years — 21 States" *Morbidity and Mortality Weekly Report*, 62(18): 347-50, 2013.

⁹⁷ Plassman, B.L., Langa, K.M., Fisher, G.G., Heeringa, S.G., Weir, D.R., Ofstedal, M.B., Burke, J.R., Hurd, M.D., Potter, G.G., Rodgers, W.L., Steffens, D.C., McArdle, J.J., Willis, R.J., Wallace, R.B., "Prevalence of Cognitive Impairment without Dementia in the United States," *Annals of Internal Medicine*, 148(6): 427-434, 2008.

⁹⁸ Hurd, M.D., Martorell, P., Delavande, A., Mullen, K.J., Langa, K.M., "Monetary costs of dementia in the United States." *New England Journal of Medicine*, 368(14): 1326-1334, 2013.

⁹⁹ Schulz, R., Mendelsohn, AB., Haley, WE., Mahoney, D., Allen, RS., Zhang, S., Thompson, L., Belle, SH., Resources for Enhancing Alzheimer's Caregiver Health Investigators, "End-of-Life Care and the Effects of Bereavement on Family Caregivers of Persons with Dementia," *New England Journal of Medicine*, 349:1936-42, 2003 and Schulz, R., Visintainer, P., Williamson, GM., "Psychiatric and Physical Morbidity Effects on Caregiving," *Journal of Gerontology: Social Sciences*, 45(5): 181-191, 1990.

¹⁰⁰ Pinguat M, Sørensen S., "Differences between caregivers and noncaregivers in psychological health and physical health: a meta-analysis," *Psychology and Aging*, 18(2): 250-67, 2003.

the cause, declines in cognitive health threaten the well-being, quality of life, and economic security of older adults and their families.

There are multiple technologies to help older adults manage cognitive impairments or maintain their current cognitive health. Some promising technologies include ones that can monitor cognition and functional performance, detect the earliest signs of cognitive impairment, and maintain and improve cognition and functional capacity. Maintenance or improvements in cognitive health could minimize the physical and emotional co-morbidities associated with cognitive impairment, help older adults remain out of institutions, and reduce burdens (both time and economic) on family caregivers.¹⁰¹

PCAST identified at least three important opportunities to develop and use technology to maintain older American's cognitive health. First, in-home sensing and wearable technologies can be employed to detect changes in an older adult's activity patterns and their ability to perform day-to-day tasks, such as cooking or medication management. These changes may indicate not only declines in physical function but in cognitive function as well. Second, technology can help older adults with their finances, such as paying bills on time or preventing fraud or exploitation. The third promising but unfulfilled opportunity is technology that promotes cognitive health by maintaining or enhancing cognition or preventing cognitive decline.

How Technology Can Monitor Cognitive Function

Technologies that monitor cognitive changes offer vast potential to foster older adults' functional independence. Many types of monitoring systems exist, and their development is continuously evolving.¹⁰² Some technologies can automatically detect events such as falling, which may be caused by problems with cognition or otherwise, while others use location devices designed to reduce potential injuries to adults with dementia who wander. There are many devices available for preventing or detecting wandering, such as Project Lifesaver,¹⁰³ Alzheimer's Association Comfort Zone,¹⁰⁴ or GPS Smart Sole.¹⁰⁵ Smart phone apps such as "FindMyFriend" can locate a wandering person.

Another type of monitoring system is unobtrusive home monitoring, such as home sensors that track activity patterns. These systems can be used to detect changes in activity or unusual patterns that might suggest functional or cognitive decline, for example, detecting that a normally active and socially-involved older adult is spending more time being sedentary, napping, or is having fewer social interactions could signal a problem. Studies have found that an adult's total active time, time out of the

¹⁰¹ A 2010 Investor Protection Trust survey found 40 percent children of parents 65 or older are "very" or "somewhat" worried that their parents "have already become or will become less able to handle their personal finances over time," 36 percent are "not worried at all" about such a development.

www.investorprotection.org/downloads/EIFFE_Survey_Report.pdf

¹⁰² Kang, H.G., Mahoney, D.F., Hoenig, H., Hirth, V.A., Bonato, P., Hajjar, I., Lipsitz, L.A., "In Situ Monitoring of Health in Older Adults: Technology and Issues," *Journal of the American Geriatric Society*, 58(8): 1579-1586, 2010.

¹⁰³ "Project Lifesaver International | Bringing Loved Ones Home," Project Lifesaver International RSS2, 2015, Accessed March 14, 2016, www.projectlifesaver.org/.

¹⁰⁴ See: www.alz.org/comfortzone/about_comfort_zone.asph.

¹⁰⁵ "Hidden GPS Enabled Insoles Keep You Connected to Who Matters Most," GPS SmartSoles GPS Tracking Device, Accessed March 14, 2016, See: www.gpssmartsole.com/.

house, walking speed, or gait may predict cognitive decline.¹⁰⁶ Changes in computer keystrokes and linguistic features of emails as well as home computer usage could also be useful for tracking cognition changes.¹⁰⁷

It is also possible to use mobile technologies to measure a person's cognitive abilities.¹⁰⁸ The FDA recently approved the use of the Defense Automated Neurobehavioral Assessment (DANA), a mobile phone-based application that operates much like a video game, to help identify cognitive decline associated with traumatic brain injury.^{109,110}

Older adults are receptive to these types of technologies if they are perceived as useful and foster their ability to live independently.¹¹¹ For example, interviews with a sample of older adults who had a sensor-based monitoring system installed in their home found that the older adults valued the monitoring system, as they perceived that it helped them to remain independent and contributed to their sense of safety.¹¹² In short, the question is whether the perceived benefits outweigh privacy concerns.

Smart technologies show promise in detecting changes in cognition and functional performance that may be indicative of cognitive decline and impairment. Before the large-scale deployment of these systems can occur, however, several issues need to be addressed. There is limited evidence, especially

¹⁰⁶ Kaye, J.A., Maxwell, S.A., Mattek, N., Hayes, T.L., Dodge, H., Pavel, M., Jimison, H.B., Wild, K., Boise, L., Zitzelberger, T.A., "Intelligent Systems For Assessing Aging Changes: home-based, unobtrusive, and continuous assessment of aging," *Journal of Gerontology*, 66B(Suppl 1): i180-i190, 2011; Aki, A., Taati, B., Mihailidis, A., "Autonomous unobtrusive detection of mild cognitive impairment in older adults," *IEEE Transactions on Biomedical Engineering*, 62(5): 1383-1394, 2015; Verghese, J., Wang, C., Lipton, R.B., Holtzer, R., Xue, X., "Quantitative gait dysfunction and risk of cognitive decline and dementia," *Journal of Neurology, Neurosurgery & Psychiatry*, 78(9): 929-935, 2007; Buracchio, T., Dodge, H.H., Howieson, D., Wasserman, D., Kaye, J., "The trajectory of gait speed preceding mild cognitive impairment," *Archives of Neurology*, 67(8): 980-986, 2010.

¹⁰⁷ Kaye, J., Mattek, N., Dodge, H.H., Campbell, I., Hayes, T., Austin, D., Hatt, W., Wild, K., Jimison, H., Pavel, M., "Unobtrusive measurement of daily computer use to detect mild cognitive impairment," *Alzheimer's & Dementia*, 10(1): 10-17, 2014.

¹⁰⁸ Allard, M., Husky, M., Catheline, G., Pelletier, A., Diharreguy, B., Amieva, H., Peres, K., Foubert-Samier, A., Dartigues, J.F., Swendsen, J., "Mobile Technologies in the Early Detection of Cognitive Decline," *PLoS ONE*, 9(12): e112197, 2014.

¹⁰⁹ Lathna, C., Spira, J.L., Bleiberg, J., Vice J., Tsao, J.W., "Defense Automated Neurobehavioral Assessment (DANA)-psychometric properties of a new field-deployable neurocognitive assessment tool," *Military Medicine*, 178(4): 365-371, 2013.

¹¹⁰ Currently, the "app" has only been used for military applications. Clearly, this is an emerging area of development as these types of systems have the potential to be used with other populations to detect cognitive change associated with other conditions such as mild cognitive impairment or dementia. DANA provides an example of how mobile "apps" can be used to monitor cognitive decline.

¹¹¹ Melenhorst, AS., Bouwhuis, D., "When do older adults consider the internet?

An exploratory study of benefit perception," *Gerontechnology*, 3(2): 89-101, 2004; Wild, K., Boise, L., Lundrell J., Foucek, A., "Unobtrusive In-Home Monitoring of Cognitive and Physical Health: Reactions and Perceptions of Older Adults," *Journal of Applied Gerontology*, 27(2): 181-200, 2008; Pol, M., van Nes, F., van Hartingsveldt, M., Buurman, B., de Rooij, S., Kroese, B., "Older People's Perspectives Regarding the Use of Sensor Monitoring in Their Home," *Gerontologist*, 00, 1-9, 2014.

¹¹² Pol, M., van Nes, F., van Hartingsveldt, M., Buurman, B., de Rooij, S., Kroese, B., "Older People's Perspectives Regarding the Use of Sensor Monitoring in Their Home," *Gerontologist*, 00, 1-9, 2014.

from large-scale studies, on the feasibility, validity, reliability, and comparative effectiveness of these approaches. There is more to learn about implementation, such as the optimal monitoring schedule, usability, and cost. While many older adults are comfortable with the privacy implications of monitoring (as noted above), more work is needed on privacy and security.¹¹³ (See Crosscutting Recommendation 3 in the Introduction.)

How Technology Can Protect Older Adults' Economic Security

Cognitive impairment can often reduce a person's ability to manage finances ("financial capacity"). When Alzheimer's, Parkinson's, or similar diseases become symptomatic, declines in financial capacity are typically even greater.¹¹⁴ Compared to younger adults, older adults may be more likely to make poor financial decisions that depend on recent learning,¹¹⁵ although older adults are likely to exhibit less risk taking if a decision relies on well-learned behaviors. This may be why older adults were more likely to express intent to purchase products the Federal Trade Commission had cited as fraudulently marketed¹¹⁶ or to make suboptimal decisions across financial tasks such as fee payments or credit card balance transfers.¹¹⁷ Notably, these decisions often either involve interactions with technology or can be identified with technology.

Changes in financial capacity—skills, knowledge, or judgment—are among the reasons that older adults are more likely to be victims of financial fraud and exploitation. The fraud can go unnoticed for some time as reduced financial capacity is often the first effect of cognitive impairment.¹¹⁸ The annual losses due to fraud and exploitation are estimated in the billions of dollars.¹¹⁹ A 2010 study gauged it as \$3

¹¹³ The President's Council of Advisors on Science and Technology, *Big Data and Privacy: A Technological Perspective*, 2014, See:

www.whitehouse.gov/sites/default/files/microsites/ostp/PCAST/pcast_big_data_and_privacy_-_may_2014.pdf.

¹¹⁴ Marson, D.C., Sawrie, S.M., Snyder, S., McInturff, B., Stalvey, T., Boothe, A., Aldridge, T., Chatterjee, A., Harrell, L.E., "Assessing financial capacity in patients with Alzheimer's disease: a conceptual model and prototype instrument," *Archives of Neurology*, 57: 877-84, 2000; Martin, R.C., Triebel, K.L., Kennedy, R.E., Nicholas, A.P., Watts, R.L., Stover, N.P., Brandon, M., Marson, D.C., "Impaired financial abilities in Parkinson's disease patients with mild cognitive impairment and dementia," *Parkinsonism & Related Disorders*, 19: 986-90, 2013.

¹¹⁵ Mata, R., Josef, A.K., Gregory R., Samanez-Larkin, G., Hertwig, R., "Age difference in risky choice: a meta-analysis." *Annals of the New York Academy of Sciences*, 1235: 18-29, 2011.

¹¹⁶ Denburg, N.L., Cole, C.A., Hernandez, M., Yamada, T.H., Tranel, D., Bechara, A., Wallace, R.B., "The orbitofrontal cortex, real-world decision making, and normal aging." *Annals of the New York Academy of Sciences*, 1121: 480-498, 2007.

¹¹⁷ Agarwal, S., Driscoll, J., Gabaix, X., D. Laibson, D., "The age of reason: Financial decisions over the life cycle and implications for regulations." *Brookings Institution*, 973790: 2009. See:

www.brookings.edu/~media/Projects/BPEA/Fall%202009/2009b_bpea_agarwal.PDF

¹¹⁸ Triebel, KL, Martin, R., Griffith, HR., Marceaux, J., Okonkwo, OC., Harrell, L., Clark, D., Brockington, J., Bartolucci, A., Marson, DC., "Declining financial capacity in mild cognitive impairment: A 1-year longitudinal study. *Neurology*," *Neurology*, 73: 928-34, 2009.

¹¹⁹ MetLife Mature Market Institute "The MetLife Study of Elder Financial Abuse: Crimes of Occasion, Desperation, and Predation Against America's Elders" www.metlife.com/assets/cao/mmi/publications/studies/2011/mmi-elder-financial-abuse.pdf, 2011 and The 2015 TruLink study used measurement that accounted for the different kinds of elder abuse and estimated the total costs of all causes of abuse to be \$36.48 billion.

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billion a year, and a 2015 study suggested annual losses to be as high as \$36 billion.¹²⁰ When these losses occur, family or public sources of funds often have to support day-to-day expenses and medical care.¹²¹ Since older adults generally are not working, they cannot rebuild their lifetime savings after making an unsuitable financial decision or being a victim of fraud or exploitation.¹²²

Exploitation and fraud manifest themselves in numerous ways.^{123,124} In the grandparent scam, for example, an older adult receives a phone call from a person who pretends to be the older adult's grandchild, claims trouble that requires urgent financial help, and begs the grandparent not to tell the child's parents. The help is a cash transfer to pay a bill, fine, or bail.

Although the kinds of fraud and exploitation and their perpetrators vary, many involve an older adult transferring or withdrawing cash, which is why banks and other financial institutions should be able to identify routinely not only declines in financial capacity but also fraud and exploitation. Bank personnel could take immediate action in a face-to-face encounter, but technology for online banking could also identify unusual activity compared to the client's past behaviors and patterns. This would be the case, for example, when a client who has never used a bank card transfers money to overseas accounts or withdraws cash at an ATM. There are also technologies that could prevent or limit fraud, such as providing read-only views of accounts to caregivers or algorithms that flag potential declines in financial capacity (Box 3). While these technologies and analytics exist, the banking and financial services industries have not widely adopted them.

Multiple Federal agencies are engaged in activities to stop or prevent financial exploitation of older adults, including the Administration for Community Living, Consumer Financial Protection Bureau's (CFPB) Office for Older Americans, Federal Trade Commission (FTC), Securities and Exchange Commission (SEC), and Department of the Treasury's Financial Crimes Enforcement Network (FinCEN),

¹²⁰ MetLife Mature Market Institute study, and True Link studies.

¹²¹ A Utah Division of Aging and Adult Services study used a review of 80 financial exploitation cases from 2010 to estimate that Utah seniors and businesses lost \$4,766,196 and the state's Medicaid program would have to pay about \$900,000 for the care of adults who suffered exploitation. Gunther, Jilene, "The 2010 Utah Cost of Financial Exploitation," Utah Division of Aging and Adult Services, 2012. See: victimsofcrime.org/docs/default-source/financial-fraud/2011-economic-cost-of-financial-exploitation.pdf?sfvrsn=2.

¹²² An example of the impact of losses in financial capacity on a patient and family is captured in "Money woes can be early clue to Alzheimer's disease," *The New York Times*, 30 October 2010, which recounts the story of Arthur Packel, whose earliest symptoms of Alzheimer's disease were troubles making financial decisions resulting in a loss of his business and much of his family's wealth in order to pay creditors. See: www.nytimes.com/2010/10/31/health/healthspecial/31finances.html?_r=0.

¹²³ The National Council on Aging categorizes fraud and exploitation into ten groups: Medicare and health insurance fraud, counterfeit prescription drugs, funeral and cemetery scams, fraudulent anti-aging products, telemarketing, Internet fraud, investment schemes, homeowner/reverse mortgage scams, sweepstakes and lottery scams, and the grandparent scam. www.ncoa.org/economic-security/money-management/scams-security/top-10-scams-targeting-seniors.

¹²⁴ United States Government Accountability Office. Report to Congressional Requesters. "Elder Justice: National Strategy Needed to Effectively Combat Elder Financial Exploitation," *GAO-13-110*, 2012.

and Department of Justice. Their activities include raising awareness of the problem, educating consumers and the industry, and intervening to address fraud and exploitation and impairments in financial capacity.¹²⁵ The 2009 Elder Justice Act created the Elder Justice Coordinating Council and an Advisory Board on Elder Abuse, Neglect, and Exploitation to develop priorities for the elder justice field, coordinate Federal activities, and provide recommendations to Congress.

Other groups, such as private organizations and industry groups, are focused on reducing financial fraud and exploitation.¹²⁶ A 2012 Government Accountability Office report on financial exploitation found that much of the investigation of fraud and exploitation is handled by State social services, criminal justice

Box 3. A case study in how a bank uses technology to enhance older adults' financial security

Bank of American Fork is a leader in using online, view-only accounts to promote age-friendly banking practices. They came to use this technology as part of a culture change that includes employee awareness and training and laws that mandate reporting cases of suspected fraud or abuse.

Five years ago two events occurred: the bank was approached by a customer writing a book about individuals over the age of 55 navigating their rights, and the Utah Division of Aging and Adult Services issued a study that demonstrated the cost of elder financial exploitation. The timing of these two events coincided with the company's recognition that Utah mandated that financial services report suspected elder abuse, but the bank managers had been reluctant to get involved in cases because of concern that this would reflect poorly on the bank, and even if they did, they were poorly equipped to address customers experiencing financial exploitation or impaired capacity.

Their response was multi-pronged. They developed a toolbox of banking services for elderly clients, built around products called *AccountSmart* Tools for Seniors. They also engaged in public seminars for seniors and caregivers to raise awareness. Employee training includes how to recognize the signs of elder financial abuse and report it and how to help families structure banking needs to protect both the senior and the caregiver, such as recommending limited power of attorney to assist seniors and their caregivers in managing finances.

Technology is essential as well. The bank offers senior-friendly iPad applications that use intuitive design, automatic transfers and bill payments, and the innovative view-only access to accounts. "View-only" access allows a third party, such as a friend or adult child, to see a senior's account transactions but does not allow the viewer to make transactions. This account allows the third party to identify concerning transactions or changes in patterns that might signal a decline in financial capacity or abuse. The inability for the third party to make transactions protects the senior from fraud and protects the third party from unwarranted suspicion that they might commit fraud.

¹²⁵ United States Government Accountability Office, "National Strategy Needed to Effectively Combat Elder Financial Exploitation," *GAO-13-110*, 2012, and White House Conference on Aging, Elder Justice: See: www.whitehouseconferenceonaging.gov/blog/policy/file.axd?file=/Elder%20Justice%20Policy%20Brief/Elder%20Justice%20Policy%20Brief%205_08_15_FINAL.pdf.

¹²⁶ As examples, see: "Protect Your Money," Protect Your Money, Accessed March 14, 2016, www.aba.com/Consumers/Pages/Consumer_PYM.aspx; and "Senior Investor Protection Resource Center," Sifma, Accessed March 14, 2016, www.sifma.org/issues/savings-and-retirement/senior-investor-protection/overview/.

and consumer protections systems, and particularly the county-by-county system of Adult Protective Service (APS) agencies that are charged with investigating and substantiating cases of suspected elder fraud, abuse, or neglect.¹²⁷ The broad range of organizations highlights the need to integrate and coordinate activities.

PCAST believes that one way the Federal Government can achieve a more integrated and coordinated network is to more accurately measure the size of the problem and issue an annual report of the kinds of abuse and exploitation and their costs to the nation. The Currency and Foreign Transactions Reporting Act, commonly called the Bank Secrecy Act, provides a regulatory framework for reporting cases of fraud and exploitation into a central database. The Act requires financial institutions to report suspicious transactions, called Suspicious Activity Reports (SARs), to FinCEN at the Department of Treasury. Since 2011, institutions can mark SARs reports as incidents of elder financial exploitation, which gives the Federal Government additional data on the size, scope, and trends in elder exploitation, data that are essential for evidence-based policymaking.¹²⁸

Beyond measurement, two technological approaches are particularly promising. Financial institutions could use algorithms to passively identify transactions that may signal impairments in financial capacity as well as fraud or exploitation. Algorithms could identify instances such as missed payments, repeated withdrawals, or transfers to atypical destinations that are indicative of a problem. These algorithms would be similar to existing ones used by large credit card issuers to detect whether a card has been lost or stolen, such as FICO's Falcon Fraud Manager Machine learning system.¹²⁹

In addition, technologies could allow trusted parties, such as a family member or caregiver, to monitor financial accounts for impaired financial capacity or exploitation. View-only online accounts, such as

Box 4. EverSafe's use of algorithms to unobtrusively monitor activity across multiple accounts

An example of technology that unobtrusively and remotely monitors multiple financial accounts across institutions has been developed by EverSafe, a company founded in 2012 after the Founder and CEO's mother was a victim of multiple credit card scams. EverSafe's rules-based learning system developed in consultation with industry experts analyzes its members' bank, investment and credit card accounts, and credit reports on a daily basis to identify suspicious activity. Once suspicious activity is identified, an alert is sent to the member along with designated trusted advocates, such as family members, professionals, powers of attorney and guardians. These advocates have read-only access to financial information and serve as an extra set of eyes in monitoring accounts, credit reports and alerts. Read-only access means money cannot be moved, and no financial transactions can be effected through the use of EverSafe. This is a safer alternative to creating a joint account which can be subject to exploitation or the joint owner's creditors. Once alerted, EverSafe assists in remediation and tracks issues through to resolution.

¹²⁷ United States Government Accountability Office, "National Strategy Needed to Effectively Combat Elder Financial Exploitation," *GAO-13-110*, 2012.

¹²⁸ Department of the Treasury, Financial Crimes Enforcement Network. "Advisory to Financial Institutions on Filing Suspicious Activity Reports Regarding Elder Financial Exploitation." FIN-2011-A003, 2011.

¹²⁹ Urban, M., *Public Comment*, 2011, See: www.federalreserve.gov/SECRS/2011/March/20110303/R-1404/R-1404_022211_67635_571427685645_1.pdf.

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described in the case studies of Bank of American Fork and EverSafe (Box 4), allow a trusted person to monitor in real time the activity of another person's account without the ability to trade or manipulate assets or without revealing the balance. General purpose bank-account monitoring software has been around for some time, but technologies specific to elder abuse—for example, specialized algorithms a customer can add to an existing account, aggregation tools to bring transactions from multiple accounts into a single viewable portal, and real-time detection systems to prevent fraudulent or exploitative transactions before they occur—have only recently been introduced into the market.

There are several barriers to industry-wide adoption of new algorithms or third-party monitoring. No business model exists to foster the creation or implementation of algorithms by the banking industry itself. In addition, after a bank identifies a transaction as suspect and therefore needs to issue a SAR, financial institutions can be concerned that reporting the SAR to Adult Protective Services could violate privacy laws at both the State and Federal level. States have laws on reporting suspected cases of elder abuse, but they vary in who can report, whether reporting is encouraged or mandatory, and whether there are protections from liability for reporting and delaying a trade.¹³⁰ All the relevant Federal agencies have issued joint guidance indicating that they do not anticipate initiating enforcement action for financial institutions reporting elder abuse pursuant to State mandates,¹³¹ but financial institutions remain concerned that taking steps to intervene on behalf of a client can violate rules on executing trades in a timely manner.

Financial institutions also noted a challenge of how to address transactions that raise a concern of impaired capacity, but not fraud or exploitation that would necessitate a SAR. As illustrated in the Bank of American Fork case study, institutions expressed a concern that bringing the transaction to the attention of the customer or even a third party the customer designated, such as an adult child or friend, or reporting to local law enforcement, could cause customer dissatisfaction and ultimately the loss of that customer.

The challenges to adopting online view-only accounts are how to make them part of routine banking practice. At the time a young or middle-aged customer is opening a bank or credit card account, he or she often does not select an institution based on the age-friendly features the customer may eventually need; in turn, banks are hesitant to raise the issue. By the time the need arises, the customer may not wish to switch accounts or may not be able to execute good judgment in the decision of how much extra financial authority should be delegated and to whom. Additionally, customers often have multiple accounts across several institutions, creating the challenge of aggregating information from multiple accounts into one secure portal.

With the entire industry facing the same problem, no one institution has the incentive to be the first to make passive monitoring and reporting and online view-only accounts part of routine practice. A

¹³⁰ PCAST identified three states—Delaware, Missouri, and Washington—that permit a financial institution to put a hold on a suspicious transaction while it is being investigated for fraud or exploitation.

¹³¹ Board of Governors of the Federal Reserve System, "Interagency Guidance on Privacy Laws and Reporting Financial Abuse of Older Adults," 1-5, 2013, See: www.fdic.gov/news/news/press/2013/Interagency-Guidance-on-Privacy-Laws-and-Reporting-Financial-Abuse-of-Older-Adults.pdf?source=govdelivery.

regulatory nudge could, we believe, overcome this barrier and make these technologies and the practices that surround them part of routine banking and financial management. Customers would expect to have these conversations as part of opening an account at an institution or in communication with an online bank to meet their needs over the long term.

To protect the finances of older adults experiencing cognitive decline, the Federal Government should encourage the banking and financial services industries to build the capability to identify declines in financial capacity, promote older adults' economic security, and protect their assets from fraud or exploitation and make the resultant information available to seniors. At minimum, the signatories to the 2013 Interagency Guidance on Privacy Laws and Reporting Financial Abuse of Older Adults [i.e., Board of Governors of the Federal Reserve System, Commodity Futures Trading Commission, CFPB, Federal Deposit Insurance Corporation (FDIC), FTC, National Credit Union Administration, Office of the Comptroller of the Currency, and SEC] should assure financial institutions that complying with State mandatory reporting requirements, and reporting suspected elder abuse and fraud in states that do not have mandatory reporting requirements, does not violate the customer's privacy rights under Gramm-Leach-Bliley Act.

In addition, the Executive Office of the President should convene State governors to identify the challenges and share successful strategies that ensure that SAR with information about suspected elder abuse or fraud are transferred to local adult protective services and law-enforcement authorities to protect seniors.

Other ways the Federal Government can protect older Americans is by facilitating and promoting the creation of industry standards for the collection and aggregation of data; requiring financial institutions to adopt commercially reasonable best practices for the use of technologies that detect potential fraud, abuse, or changes in financial capacity; and making rules that will cause financial institutions that offer online banking to create a means for seniors to give monitoring power to a trusted party without enabling that party to initiate transactions, change the senior's profile information, or otherwise engage in fraud or abuse. The SEC should assure financial institutions that holding a transaction due to suspected elder abuse or fraud or impaired capacity does not violate regulations for efficient and timely execution of a transaction, and the FDIC should require financial institutions to routinely offer safe-harbor forms to customers that authorize the institution to share information with a designated family member or other trusted actor if an event of fraud or financial abuse is suspected or discovered.

Recommendation 7: Financial Services

The Federal Government should encourage the banking and financial services sector to offer monitoring services to protect assets from fraud and exploitation.

1. Signatories to the 2013 Interagency Guidance on Privacy Laws and Reporting Financial Abuse of Older Adults should accelerate expectations of banks to offer a range of available protective services.
2. The Executive Office of the President should convene State governors to ensure that reports of suspicious activity are reported to relevant adult protective services agencies.

The Promise of Technology to Maintain or Enhance Cognitive Health

Cognition changes across the lifespan of an adult, but people differ substantially from each other in how they perform as they get older.¹³² Although many older adults show poorer performance than younger adults on a variety of cognitive tasks and skills, the trajectories of individuals' attention, reasoning, memory, and other cognitive processes vary greatly over time. Importantly, factors including genetics, health, sensory function including vision and hearing, mood, personality, and lifestyle factors such as physical activity, diet, cognitive engagement, and social interaction seem to influence these individual differences.^{133,134} For example, several animal and human studies now suggest that physical activity and exercise can enhance cognitive performance and brain health in older animals and humans.¹³⁵

This study looked at two related areas where research studies and commercial entities have tried to use technology to understand, modify, or compensate for adults' cognitive abilities. The first is cognitive-enhancement technologies or "brain games" that intend to improve an adult's cognitive performance. The second is cognitive assistive systems that coach an older adult on activities in the home. These are described in more detail below.

Cognitive Enhancement

Researchers believe that technologies intended to enhance cognition are promising, but there is little evidence that technologies affect real-world abilities.¹³⁶ Computer-based cognitive training can improve older adults' performance on a variety of trained tasks, albeit often at a slower rate than younger adults.¹³⁷ Training can improve memory,¹³⁸ sustained attention,¹³⁹ and dual-task performance.¹⁴⁰

¹³² Hertzog, C., Kramer, A.F., Wilson, R.S., Lindenberger, U., "Enrichment Effects on Adult Cognitive Development: Can the Functional Capacity of Older Adults Be Preserved and Enhanced?" *Psychological Science in the Public Interest*, 9(1): 1-65, 2008.

¹³³ Ibid.

¹³⁴ Salthouse, T.A., "Why are there different age relations in cross-sectional and longitudinal comparisons of cognitive functioning?" *Current Directions in Psychological Science*, 23(4): 252-256, 2014.

¹³⁵ Voss, M.W., Vivar, C., Kramer, A.F., van Praag, H., "Bridging animal and human models of exercise-induced brain plasticity," *Trends in Cognitive Sciences*, 17(10): 525-544, 2013.

¹³⁶ "Authoritative, Comprehensive and Systematic," Elsevier Current Opinion, Accessed March 14, 2016, www.current-opinion.com/journals/current-opinion-in-behavioral-sciences.

¹³⁷ Li, T., Yao, Y., Cheng, Y., Xu, B., Cao, X7., Waxman, D., Feng, W., Shen, Y., Li, Q., Wang, J., Wu, W., Li, C., Feng, J., "Cognitive Training Can Reduce the Rate of Cognitive Aging: A Neuroimaging Cohort Study," *BMC Geriatrics*, 16(1) 1-12, 2008; Strobach, T., Frensch, P., Müller, H.J., Schubert, T., "Testing the Limits of Optimizing Dual-Task Performance in Younger and Older Adults," *Frontiers in Human Neuroscience*, 6(39), 2012.

¹³⁸ Richmond, L.L., Morrison, AB., Chein, JM., Olson, IR., "Working Memory Training and Transfer in Older Adults," *Psychology of Aging*, 26(4): 813, 2011.

¹³⁹ Fortenbaugh, F.C., DeGutis, J., Germine, L., Wilmer, JB., Grosso, M., Russo, K., Esterman, M., "Sustained Attention Across the Life Span in a Sample of 10,000: Dissociating Ability and Strategy," 26(9): 1497-1510, 2015.

¹⁴⁰ Kramer, A.F., Hahn, S., Gopher, D., "Task Coordination and Aging: Explorations of Executive Control Processes in the Task Switching Paradigm," *Acta Psychologica*, 101(2): 339-378, 1999.

It can improve reasoning, processing speed,¹⁴¹ and other cognitive abilities as well.

Studies have investigated whether trained skills are retained over time and if the trained skills can be applied or transferred to other tasks. Similar to younger adults, older adults can maintain trained skills for months to years.¹⁴² The evidence is less definitive whether training helps with dissimilar tasks. For example, there is little research that computer-based cognitive training can improve normal activities, such as driving, professional work, or leisure activities.¹⁴³ That is, computer-based training has only infrequently been shown to improve other real-world skills and tasks.

The same concerns also apply to the commercial “brain training industry,” which offers multiple products to consumers.¹⁴⁴ Unfortunately, product development has often gotten ahead of the demonstration that these products enhance cognitive processes and skills that are directly relevant to older adults’ lives.

The FTC should determine the appropriate regulatory review and guidelines for commercial cognitive training and coaching technologies and applications. These policies and guidelines are particularly warranted for those commercial products that make claims about general cognitive enhancement; maintenance and improvement of everyday skills and functional abilities such as driving, living independently, or functioning such as in employment and leisure activities; and improvements in

Recommendation 8: Cognitive Training

The Federal Trade Commission (FTC) should continue to enforce regulatory review and guidelines for commercial cognitive training products.

¹⁴¹ Ball, K., Berch, D.B., Helmers, K.F., Jobe, J.B., Leveck, M.D., Marsiske, M., Morris, J.N., Rebok, G.W., Smith, D.M., Tennstedt, S.L., Unverzagt, F.W., Willis, S.L., “Effects of cognitive training interventions with older adults: a randomized controlled trial,” *JAMA*, 288(18): 2271-2281, 2002.

¹⁴² Ball, K., Berch, D.B., Helmers, K.F., Jobe, J.B., Leveck, M.D., Marsiske, M., Morris, J.N., Rebok, G.W., Smith, D.M., Tennstedt, S.L., Unverzagt, F.W., Willis, S.L., “Effects of cognitive training interventions with older adults: a randomized controlled trial,” *JAMA*, 288(18): 2271-2281, 2002; Kramer, A.F., Hahn, S., Gopher, D., “Task Coordination and Aging: Explorations of Executive Control Processes in the Task Switching Paradigm,” *Acta Psychologica*, 101(2): 339-378, 1999; Rebok, G.W., Ball, K., Guey, L.T., Jones, R.N., Kim, H.Y., King, J.W., Marsiske, M., Morris, J.N., Tennstedt, S.L., Unverzagt, F.W., Willis, S.L., “Ten-year effects of the advanced cognitive training for independent and vital elderly cognitive training trial on cognition and everyday functioning in older adults,” *Journal of the American Geriatrics Society*, 62(1): 16-24, 2014.

¹⁴³ Kelly, M.E., Loughrey, D., Lawlor, B.A., Robertson, I.H., Walsh, C., Brennan, S., “The impact of cognitive training and mental stimulation on cognitive and everyday functioning of healthy older adults: a systematic review and meta-analysis,” *Ageing Research Reviews*, 15: 28-43, 2014; Willis, S.L., Tennstedt, S.L., Marsiske, M., Ball, K., Elias, J., Koepke, K.M., Morris, J.N., Rebok, G.W., Unverzagt, F.W., Stoddard, A.M., Wright, E., “Long-term effects of cognitive training on everyday functional outcomes in older adults,” 296(23): 2805-2814. *JAMA*, 2006.

¹⁴⁴ “Cognitive Training Data,” Cognitive Training Data., Accessed March 14, 2016, www.cognitivetrainingdata.org; and “A Consensus on the Brain Training Industry from the Scientific Community,” Max Planck Institute for Human Development and Stanford Center on Longevity, Accessed March 14, 2016, longevity3.stanford.edu/blog/2014/10/15/the-consensus-on-the-brain-training-industry-from-the-scientific-community/

cognitive function for older individuals with and without age-associated neurodegenerative disorders such as Alzheimer's and Parkinson's diseases.

Cognitive Assistive Systems

In recent years, there has been an increasing interest in the use of artificial intelligence and cognitive science to develop technologies that can support older adults' independence. These technologies are new and have been studied in research settings. They are referred to as cognitive assistive technologies and cognitive coaching and prompting systems. Some technologies are referred to as assurance systems and usually include a wide range of sensors and software to monitor whether older adults are displaying changes of behavior that can signal cognitive or physical distress.¹⁴⁵ For example, one set of researchers developed a system using image-based sensors and computer-vision algorithms to detect falls in the home.¹⁴⁶ Initial tests indicated that the system detected falls on 77 percent of occasions.¹⁴⁷ Other systems have been developed using ingestible sensors to detect that elderly patients are taking their medication as prescribed.¹⁴⁸

Compensation systems are another class of cognitive-assistive technologies. These systems go beyond detecting that something is amiss and also provide prompts or instructions to guide the user to ensure safe and effective behavior. For example, the COACH prompting system has been designed to assist older adults with dementia in effective hand washing.¹⁴⁹ This system uses computational vision and artificial intelligence algorithms to detect hand-washing behaviors and provide audio-visual prompts if individuals lose their place in the process. A study with six patients found that, in general, the COACH system did as well or better than human caregivers in engendering effective hand washing behavior. As an added benefit, it also reduced the time required for human caregiving.¹⁵⁰ Other systems have been developed to help maintain and enhance socialization, and in turn cognition, of older adults through the use of integrated technology including web cameras, Skype software, email, and phone systems.

In general, cognitive assistive technologies, in particular cognitive coaching and prompting systems, show promise in maintaining and enhancing the cognitive abilities of adults with and without neurodegenerative diseases. Given that these technologies are rather new, there are many important issues to be addressed in both research and product development. One way to support both the research and development of these potentially important products is through the funding of Small

¹⁴⁵ Pollack, M. E., "Intelligent technology for an aging population: The use of AI to assist elders with cognitive impairment", *AI Magazine* 26(2): 9-24, 2005.

¹⁴⁶ Lee, T., and Mihailidis, A., "An Intelligent Emergency Response System: Preliminary Development and Testing of Automated Fall Detection," *Journal of Telemedicine and Telecare*, 11(4): 194-198, 2005.

¹⁴⁷ Yu, X., "Approaches and principles of fall detection for elderly and patient," *e-health Networking, Applications and Services*, 10: 42-47, 2008.

¹⁴⁸ Au-Yeung, K., Moon, G., Robertson, T., DiCarlo, L., Epstein, M., Weis, S.E., Reves, R.R., Engel, G., "Early clinical experience with networked system for promoting patient self-management," *American Journal of Managed Care* 17: e277-87, 2011; Belknap, R., Weis, S., Brookens, A., Au-Yeung, K. Y., Moon, G., DiCarlo, L., and Reves, R. "Feasibility of an ingestible sensor-based system for monitoring adherence to tuberculosis therapy", *PLoS ONE*, 8(1): e53373, 2013.

¹⁴⁹ Mihailidis, A., Boger, J.N., Craig, T., Hoey, J., "The COACH Prompting System to Assist Older Adults with Dementia Through Handwashing: An efficiency Study," *BMC Geriatric*, 8(1): 2008.

¹⁵⁰ Zhou, J., Salvendy, G., eds. "Human Aspects of IT for the Aged Population. Design for Aging: First International Conference," Springer, 2015.

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Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) from Federal agencies and from targeted funding programs from private organizations.



4. Technologies to Address Changes in Physical Ability

Mobility and successful aging are inextricably intertwined. Sustained mobility is a key ingredient for independence, quality of life, community participation, and—as needed or desired—employment for older adults. Successful aging in place heavily depends on an individual’s ability to remain mobile in and around his or her home, to maintain normal daily activities, and to access appropriate nutrition.

Mobility loss is frequently a precursor to declining health and increased costs of care. Falls are a common problem. Over one-third of older adults reported a fall within a recent two year period.¹⁵¹ Injuries due to falls are a frequent cause for emergency room visits by older adults,¹⁵² and unintentional falls are the leading cause of death by injury for adults over 65 years old.¹⁵³

There are multiple technologies that could improve mobility. Power wheelchairs, manual wheelchairs, walkers, and scooters are in common use now, and there are growing capabilities in prosthetic devices and robotic assistants. Several United States-based programs, such as those offered by the Department of Veterans Affairs, show potential approaches to meeting a spectrum of mobility needs.

There are multiple barriers to mobility for older adults. Architectural barriers in homes, buildings, and the environment may limit an individual’s mobility, and it may further limit mobility aids like scooters or walkers. Commercially available technologies such as hands-free faucets and door openers are rarely available in private homes. Post-construction architectural modifications to increase the accessibility of a home often are difficult or have high cost. Inaccessible or hard-to-use fixtures, cabinets, and furniture can make normal daily activities a challenge; difficulty reaching items or difficulty transferring on and off the toilet or in and out of a tub, chair, or bed create significant barriers to daily living. Kitchen appliances with challenging interfaces or food sealed in difficult-to-open packaging may make accessing proper nutrition a problem.

There are multiple ways to define mobility, which has implications for judging the success of a particular technology or treatment. There are clinical assessments that measure a person’s ability to walk a series of steps, to rise from a chair, or to exhibit fine-motor skills. Beyond that, others look at independence, such as whether an individual is mobile enough to conduct basic activities of daily living or take part in the community. A recurring theme is the tension between providing targeted medical treatment, in some cases very expensive medical treatment, without sufficient consideration for comprehensive

¹⁵¹ Cigolle, C. T., Ha, J., Min, L. C., Lee, P. G., Gure, T. R., Alexander, N. B., Blaum, C.S., “The Epidemiologic Data on Falls, 1998-2010: More Older Americans Report Falling,” *JAMA Internal Medicine*, 175(3): 443-445, 2015, See: archinte.jamanetwork.com/article.aspx?articleid=2091398.

¹⁵² Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. Web-based Injury Statistics Query and Reporting System (WISQARS) Nonfatal Injury Data, 2015.

¹⁵³ *ibid.*

approaches that can sustain a range of activities, continued employment, and meaningful community participation. Enabling these comprehensive approaches requires new policy approaches and multi-agency cooperation in addition to technical advances.

This chapter discusses mobility capabilities at multiple levels. One is improving access to health care regardless of an individual's physical mobility, using telehealth tools. Another is to promote universal design that helps ensure people can navigate a home or building independently. Third, the chapter will look at challenges in manipulating objects by hand—fine-grained mobility—which is critical to using tools and handling modern packaging. Finally, it will examine technologies to compensate for mobility loss, both within and outside the home.

Telehealth

Telehealth includes a wide range of technology and approaches that can allow adults to access health care regardless of their physical mobility or location. By taking advantage of advances in communications and monitoring technologies, together with the capabilities of modern smartphones, telehealth can allow older adults to remain independent at home, prevent or delay institutionalization, effectively monitor chronic diseases and movement, and coordinate care between multiple providers that are not in the same location.

Promise of Telehealth

One of the clearest benefits of telehealth is the ability to expand access. This capability can be particularly useful for older adults who live far away from medical centers or clinics, such as those who live in rural areas (Box 5). Furthermore, many older adults have difficulty getting to a health care appointment because they cannot drive, there are few public transit options, or they have limited personal mobility. Telehealth can provide additional options for those adults by allowing them to communicate with their healthcare provider from home. This can be useful for both primary care and specialty care, in areas ranging from minor injury to hepatology to cancer to mental health.¹⁵⁴

New forms of technology also can strengthen the expertise of the local healthcare workforce. As described in Box 5, distance technology can expand the skills of local primary care providers with education and consultation, which will allow those providers to directly care for patients with specific complex conditions.

Another form of telehealth can help provide specialty consultation on medical images or scans (store-and-forward services). Those services are flexible in that they can be provided asynchronously, so that the patient and clinician do not need to be available at the same time. With this technology, a remote radiologist can examine a patient's x-ray or MRI, or an ophthalmologist can review a picture of a patient's eye to look for early signs of vision loss from diabetes.

¹⁵⁴ eHealth Initiative, "A Study and Report on the Use of eHealth Tools for Chronic Disease Care Among Socially Disadvantaged Populations," 2012.

Box 5. Expanding access to specialty care

Throughout the country, access to specialty care for complex health conditions remains limited, particularly in rural and underserved communities. Telemedicine has been proposed as a solution to bring specialty care to rural areas. Although telemedicine reduces travel time for patients, it does not build overall system capacity for specialized care. For every patient seen via telemedicine in a rural area, one less underserved patient is seen in the urban setting. Project ECHO (Extension for Community Healthcare Outcomes) addresses both the individual needs of patients and the collective needs of communities by providing medical education and care management that empowers clinicians everywhere to provide better care to more people, right where they live. In the ECHO model, primary care clinicians, nurses, and community health workers from multiple sites hold virtual clinics with expert specialist teams weekly to present patient cases, discuss new developments relating to their patients, and determine treatment. Specialists serve as mentors and colleagues, sharing their medical knowledge and expertise. At the same time, primary care providers learn from one another and, through mentoring and education, enhance their own knowledge and skills so that they can continue caring for their patients who might otherwise have to wait many months or travel many miles to receive care.

Headquartered in Albuquerque, Project ECHO began with Sanjeev Arora, MD, a hepatologist (liver disease specialist) who was one of only a few experts providing care for Hepatitis C in the rural state of New Mexico. Many sick, weak, and older patients could not travel hundreds of miles to see him, and those who could might have to wait 8 months or more for an appointment. Recognizing that he could never meet the tremendous need for care, Dr. Arora developed this technology mediated consultation/mentoring model that allowed him to extend his expertise to many more patients while at the same time exponentially increasing the expertise among the rural primary care providers. Always knowing they could come back to Dr. Arora and his team with questions, a virtual multi-specialty team was created, and the non-specialists helped extend effective treatment to thousands of patients.

ECHO has now extended this model to HIV/AIDS, diabetes, behavioral health and substance abuse, chronic pain, dementia, and other complex chronic illnesses. The ECHO model is also being applied to correctional (prison) care, which includes treating tuberculosis and preventing drug resistance. The ECHO team also trains community health workers in remote locations to help communities with obesity prevention, health literacy, and cultural competency. Recently they began training programs in systems engineering approaches to quality improvement.

ECHO programs now exist in more than 20 states and a dozen countries throughout the world. Initially funded through foundation and grant support, policymakers are increasingly recognizing the potential of ECHO to exponentially expand workforce capacity to treat more patients sooner, using existing resources. Many State and national governments have found the ECHO approach to be cost-effective and deserving of direct government funding.

Other technologies allow for greater remote monitoring of patients (as noted earlier in Chapter 3). This can assist older adults remain stable when coming home from the hospital, as many are readmitted to the hospital in a short time after being discharged. Telehealth could monitor their vital signs to spot

potential critical issues (such as changes in weight or blood pressure) before they require going back to the hospital. Similarly, many healthy older adults end up in nursing homes simply because they need more monitoring to ensure their safety. These technologies could offer a way to keep them in their home and community (Box 6).¹⁵⁵

Other countries have increased their use of telehealth. For example, Australia has used such technologies to deliver cancer services to their large rural populations, including disadvantaged indigenous patients. Without telehealth, fewer diagnostic and treatment services would be available and there would be shortages, which would lead to later diagnoses and poorer health outcomes.^{156,157} Studies found that technology has made it feasible to deliver cancer services by telehealth,¹⁵⁸ patients and health care workers were satisfied with teleoncology services,¹⁵⁹ and that the services could be delivered safely.¹⁶⁰

Box 6. Case study of unobtrusive monitoring

TigerPlace is an example of how technology can foster older adults' independence and allow them to age in place. It is also an example of an academic/private business partnership, as it involves the University of Missouri Sinclair School of Nursing and the long-term care corporation Americare, thereby showing how researchers and private industry can collaborate to help meet the challenges of an aging society.

TigerPlace is a licensed aging-in-place building that allows seniors to live independently in an infrastructure that supports age-related research. By incorporating research in this way, the intent is to have residents be part of the research process and have a voice in it. One notable research initiative is to develop an integrated sensor network that maps patterns of motion. It is intended to identify the earliest signs of health or functional decline, and initial results suggest the system can provide clinically relevant alerts to caregivers to identify an older adult at risk.

¹⁵⁵ Skubic, M., Rantz, N., Miller, S., Guevara, Koopman, R., Alexander, G., Phillips, L., "Evaluation of Health Alerts from an Early Illness Warning System in Independent Living," *Computers, Informatics, Nursing*, 31(6): 274-280, 2013.

¹⁵⁶ George, M., Ngo, P., Prawira, A., "Rural oncology: overcoming the tyranny of distance for improved cancer care," *Journal of Oncology Practice* 10(3), e146-e149, 2014.

¹⁵⁷ Sabesan, S., Brennan, S., "Telemedicine Techniques and Applications," *Tele Oncology for Cancer Care in Rural Australia*, ISBN: 978-953-307-354-5, 2011, See: www.intechopen.com/books/telemedicine-techniques-and-applications/tele-oncology-for-cancer-care-in-rural-australia.

¹⁵⁸ Sabesan, S., Larkins, S., Evans, R., Varma, S., Andrews, A., Beuttner, P., Brennan, S., Young, M., "Telemedicine for Rural Cancer Care in North Queensland: Bringing Cancer Care Home," *Australian Journal of Rural Health*, 20(5): 259-264, 2012.

¹⁵⁹ Mooi, J.K, Whop, L.J, Valery, P.C, Sabesan, S.S., "Technology for Indigenous patients: the responses of patients and health workers," *Australian Journal of Rural Health*, 20(5): 265-269, 2012.

¹⁶⁰ Sabesan, S., Brennan, S., "Telemedicine Techniques and Applications," *Tele Oncology for Cancer Care in Rural Australia*, ISBN: 978-953-307-354-5, 2011, See: www.intechopen.com/books/telemedicine-techniques-and-applications/tele-oncology-for-cancer-care-in-rural-australia.

In general, the use of telehealth has grown in recent years—in 2012, over 40 percent of hospitals had telehealth capabilities.¹⁶¹ The potential for telehealth is expanding, as noted in the cases above, and there are other new horizons in telehealth, like expanding the ability to deliver medical advice via mobile devices.

Federal Government Initiatives in Telehealth

Several Federal agencies use telehealth technologies to directly provide health care. The Veterans Health Administration (VHA) directly provides patient care using telehealth, fielding one of the largest integrated telehealth services across the United States. The services include mental health, pulmonary monitoring, ICU monitoring, and teleaudiology. The Department of Defense's (DOD) Defense Health Agency similarly uses telehealth for direct patient care, and the TRICARE insurance program reimburses for telehealth services, including for mental health. The Indian Health Service (IHS) uses telehealth to provide services to Native American, Alaska Native, and Pacific-Islander populations, and it collaborates with the VHA in providing telehealth to veterans in those populations. The IHS uses telehealth for healthcare services such as eye screening for diabetic patients, cardiology consultations, and primary care.

The Centers for Medicare and Medicaid Services (CMS) support telehealth in the Medicare and Medicaid programs. Many State Medicaid programs cover some telehealth services, without being exclusive to just rural areas. Traditional Medicare, however, is limited by law in reimbursing telehealth.¹⁶² It can only pay for telehealth services where the patient lives in a rural area and receives the telehealth services in a healthcare setting, like a physician's office or hospital, rather than in a patient's home. The telehealth services must further be real-time communications, not asynchronous. There are further limitations on the types of clinicians who may provide the remote services and the types of services that can be provided. Other parts of Medicare provide additional telehealth services. Medicare Part D plans must cover a comprehensive medication review, which may be done in person or by telehealth. Medicare Advantage plans must offer at least the same telehealth benefits as traditional Medicare, but have the option to offer more. The recent Medicare Access and CHIP Reauthorization Act of 2015 (MACRA) legislation required the Government Accountability Office to develop two reports examining telehealth: one on the Medicare telehealth program and another on remote patient monitoring technology and services. These reports will identify opportunities to improve telehealth for Federal programs.

In addition, there are a variety of Federal initiatives focused on research into improving telehealth. The Department of Defense (DOD) operates the Telemedicine & Advanced Technology Research Center that researches, prototypes, and evaluates telemedicine technologies. The DOD also runs the National Center for Telehealth & Technology that seeks to advance technologies in mobile health and telehealth for psychological health and traumatic brain injury care, which is a common injury for service members. The Substance Abuse and Mental Health Services Administration (SAMHSA) provides grants for telemental health, and the Agency for Healthcare Research and Quality (AHRQ) supports research on

¹⁶¹ Adler-Milstein, J., Kvedar, J., Bates, D.W., "Telehealth among US hospitals: several factors, including state reimbursement and licensure policies, influence adoption," *Health Affairs*, 33(2): 207-215, 2014, See: content.healthaffairs.org/content/33/2/207.

¹⁶² 42 USC 1395I: Payment of benefits, From Title 42-The public health and welfare, See: [uscode.house.gov/view.xhtml?req=\(title:42%20section:1395I%20edition:prelim](http://uscode.house.gov/view.xhtml?req=(title:42%20section:1395I%20edition:prelim).

telehealth. Recent AHRQ-supported projects focus on monitoring a patient after surgery to prevent surgical site infections, thereby reducing unnecessary hospitalizations, and supporting patients in performing physical therapy at home to help them heal more quickly. Those capabilities are particularly important for older patients for whom travel is difficult. The Office of the National Coordinator for Health IT (ONC) has included telehealth in its Federal health IT strategic plan for 2015–2020,¹⁶³ and provided guidance on advancing telehealth and remote visits for consumers.¹⁶⁴

Telehealth depends on an advanced broadband infrastructure. The United States Department of Agriculture (USDA) gives grants for broadband and advanced telecom systems, including the Distance Learning and Telemedicine program for rural communities. On National Rural Health Day (November 19, 2015), the Secretary of Agriculture announced almost \$10 million in grants for expanding telehealth capabilities in rural areas under the Distance Learning and Telemedicine program, including creating a tele-psychiatry network in Alaska and installing a telemedicine system that will coordinate care for high-risk patients in Georgia.¹⁶⁵ Furthermore, the Federal Communications Commission (FCC) provides grants for broadband and advanced telecommunication systems, including grants to health care providers for broadband connectivity.

Beyond traditional telehealth models, there are ways for data and information technology to support novel programs that encourage aging in place. The Vermont pilot program Support And Services at Home (SASH) was funded by the Department of Housing and Urban Development (HUD) and the Department of Health and Human Services (HHS) as a Medicare/Medicaid demonstration measuring what happens when health and supportive services are coordinated with affordable housing for older adults. SASH is part of the HHS Multi-payer Advanced Primary Care Practice (MAPCP) demonstration, and the model is part of Vermont’s statewide health care reform program, with access to the state-wide data and analytics platform. Cathedral Square, a non-profit organization focused on developing and operating communities for seniors and individuals with special needs, manages the regional implementation of SASH throughout Vermont alongside other State and local organizations. An evaluation found that the model had to potential to reduce growth of Medicare expenditures.¹⁶⁶

The cross-agency Federal Telemedicine Working Group, led by the Health Resources and Services Administration (HRSA), coordinates Federal telemedicine grants and funding opportunities. HRSA also

¹⁶³ Office of the National Coordinator for Health Information Technology, “Federal Health IT Strategic Plan 2015-2020,” *United States Department of Health & Human Services*, 2015, see: www.healthit.gov/sites/default/files/9-5-federalhealthitstratplanfinal_0.pdf.

¹⁶⁴ Bobinet, K., Petito, J., “Designing The Consumer-Centered Telehealth & eVisit Experience,” *United States Department of Health & Human Services*, 2015, See: www.healthit.gov/sites/default/files/DesigningConsumerCenteredTelehealthVisit-ONC-WHITEPAPER-2015V2edits.pdf.

¹⁶⁵ United States Department of Agriculture, “FY 2015 Distance Learning & Telemedicine Grants,” 2015, See: www.rd.usda.gov/files/RD_DLTAWardsNovember2015.pdf.

¹⁶⁶ U.S. Department of Health and Human Services Assistant Secretary for Planning and Evaluation Office of Disability, Aging and Long-Term Care Policy, “Support and Services at Home (SASH) Evaluation: First Annual Report,” 1-25, 2015, See: aspe.hhs.gov/report/support-and-services-home-sash-evaluation-first-annual-report.

provides grants for regional telehealth networks, funds research on license portability, and operates the Office for the Advancement of Telehealth (OAT).

Challenges for Telehealth Implementation

Telehealth technology continues to evolve, and there are several challenges in implementing it successfully. Technology is only part of the solution; implementation requires addressing a number of human and social factors. Moreover, there are multiple types of technologies and approaches, and each has different advantages and disadvantages.

The evidence behind telehealth reflects its evolution and the challenges in its implementation. One study found that telehealth reduced mortality risks for patients with three chronic diseases (congestive heart failure, diabetes (mellitus), and chronic obstructive pulmonary disease) and also reduced healthcare costs by 8–13 percent.¹⁶⁷ A systematic review of chronic disease management programs provided via telehealth showed reductions in hospitalizations, shorter hospital stays, and fewer emergency-room visits.¹⁶⁸ At the same time, some studies have shown some forms of telehealth have not necessarily improved care. For example, a study looking at older adults with multiple health conditions found that remote monitoring did not reduce hospitalizations or emergency department visits, and it found that mortality slightly increased for those adults receiving monitoring than for those under usual care.¹⁶⁹ The mixed evidence highlights the need for rigorous studies to identify which forms of telehealth are the most effective for different situations.¹⁷⁰

There are multiple policy barriers that limit telehealth. One major one is professional licensure. Licensure is historically a State responsibility, so physicians, nurses, pharmacists, and other health care professionals are generally only able to legally practice in the one State where they have a license. As a result, telehealth is generally only able to connect patients and providers in the same State, and not take advantage of clinicians from other States unless those clinicians obtain multiple licenses for each State where they would deliver telehealth services.

There has been movement to allow professionals to practice across State lines. The Nurse Licensure Compact, developed about 15 years ago, provides nurses the opportunity to obtain a multistate license that is valid in the states that have ratified the compact. As of 2015, 25 states have joined the

¹⁶⁷ Baker, L. C., Johnson, S. J., Macaulay, D., Birnbaum, H., “Integrated telehealth and care management program for Medicare beneficiaries with chronic disease linked to savings,” *Health Affairs*, 30(9): 1689-1697, 2011, See: www.ncbi.nlm.nih.gov/pubmed/21900660.

¹⁶⁸ Bashshur, R.L., Shannon, G.W., Smith, B.R., Alverson, D.C., Antoniotti, N., Barsan, W.G., Bashshur, N., Brown, E.M., Coye, M.J., Doarn, C.R., Ferguson, S., “The empirical foundations of telemedicine interventions for chronic disease management,” *Telemedicine and e-Health*, 20(9): 769-800, 2014, See: online.liebertpub.com/doi/abs/10.1089/tmj.2014.9981?src=recsys&journalCode=tmj&.

¹⁶⁹ Takahashi, P.Y., Pecina, J.L., Upatising, B., Chaudhry, R., Shah, N.D., Van Houten, H., Cha, S., Croghan, I., Naessens, J.M., Hanson, G.J., “A randomized controlled trial of telemonitoring in older adults with multiple health issues to prevent hospitalizations and emergency department visits,” *Archives of Internal Medicine*, 172(10): 773-779, 2012, See: www.ncbi.nlm.nih.gov/pmc/articles/PMC3914200.

¹⁷⁰ Kahn, J.M., “Virtual visits—Confronting the challenges of telemedicine,” *New England Journal of Medicine*, 372(18): 1684-85, 2015.

compact.¹⁷¹ More recently, the Federation of State Medical Boards has spearheaded the Interstate Medical Licensure Compact to allow physicians the opportunity to practice across State lines in participating states. In its first year, 11 States have enacted the Compact, and an Interstate Medical Licensure Compact Commission has been formed with representatives from each of the States participating.¹⁷²

Another barrier is reimbursement, especially whether telehealth services are covered at all or what forms of the technology are reimbursed. There has been movement in this regard, although there are gaps in many plans and for many innovative services. Many private payers are now covering some form of telehealth services, and many states have passed laws requiring coverage of some types of telehealth services. Public payers have also expanded their telehealth coverage, and, as of July 2015, 47 Medicaid programs cover some form of telehealth services.¹⁷³ As noted earlier, traditional Medicare is limited by law in reimbursing telehealth, especially by requiring that telehealth services can only be receiving in a clinic or healthcare setting (not a patient's home).¹⁷⁴ There are additional restrictions in the type of telehealth technologies covered by Medicare, the types of clinicians who may participate, and the types of services that can be provided by these technologies. It is important to note that these restrictions do not apply to Medicare Advantage plans or care models designed by the CMS Innovation Center.

Improving Telehealth

The early results for telehealth demonstrated that it can improve access, especially in underserved areas and for adults who have mobility impairments. Furthermore, telehealth has been applied to expand the skill set of primary care clinicians, such as to manage complex conditions that often require specialty care and to remotely monitor people who may be dealing with cognitive or physical impairments. Reciprocal state licensure policies would improve the access to care. New technologies, such as greater use of smartphones, sensor technology, and faster Internet, will expand the range of telehealth services and how they may be incorporated into routine healthcare.

As noted in Chapter 2 on social connectivity, broadband is a prerequisite for many technological advances. This holds true for telehealth as well, as it cannot be delivered without a robust Internet connection. Lack of broadband may be especially acute in rural areas, which are the same areas that may need telehealth most to augment health care workforce shortages.

While there are legislative restrictions on how Medicare can cover telehealth, CMS can act by increasingly incorporating telehealth in Alternative Payment Models, demonstration projects, and Innovation Center models. The CMS Innovation Center has already included expanded access to telehealth in the Next Generation ACO model program and in the Bundled Payment for Care

¹⁷¹ "25 Nurse Licensure Compact (NLC) States," *National Council of State Boards of Nursing*, 2015, See: www.ncsbn.org/NLC_Implementation_2015.pdf.

¹⁷² See: www.fsmb.org/Media/Default/PDF/Publications/compact_commission_meeting_oct2015.pdf and licenseportability.org.

¹⁷³ "National Statistics," Centers for Disease Control and Prevention, 2015, Accessed March 14, 2016. See: www.cdc.gov/arthritis/data_statistics/national-statistics.html.

¹⁷⁴ 42 USC 1395I: Payment of benefits, From Title 42-The public health and welfare, See: [uscode.house.gov/view.xhtml?req=\(title:42%20section:1395I%20edition:prelim](http://uscode.house.gov/view.xhtml?req=(title:42%20section:1395I%20edition:prelim)

Improvement Initiative, and further action would be welcome. In addition to Medicare, CMS can increase the number of state Medicaid waivers that allow for more use of telehealth in Medicaid programs. Actions by these two large payers would have ripple effects and remove significant barriers.

Recommendation 9: Improve Regulation and Payment to Reflect Innovation in Telehealth

HHS should convene the Federation of State Medical Boards and the National Governors Association to accelerate reciprocal State licensure policies. CMS should use the full capacity of the Innovation Center to advance payment policies that support innovation in telehealth.

Designing Buildings to Ensure Independence in the Home

Maintaining independence in the home is paramount for many older adults as they age. The ability to navigate one's home is important for completing regular activities of daily living. If the home is designed to help people maintain their mobility as they age, these capabilities could delay or avoid the need for moving to a nursing home or institution. Well-designed lighting; an absence of slippery surfaces, sharp corners, or narrow corridors and doorways; and easily reached heights can all contribute to successful navigation. A well-designed environment can even reduce the need for using mobility aids and limit the risks of falls and injury. For example, although an individual in a wheelchair needs a chair lift or an elevator to move between floors in many houses, a home with ramps or that is a single story eliminates the need for the lift or elevator. The goal of all of this is to help people meet their needs across their lifespan.

Role of Home Design and Modifications

Through thoughtful design, the home can compensate for limitations in functional abilities to enable individuals to carry out basic activities associated with daily living safely and independently, participate in social roles, and receive personal assistance from caregivers as needed. The environment can also facilitate health maintenance and management by supporting health-promoting behaviors and provision of health care services.¹⁷⁵

Conversely, a poorly designed home environment can exacerbate functional declines and raise the risk of injury. Physical environmental barriers such as stairs, the lack of tub and toilet grab bars or low-threshold showers, poor visual contrast, lack of space and floor hazards such as rugs, are unfortunately

¹⁷⁵ Harvard Joint Center for Housing Studies (with support of the AARP Foundation), "Housing America's Older Adults: Meeting the Needs of an Aging Population," 2014.

common. One study found homes average 13 problems that posed barriers to safe and independent living.¹⁷⁶

Home modifications (including assistive and communication technologies) have been found to prevent functional decline and disability, promote independence and safety, enhance health outcomes, increase caregivers' effectiveness and well-being, and decrease caregiver stress.¹⁷⁷

Despite numerous successful examples of new home designs and retrofitted modifications, without broader knowledge and expertise regarding these approaches, the majority of Americans will not experience these benefits. Training and guidance needs to be provided to create standards for the assessment of risks from residential environments and best practices about the effectiveness of different interventions.

The separation of housing and health care in different governmental agencies has created various systems of public subsidies that make it difficult for individuals to find or receive adequate funding. As a result, funding to support mobility during aging can come from a number of sources that are hard to categorize and locate. Even within the seven departments that have programs in which funds can be used for home modifications, including Agriculture, Energy, Education, Health and Human Services, Housing and Urban Development (HUD), Treasury, and Veterans Affairs, there is a lack of coordination and the overall amounts may be inadequate.

As aging at home, instead of in an institution, has been shown to improve health and happiness and reduce cost, the Federal Government should take action to support successful aging at home, including home modifications and mobility technologies. One way would be for HHS to convene a public-private task force to examine regulations and payment policies associated with CMS, ADA, and HUD that govern home accessibility and home modifications for aging and the disabled. Recommendations from the task force would strive to harmonize those policies with the goal of long-term, home-based aging-in-place. The agencies together should find ways to encourage private and government-funded retirement communities to adopt home design principles that can support successful aging, allow the growth of monitoring and oversight capabilities for predictive risk management, and deal with emergency situations.

Recommendation 10: Home Design to Sustain Independence

HHS should work with the Department of Housing and Urban Development (HUD) to streamline and strengthen regulations and payment policies that govern home accessibility standards in order to promote uniform standards allowing efficient use and changes in technological support systems. This is especially important for retirement communities.

¹⁷⁶ Gitlin, L.N., Corcoran, M., Winter, L., Boyce, A., Hauck, W.W., "A randomized, controlled trial of a home environmental intervention: effect on efficacy and upset in caregivers and on daily function of persons with dementia," *Gerontologist*, 41(1): 4-14, 2001.

¹⁷⁷ Sanford, J.A., National Research Council Committee on the Role of Human Factors in Home Healthcare, "The Physical Environment and Home Healthcare Role of Human Factors in Home Healthcare," *National Academies Press*, 2010.

Role of Product Design

Sustaining mobility as a person ages also requires compensating for losses in fine motor capabilities. Over half of older Americans have been diagnosed with arthritis by a doctor, and half of those have some limitation in their daily activities due to arthritis.¹⁷⁸ By 2030, it is expected that arthritis will affect an estimated 67 million American adults.¹⁷⁹ Arthritis in the wrist, hand, and fingers can impair many daily activities including food preparation and consumption. Individuals with arthritis may experience painful inflammation of the joints causing a reduction in tactile sensation, range of movement, and a loss of dexterity and mobility.

Many individuals with arthritis experience significant difficulty and pain when attempting to perform a variety of routine, everyday tasks. Studies have shown that arthritis can reduce hand strength by 70 percent and also reduce hand functionality by almost half.^{180,181} Technologies developed for other purposes, such as hands-free faucets and doors, and voice-controlled devices, can mitigate the challenges of arthritis, but are not readily available for that purpose.

Exacerbating these challenges is the increasing use of inaccessible packaging. Child-proof pharmaceutical packing can be a burden to older adults. Driven by efficiencies in transportation, increasing shelf life and deterring theft, food stuffs and many other household objects are commonly encased in difficult-to-open, often hard-shell plastics. Problems that ensue include:

- *Malnutrition.* A study in Australian hospitals found several food and beverage packages were difficult to open by at least 40 percent of patients. These included milk and juices, cereal, and water bottles. Patients level of malnutrition increased, correlated with longer hospital stays.¹⁸²
- *Injury.* Faced with difficult-to-open packages, many people will resort to unsafe tools such as kitchen knives and screwdrivers to pry open packages.^{183,184}

¹⁷⁸ Centers for Disease Control and Prevention, "Prevalence of Doctor-Diagnosed Arthritis and Arthritis-Attributable Activity Limitation," *Morbidity and Mortality Weekly Report*, 59(30): 1261-1265, 2010, www.cdc.gov/mmwr/pdf/wk/mm5939.pdf.

¹⁷⁹ "National Statistics." Centers for Disease Control and Prevention. Accessed March 14, 2016, 2016, www.cdc.gov/arthritis/data_statistics/national-statistics.html

¹⁸⁰ Bagis, S., Sahin, G., Yapici, Y., Bolgen Cimen, O., & Erdogan, C. "The effect of hand osteoarthritis on grip and pinch strength and hand function in postmenopausal women," *Clinical Rheumatology*, 22: 420-424, 2003.

¹⁸¹ Centers for Disease Control and Prevention, "Prevalence of Doctor-Diagnosed Arthritis and Arthritis-Attributable Activity Limitation," *Morbidity and Mortality Weekly Report*, 59(30): 1261-1265, 2010.

¹⁸² Garling, Peter, "Final Report of the Special Commission of Inquiry into Acute Care Services in NSW Public Hospitals," 2008.

¹⁸³ Spittler, V., Mills, A., Marcey, N., O'Brien, C., "Packaging and Containers for Household Products." *Hazard Screening Report*, Consumer Product Safety Commission, 1-19, 2005.

¹⁸⁴ DTI, "Domestic Accidents Related to Packaging: Analysis and Tabulation of Data," Vol. II., Consumer Safety Research, 1-28, 1997; also: DTI, "Domestic Accidents Related to Packaging," Vol. I., Consumer Safety Research, 1-28, 1997.

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- *Inadequate aid.* Over 2 million MREs (Meals Ready to Eat) were distributed in the aftermath of Superstorm Sandy. Unfortunately the packaging of the MREs (in addition to the hard-to-read fine print) left these MREs inaccessible to many senior adults.¹⁸⁵

Older adults may transition from kitchen prepared meals to the regular consumption of pre-packaged meals when manual food preparation becomes too difficult, costly, or tedious. Packaging solutions for pre-packaged meals are often not accessible to older adults or require the use of tools such as knives to open the packaging, increasing chances of packaging-related injuries. When pre-packaged foods become too difficult for the person to open, she may transition to easy-to-open snack foods. This downward spiral in nutrition contributes to obesity and accelerates aging-related disabilities. Packaging designers are often able to develop solutions that meet the needs of older adults if they have access to research documenting the abilities and functional limitations associated with aging that are specific to their industry. Food-packaging guidelines exist but these guidelines are not well known and have not been widely adopted.¹⁸⁶ The Federal Government should encourage product packaging that is useful to senior adults regardless of functional challenges, such as decreased vision, fine motor control, strength, and dexterity. The Consumer Product Safety Commission (CPSC) should work with AARP, the Arthritis Foundation and other relevant groups including Institute of Packaging Professionals and Association for Packaging and Processing Technologies to solicit design guidelines for senior-friendly product packaging. Federal purchasing guidelines by the Department of Defense (DOD) and the Federal Emergency Management Agency (FEMA) for supplies repurposed for civilian use, such as emergency and hospital food supplies, should drive the adoption of accessible food packaging.

Recommendation 11: Improving Product Design for Older Adults' Needs

The Consumer Product Safety Commission (CPSC) should work with AARP and other relevant groups to accelerate better design guidelines for senior-friendly packaging, especially of technology and essential products like food and medical supplies.

Compensating for Mobility Loss

In addition to the universal design approaches discussed previously, technology can also play an important role in compensating for mobility loss through the design of prosthetic devices and other technologies that enable access to private and public services that meet transportations needs outside the home.

Power wheelchairs and scooters are now more commonly used in community settings than their older mechanical versions, and recent advances in motorized wheelchairs bear an increasing resemblance to home robots, electronic vehicles, and autonomous vehicles. Innovations spurred by the DoD and the

¹⁸⁵ "LES Ready: Caring For Seniors in Hurricane Sandy & Beyond," The LoDown News from the Lower East Side, 2013, Accessed March 14, 2016, See: www.thelodownny.com/leslog/2013/10/les-ready-caring-for-seniors-in-hurricane-sandy-beyond.html#.

¹⁸⁶ New South Wales Government HealthShare, "Food Packaging Design Accessibility Guidelines," George Tech Research Institute and Arthritis Australia, 2012; see: [www.packagingcovenant.org.au/data/Resources/NSW Health - Food Packaing Accessibility Guidelines.pdf](http://www.packagingcovenant.org.au/data/Resources/NSW_Health_-_Food_Packaging_Accessibility_Guidelines.pdf).

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U.S. Department of Veterans Affairs (VA) have made substantial strides in creating robust power wheelchairs that can navigate difficult settings, are easy to drive and manipulate, have usable controls, provide long-lasting power, and minimize further injury from pressure sores and muscle strain.

Moreover, these innovations include advances in prosthetics augmentations to the human body and to the wheelchair. For example, prosthetic arms can increase the ability to conduct many daily activities. Finally, these arms can be separated from the body/chair and operate as an independent home robot attached to a kitchen counter or worktable. In a related way, caregiver robots are starting to appear, which could provide additional support in the home or institutional settings.

A glimpse into the future of powered mobility aids is a combination of extending the body, supporting the body, moving the body, and manipulating the physical world. A system currently under design includes a home-assistance robot designed to be safe and gentle enough to brush crumbs from its owner's face following lunch, coupled with a robotic bed that can move its owner's body to avoid pressure sores and to better position him to work with the assistance robot, coupled with hi-tech and low-tech prosthetic devices that help its owner use augmented communication tools.¹⁸⁷ These assistive technologies, wheelchair, bed, prosthetic arm and more, are no longer stand-alone technologies but can work in concert together, across a variety of tasks.

Other advances in mobility aids include:

- Advanced battery technologies to accommodate long days traveling outside the home
- Laser navigation to simplify basic mobility tasks
- Additive printing for customized seats and prosthetic controls
- Sliding automation for semi-autonomous wheelchair operation
- Human-robot interaction to simplify controls and enable a wider range of activities

There are policy challenges in ensuring these technological advances are accessible for all older adults, not just those that can afford them. One challenge is that the Medicare statute focuses on devices that can help people move around their homes. This limited statutory mandate generally prevents CMS from paying for advanced rehabilitative equipment or power wheelchairs capable of moving from home to car, since basic manual wheelchairs or power-operated scooters provide in-home mobility. Advanced technologies usually are designed to help people to move more easily around their community. In contrast, the VA's statutory authority is different than Medicare's, and the agency focuses on mobility both inside and outside the home, which can enable continued employment and community participation. This approach allows for integrating technologies and manufacturing on-demand, personalized solutions and integrating holistic support that also includes environmental modifications to the home and car, as well as training.

Health care reimbursement policies can inhibit or encourage innovation and use of advanced mobility technologies, and broader coordination is needed to improve mobility technologies. A multi-agency and industry task force including VA, DOD, DARPA, and HHS, should recommend a roadmap for wheelchair

¹⁸⁷ Georgia Institute of Technology, "Hi, How Can I Help You?" 2014, Accessed March 14, 2016. See: www.rh.gatech.edu/features/hi-how-can-i-help-you.

functional capabilities for the next decade. This roadmap should, at a minimum, address advances in batteries, displays, sensors, wireless communication, security, navigation automation, and responsive materials. This task force should anticipate that wheelchairs become cloud devices that communicate and coordinate with home-based and public infrastructure as well as personalized robotic and prosthetic technologies.

Recommendation 12: Future Role of Assistive and Robotic Technologies

Advances have been made in wheelchairs and other mobility-necessary technologies, but Medicare payment policies inhibit access and market innovation.

1. CMS should examine current payment policies and implement changes that allow people to buy higher functioning products with some government support.
2. A multiagency and industry task force led by VHA, DOD, DARPA, and HHS should recommend a ten-year roadmap for improving wheelchair functional capabilities.



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