Center for
Technology and Aging

THE NEW ERA OF CONNECTED AGING:

A Framework for Understanding Technologies that Support Older Adults in Aging in Place

April 2013

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✖ Executive Summary

The United States is a rapidly aging nation. A demographic change is quickly outstripping the capacity of family caregivers, providers, and programs and services that serve the aging population. To address the impending increase in the demand for health care and long-term care, new programs must be created that reinforce the ability of older adults to thrive in their homes and communities, and support them in aging independently.

We are at the dawning of "connected aging" in which the growing array of Internet-based technologies and mobile devices increasingly will support older adults in aging in place. Emerging technologies will enable both older adults and their caregivers to address a comprehensive range of medical, health, social, and functional needs. In addition, technology-based solutions that connect older adults to friends, family, and the community are becoming more viable; older adults and their caregivers are growing increasingly tech savvy; technology usability is improving; and price points are descending. As indicated in Figures 1 and 2 older adults' use of technology, whether it be social networking, text messaging, use of the internet, or use of mobile phones/tablets, is growing at an ever increasing rate.
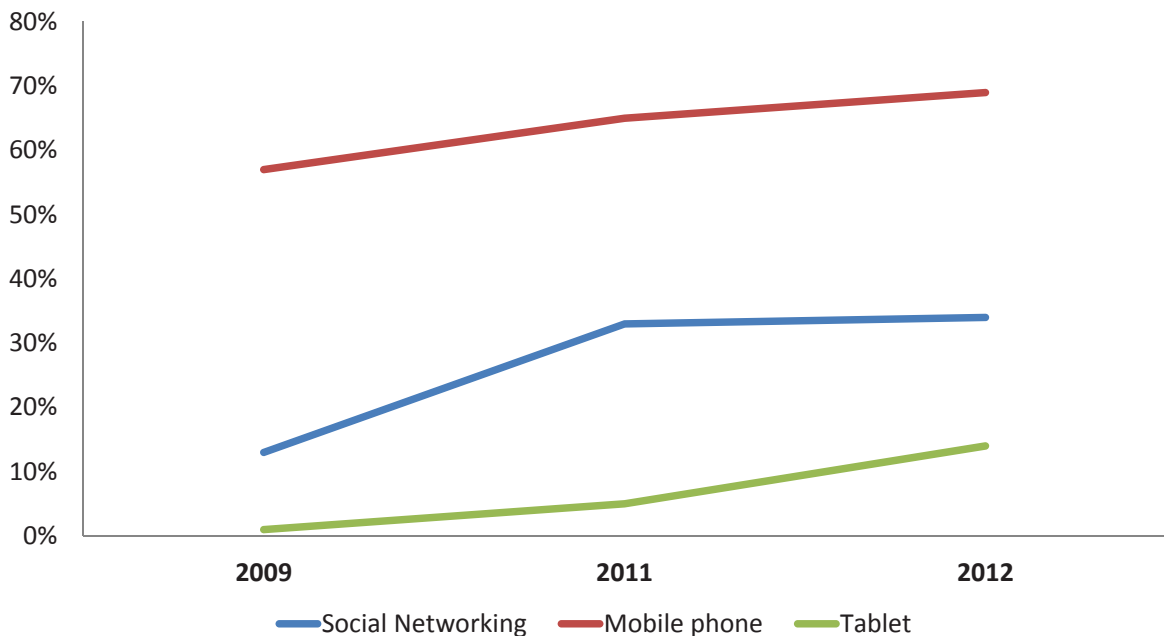
Fig 1: Trends in technology use by older (65+) adults (Pew Internet Research report 2009-2012)
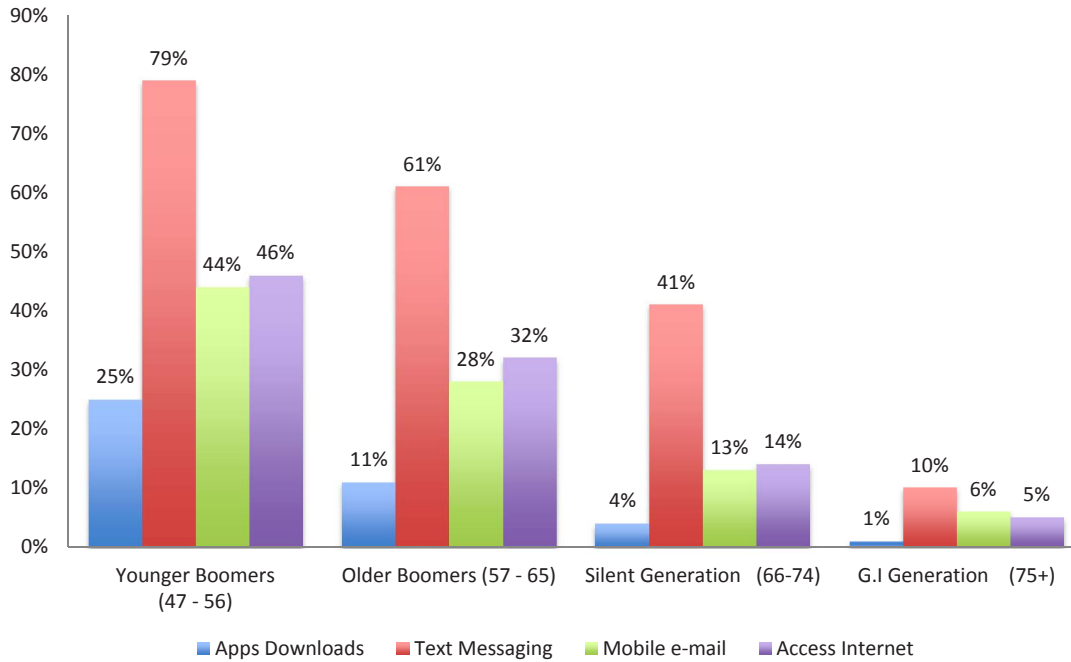
Fig 2: Mobile phone use by age groups (Pew Internet Research report 2012)

At the same time, technology is rapidly evolving. For example, early technologies such as remote patient monitoring have proven successful in supporting care coordination and management for older adults with complex conditions and needs, leading to improved health and well-being and reduced health care utilization. Existing technologies are now moving off of purpose-built devices and on to off-the-shelf cell phones, smart phones, tablets, and PCs. Meanwhile, a wide range of new consumer-oriented technologies is coming into use. These include activity trackers paired with mobile apps for virtual health coaching, web sites that help older adults and caregivers get access to critical resources such as non-medical home care, and provider platforms that can support increasingly mobile professional homecare workers, to name just a few.

This issue brief is intended to help decision makers in the health care, aging-services, and policy communities understand the emerging range of technologies that can empower older adults to remain independent in the community, while increasing the capacity of formal and informal caregivers. To assist in better understanding the landscape, the issue brief describes a framework that organizes connected aging technologies into four main categories based on its primary location of use: body, home environment, community, and caregiving. It also identifies key emerging technologies. Finally, it provides a discussion of how the new era of connected aging can unfold, including some key barriers and how those might be overcome.

✖ Executive Summary

The Emerging Landscape of Connected Aging

By 2030, according to the U.S. Census Bureau projections, 25 percent of the U.S. population will be 60 and older and 19 percent of the population will be 65 years and older.[1] Every day, 10,000 baby boomers are turning 65. At least 90 percent of those 65+ have one or more chronic conditions. At the same time, the population of professional and informal caregivers is declining, especially in relation to the potential demand for care and support.

A collision of factors threatens to undermine the health and independence of older Americans – at a time when that independence needs to be reinforced.[2] AARP surveys consistently reflect that seniors prefer to age in place at home. However, 20 percent of older adults go without the care they need because of a lack of caregiver support.[3] In addition, 30 percent of U.S. adults who are caregivers for parents or spouses sacrifice wages and benefits. On a societal level, U.S. employers lose up to $33.6 billion per year because of absenteeism due to caring for an older relative.

How do we solve these challenges? Usable and affordable technologies could help. These technologies can empower seniors to better manage their health, stay connected to their communities, and get access to the services they need to remain independent in their homes and other community-based settings. New technologies also can make family caregivers' lives easier by giving them tools to more easily support their loved ones being able to age in place. Finally, new connected health technologies create new opportunities for equipping health care professionals to better and more efficiently attend to the social, medical, and functional needs of older adults in the community.

Decision makers in the health care, aging-services, and policy communities need to understand the range of existing and emerging technologies that support and empower older adults and their caregivers in remaining independent in the community. To date, much of the attention has gone to traditional telehealth and telemedicine technologies, which until recently were largely purpose-built, highly specific hardware products that are both expensive and costly to scale in deployment (e.g., telehealth hubs). When deployed as a tool in community-based care coordination and management programs, the technologies have often been successful in helping older adults remain healthier and out of the hospital. However, those technologies are fast becoming one small piece of the connected-aging universe, as this issue brief will show.

✖ Executive Summary

For definitional purposes, this brief seeks to create a new concept of connected aging that builds upon the concept of connected health. Connected health focuses on the use of telecommunications and Internet-based technologies to broaden the provision of care to non-clinical settings, such as the home and the broader community. One dimension of these technologies is that they can be used to monitor individuals with chronic conditions to detect, and thus prevent, complications and crises that can lead to acute episodes. To maintain their health and well-being, it is just as important to provide individuals with automated health coaching, based on monitoring vital signs, activity, and behavior. Connected health is about both providing the basis for timely, preventive treatment and for precluding the need for treatment through empowerment and self-management.

Connected aging recognizes that successful aging is more than just about health – it is about empowering and supporting the whole person through telecommunications and Internet-based technologies. A widely recognized study published in the Archives of Internal Medicine in Summer 2012[4] reinforces the interplay of social, health, and functional factors: 43 percent of older adults say they are lonely, and those individuals are twice as likely to have functional limitations that could lead to nursing home placement and/or result in premature death. As such, connected aging is about the use of Internet-connected technologies to support the whole person in multiple ways, including:

- Health, wellness (including both physical and cognitive health), and prevention
- Functional limitations and chronic disease management
- Social connectedness to friends, family, and community organizations

Touring the Connected Aging Landscape

The following framework presents the landscape of technologies for connected aging in four categories based on the purpose and primary location of the technology:

Body: Products that support monitoring and management of an older adult's physiological status and mental health for maintaining wellness and managing chronic conditions

Home Environment: Products that support monitoring and maintaining the functional status of older adults in their home environments

Community: Technologies that enable older adults to stay socially connected to their families, friends, and local communities

Caregiving: Technologies and products that support both informal and formal caregivers in providing timely and effective care and support to older adults and persons with disabilities in their homes

The final category in particular highlights how technologies can be used both to empower older adults in managing their own health and remaining independent while also enabling them to be monitored and supported by either professional or informal caregivers.

⟩⟨ Touring the Connected Aging Landscape

Body

Technologies that fall under this category primarily support the health and wellness of older adults by monitoring physiological and mental health status (Figure 3). This includes traditional devices such as weight scales, blood pressure cuffs, and blood-glucose meters that are now also connected to the Internet. A rapidly proliferating range of body-worn sensors can measure everything from activity levels to sleep patterns to heart rate. Many products provide web and mobile tools for tracking and analyzing data generated by sensors and other devices. Some can provide automated virtual coaching – such as sleep monitors that offer automated advice to improve sleep quality.
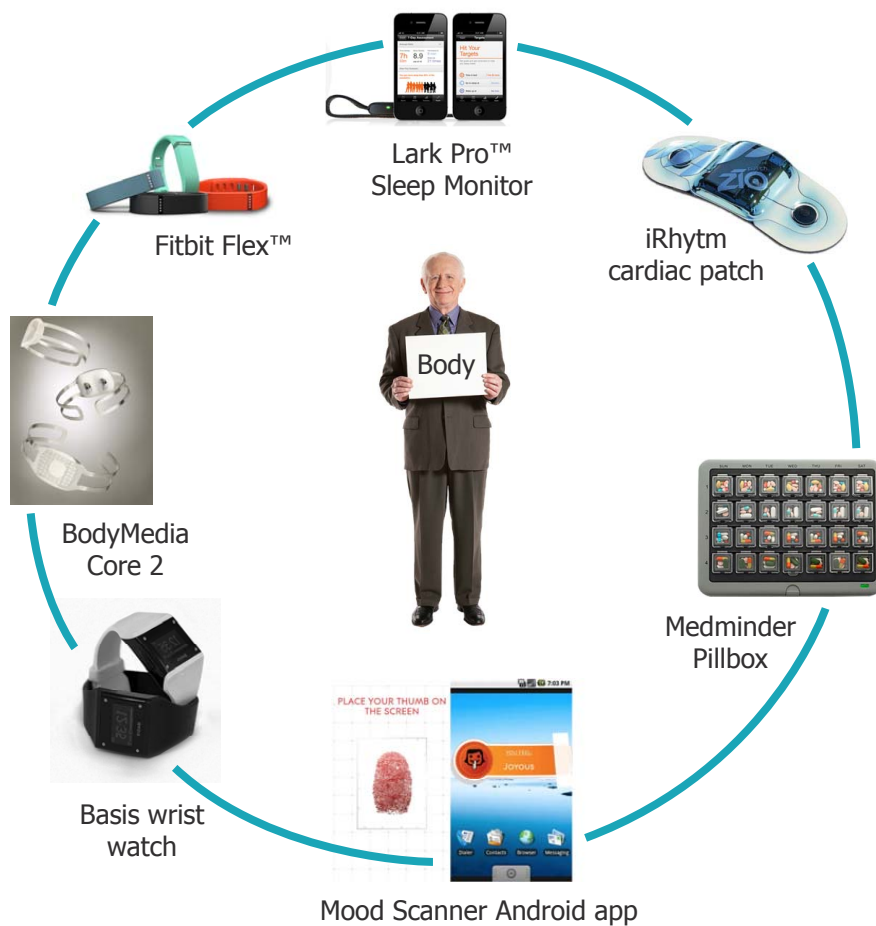

Fig 3: Connected aging health technologies for the body

Body *(cont.)*

Body		
Sub Category	**Description**	**Example Products**
Vital sign monitors	Measure vital signs such as weight, blood pressure, blood glucose, heart rate, temperature, ECG, galvanic skin response, gait, and hydration. Some products are designed to measure multiple vital signs in one elegant package while others are available only as "professional" models.	Consumer: Jawbone UP™ Fitbit Flex™ Basis Watch Fitbit Aria™ scale Withings blood pressure monitor and scale Provider: CardioNet® MCOT Preventice BodyGuardian iRhythm Zio®
Activity monitors	A rapidly growing set of activity tracking products measures steps taken, speed, activity levels, calories spent, and amount of time spent in rest or without getting up. Most activity monitors are wrist-worn devices, while others can be carried in the pocket. Smart phones contain accelerometers that enable their use as activity monitors.	Jawbone UP™ Fitbit Flex™ Misfit Wearable's Shine™ FitLinxx Pebble
Sleep monitors	Individuals and clinicians use these products to monitor sleep to adjust behavior (caffeine intake and other elements of sleep hygiene) or to provide indications of other issues that might require a professional intervention, such as sleep apnea.	Fitbit One™ Lark Pro™ sleep monitor BAM Labs® Smart Bed
Mood/depression monitors	Mood/depression monitors provide objective sensing of mood in a reliable manner, though to date, their efficacy is not clinically substantiated. The standard process for using connected health devices to assess mood or depression is based on a questionnaire format. General availability and mass adoption are a few years out.	Mood Scanner (Android app) M3™ (Android and iOS app)
Emotion monitors	Products enable objective, long-term emotion monitoring. One product is a wearable wireless biosensor that can detect arousal via skin conductance, a form of electro dermal activity that grows higher during states of excitement, attention, or anxiety, and lower during states of boredom or relaxation. Another product can identify from a caller's voice whether the caller is at risk for suffering from depression or psychological distress or has co-morbid behavioral health conditions. Originally designed for use in call center applications to improve agents' interaction quality and customer engagement, the technology now can be used for remote monitoring of patients vulnerable to mental health problems.	Affectiva Q Sensor Curve and Q Sensor Pod Cogito's Social Signal Platform (SSP)

Touring the Connected Aging Landscape

Body *(cont.)*

Body		
Sub Category	**Description**	**Example Products**
Mobile PERS with GPS	Products for personal safety, including Personal Emergency Response Systems (PERS) and global positioning service (GPS) tracking devices, have evolved so that they can be activated while outside of the home, providing an important element of protection for older adults. PERS functionality is being combined with a cell phone to provide a powerful mobile tool. Shoes with built-in GPS tracking systems are becoming popular for persons suffering from early stage dementia. Caregivers can create "geo-fencing" to allow movement within a certain boundary around the home, but receive alerts with the geo-position when an older adult "wanders off."	Phillips LifeLine® GoSafe Aetrex Navistar shoes (GPS enabled) Jitterbug® phone with 5Star™ urgent response service
Medication adherence systems	Medication adherence devices can now provide medication reminder alerts via interactive voice response (IVR), text messaging, or e-mail. Products are available as multi-day container trays or as lids on pill containers. Caregivers or a pharmacy can program such reminders using a web interface. If an older adult does not open a compartment of a pillbox (or the lid of a pill container) after receiving an alert, the devices can notify a remote caregiver via text messaging or e-mail. In a poly-pharmacy situation, to ensure that an older adult has taken the right medication, one product in this category comes with a built-in scanner that takes images of the medication being loaded and status of the prescription after each use. The back-end system can then confirm if the right medication has been taken.	MedMinder Maya™ SentiCare Pillstation Vitality GlowCap™ Pilljogger
Medication dispensers	Medication dispensers provide the right dosage of medication to a person when his/her medication is due, avoiding harm that can be caused by an overdose, as well as preventing drug abuse, especially for narcotic drugs, sleeping pills, etc.	Phillips' pill dispenser InRange System's Emma®
Smart toilets	Intelligent toilets can passively measure physiological signals using discharged body fluids. Japanese companies have been building smart toilets for more than a decade, but the bathroom products have not yet caught the imagination of U.S. consumers. Products are available but expensive for mass adoption.	Toto's smart toilet
Subjective Health Risk Assessment (HRA)	HRAs include interactive voice response systems, web applications, or mobile app-based solutions to assess health risks of older adults using subjective questions and scoring. While body-worn sensors can collect numerous physiological data, care providers still need to assess specific patient health risks that cannot be objectively measured. An IVR system that can automatically call an older adult is well suited for a small number of fixed questions that need to be asked for a limited time (e.g., prevention of 30-day CHF readmission program). In the future, Internet and app-enabled TV also will be used to deliver HRA content.	Health Interlink's HRA mobile apps (on Beacon™ platform) Independa's Angela™ application (for tablet and Internet enabled TV) Proximiti's IVR solution Bosch Health Buddy System Cardiocom telehealth system

✖ Touring the Connected Aging Landscape

Home Environment

The era of the "smart home" has arrived, enriching home security, automation, and personal control. Technologies for the home environment can have a profound positive impact on the lives of older adults who are beginning to develop functional and cognitive limitations but wish to remain in their homes. These technologies monitor activities of daily living, such as getting out of bed, bathing, and toileting, and generate alerts if activities are out-of-sync with observed and established behavior patterns (Figure 4). Other technology products in this category include a variety of sensors that can identify other potential problems, ranging from gas leaks to falls, as well as methods for proactively controlling home appliances and utilities.

Fig 4: Connected aging technologies for the home environment

✕ Touring the Connected Aging Landscape

Home Environment *(cont)*

Home Environment		
Sub Category	**Description**	**Example Products**
Fall detection	Fall detection technologies can detect falls and automatically call for help when an older adult cannot get up on his/her own or press a personal emergency response system (PERS) button.	Phillips Lifeline MobileHelp SafetyCare EMTWatch™ FallDetect™
Environment sensors/passive monitoring sensors	Many different sensors are used in passive sensing for safety at home. This is by far the most advanced and well-diffused technology area of the aging-in-place market. Sensor products can check motion patterns, stove on/off status, carbon dioxide or carbon monoxide levels inside the house, presence of smoke, air quality inside the house, humidity, and fire. They can dim lights remotely and lock unlocked doors. Motion sensor products can be used solely for monitoring through algorithms to automatically detect movement aberrations and reliably generate appropriate alarms.	Lowe's Iris system GE Quietcare®
Video monitoring	Video cameras can monitor an individual's activities of daily living and provide caregivers with direct video feed on a smart phone, tablet app, or on the web to check on the status of a family member.	Netgear VueZone™ Lorex LIVE

Touring the Connected Aging Landscape

Community

This category includes technologies that can aid older adults in maintaining and strengthening their social ties to other individuals in their local communities (Figure 5). Devices connect older adults to activities, such as health and wellness classes, lifelong learning classes, and clubs and groups of older adults with similar interests. The connected aging framework posits that keeping older adults connected to their communities and their interests is a key element to enabling older adults to flourish and remain independent.
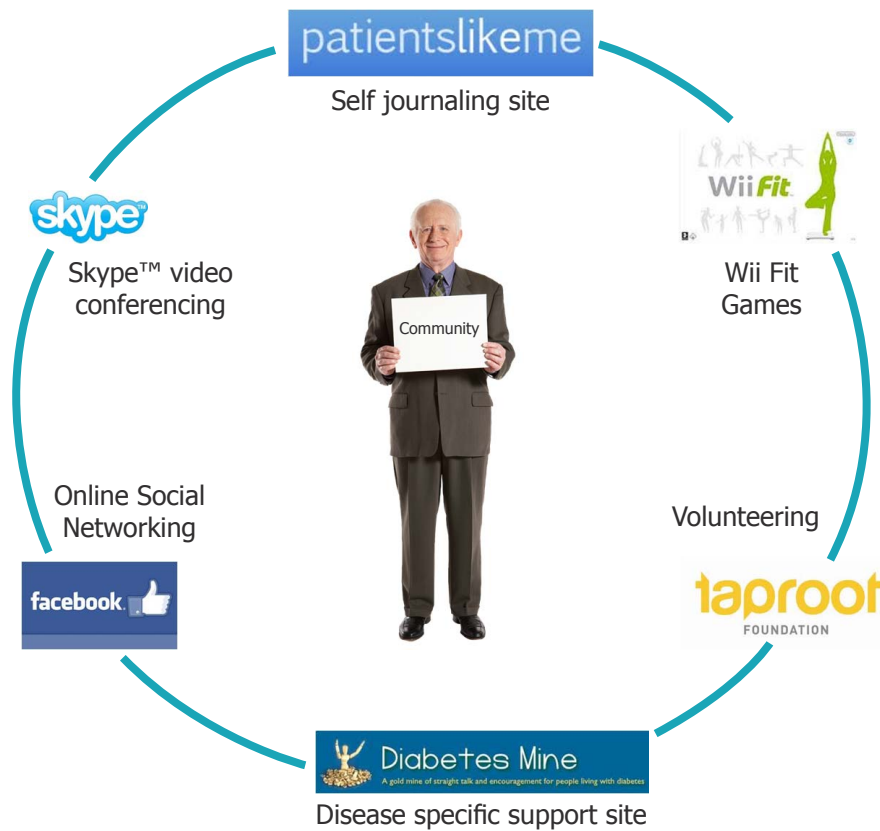

Fig 5: Connected aging technologies for the community

✖ Touring the Connected Aging Landscape

Community *(cont)*

Community		
Sub Category	**Description**	**Example Products**
Social communication	Social communication technologies include video-enabled PC or mobile app solutions to communicate with remote family caregivers or friends. Devices include web sites that enable older adults to share experiences in a virtual world in the form of online journaling. They turn older adults into empowered "prosumers" of information in the digital world where they both share and learn from each other.	<u>Video communication</u>: Skype <u>Self-journaling sites</u>: PatientsLikeMe.com CureTogether.com DiabetesMine.com Smart Patients
Gaming and cognitive training	Technologies include both online and mobile app-based cognitive games along with Wii or Kinect games for physical activity and entertainment. Studies of Wii and Xbox Kinect games with gesture recognition have shown good results in improving cognitive ability and/or physical rehabilitation of older adults.	Wii Fit Onlinegamesforseniors.com Lumosity.com PositScience.com Happy-Neuron.com games.AARP.org
Social networking	Includes general online social networking sites, as well as sites that are specially designed for older adults who are among the fastest growing online social networker segments, according to Pew Internet Research.	Facebook.com Aarp.org/onlinecommunity MyBoomerPlace.com
Social contribution	Technologies that support personal activities and societal contributions include web sites that enable older adults to pursue their hobbies, make charitable donations for philanthropic projects, and volunteer.	<u>Volunteer work sites</u>: SeniorCorps.org TapRootFoundation.org <u>Charitable donation sites</u>: Causes.com Razoo.com

✖ Touring the Connected Aging Landscape

Caregiving

Caregiving includes both formal (professional) coordination of care and informal care (family caregivers). Technology-enabled caregiving products are typically web sites and technology platforms that support both informal and professional caregivers (Figure 6). Platforms and services can be used either to make care workflow more efficient (e.g., the Procura platform for mobile care providers) or act as the aggregator to deliver various services seniors require to safely age in their own home. Professional care providers who oversee many older adults with one or more chronic conditions can use a platform that supports various patient-facing technologies for assessing health risks, providing education, or modifying behavior.
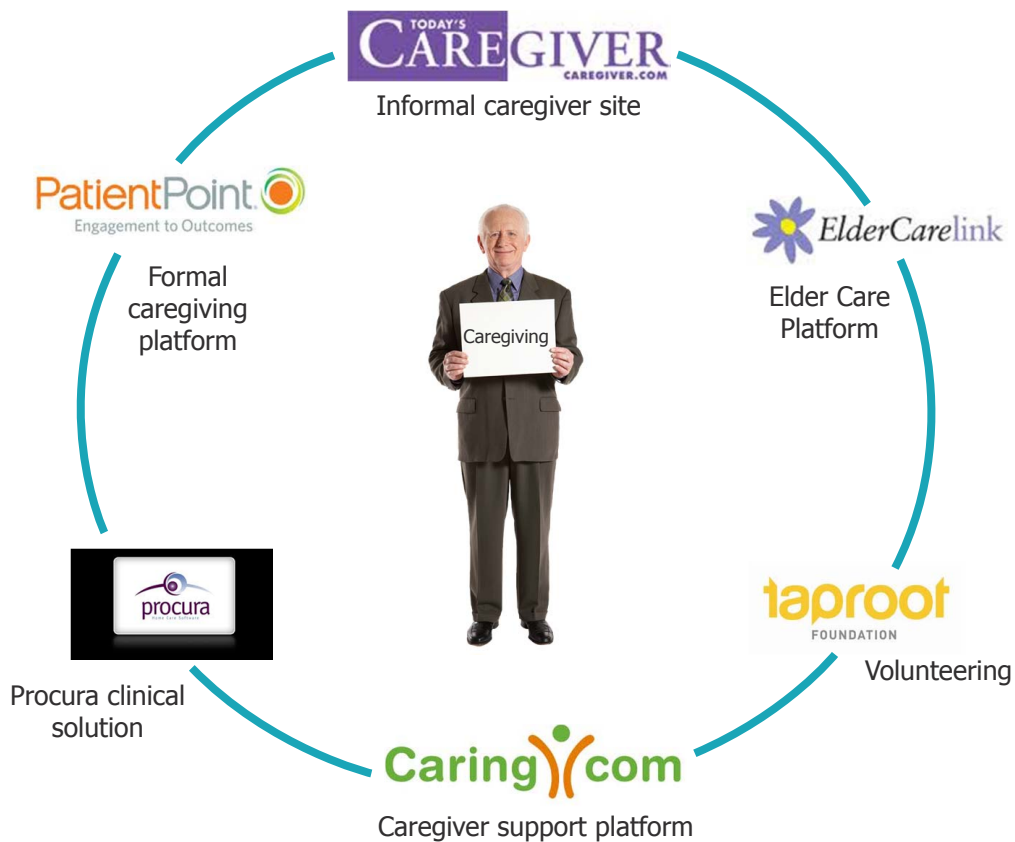

Fig 6: Connected aging technologies for caregiving

Caregiving *(cont)*

Caregiving		
Sub Category	**Description**	**Example Products**
Informal caregiver platform	Products are mostly platforms with a portal service (tips and best practices) that match service providers with older adult-caregivers who are searching for specific services. These platforms are continuing to mature and in the near future are likely going to include extensive user reviews such as Yelp.com or Angie's List to assist caregivers in making informed decisions.	Caring.com Caregiver.com EldercareLink.com AARP.org/caregiving
Formal care coordination platform	Mature telehealth platforms have been in service for a decade or more. New platforms with web and/or mobile app interfaces are being used by professional care coordinators to either streamline care coordination workflow or manage patients with complex disease conditions through remote monitoring solutions.	Procura clinical solution PatientPoint.com McKesson Vital Lumeris care collaboration platform

✖ The New World of Connected Aging: What's Next?

Connected aging technologies have touched the lives of a relatively small percentage of the older adult population. Within the next one to five years a number of new or under developed connected aging technologies and platforms will be available for older adults, family caregivers, and health and social service providers. Figure 7 provides a sample of the connected aging technologies and platforms that have significant growth potential:

Remote Lab

Smart Body sensors

Smart medication management

Assistive robots

Fig 7: Future connected aging technologies

Technology	Description
Body	
Smart medication management	Through an ingestible sensor activated only when inside the body, Smart pills objectively determine whether a person has taken their medication. Products are CE-marked and FDA-cleared, but not yet mass marketed in the U.S. Proteus Digital is pioneering the technology.
Smart body sensors	"Flexible electronics" enables manufacturing of external, tattoo-like sensor patches that can be attached to skin or clothing, depending on what needs to be monitored. They are effective in gauging function of specific organs and in monitoring heart rate, blood oxidation, and hydration. Boston-based MC-10 and Sano Intelligence are working on such technologies.
EMR connected medical devices for remote monitoring	Work is ongoing to enable medical devices used for measuring vital signs at home to connect directly to the care provider's EMR system.

✳ The New World of Connected Aging: What's Next?

Technology	Description
Body	
External sensors for remote monitoring	The diabetes foot ulcer detection mat is an emerging technology that will allow detection of foot ulcers in diabetic patients. Boston-based MIT Labs spin-off Podimetrics is developing a sensor pad that will collect blood flow data and transmit it wirelessly when a user steps on the mat. An algorithm in the cloud will detect if the user is developing an ulcer.
Remote laboratory/ diagnostics	A fast emerging technology is remote diagnostics, or Lab-on-a-chip, that will permit home application of many tests (e.g., liver tests for patients on statin) which today can be performed only at a laboratory.
Home Environment	
Fall prevention	Technologies that prevent rather than monitor falls are being developed with both wearable sensors to measure posture and gait and an algorithm to predict a fall so that caregivers can prevent it with simple assistive technologies (e.g., providing a walker).
Community	
Patient/provider/ caregiver communication platform	Technologies are being developed using HIPAA-compliant software platforms that will enable older adults to connect and communicate seamlessly with their provider, family members, friends, and other community members. A variation is available today but is not fully mature.
Caregiving	
Local social and commerce networks for aging in place	Software platforms that will connect older adults, care providers, pharmacies, labs, and ancillary service providers are being developed that will create a virtual neighborhood for providing coordinated elder care services to support aging in place.
Assistive robots	Robots that support personal care and chores will likely drive the future of home care. Today robotic technologies are available to do some specific household chores. When this technology becomes broadly available and affordable it will transform home care for older adults. Currently almost all major universities with robotics programs are conducting quality-of-life improvement projects. Broader commercialization of multi-function robots is likely in the near future.

Turning the Dream of Connected Aging into a Reality

Connected aging can be integral in older adults' lives whether they are high functioning, actively engaged individuals or persons who need multiple supports to remain independent in their homes. Many of the technologies described have barely scratched the surface of their ultimate potential to transform the lives of older adults.

The mass diffusion of connected aging technologies that can support older adults in wellness and independence is inevitable. As Figure 8 illustrates younger Baby Boomers' use of technology tracks closely with that of the overall adult population, indicating the potential for great receptivity to connected aging technology over time.

The New World of Connected Aging: What's Next?

	Young Boomers (47 - 56)	Older Boomers (57 - 65)	Silent Generation (66-74)	G.I Generation (75+)	All online adults (18+)
Cell phone	91%	85%	76%	63%	89%
Smart phone	38%	27%	12%	3%	63%
Desktop computer	66%	61%	54%	31%	58%
Laptop computer	62%	49%	39%	20%	61%
iPod or MP3 player	36%	24%	10%	5%	44%
Game console	38%	19%	8%	3%	42%
e-book reader	19%	13%	9%	5%	21%
Tablet (e.g. iPad)	27%	23%	17%	6%	25%

Fig 8: Digital device use by age groups (Pew Internet Research report 2012)[5]

Although one might anticipate that the process of adoption and diffusion of connected technology for older adults will be lengthy - the last Boomer doesn't qualify for full Social Security benefits until 2031 - adoption is likely to go much more quickly because of the following factors:

- Costs of technology will continue to drop dramatically, making it increasingly economically viable for payers and providers to expand use of technologies such as tablets, other mobile devices, and a range of smart-home technologies.

- Usability will increase significantly as technologies such as voice-based user interfaces (e.g., Apple's Siri) improve in quality.

- The number of technologically savvy older adults will continue to grow rapidly.

- The shrinking pool of providers and family caregivers will lead to a greater use of technology to engage older adults and improve program efficiency.

- The ability to include data analytics within connected-aging technologies will significantly expand their utility in health promotion and disease prevention.

- Improved interoperability will increase the seamless linkage of connected aging technologies.

- Payers and providers will become more sophisticated in curating among a vast array of hardware products and software apps and in using them to support population health management.

- Health care and aging services will continue their integration enabling the emergence of a cohesive concept of whole-person-oriented community-based connected aging.

The value of connected aging has already resulted in reduced use of health care services and improvements in care delivery, quality of life, and satisfaction. However, technology can have an even greater benefit for older adults and their caregivers through increased connectivity with family and community and by offering them greater independence in their own health care. In that sense, the real goal of connected aging is to not just keep older adults from inappropriate levels of care, but to support them in thriving, being independent, and having a significantly better quality of life.

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