Chapter 3
Older Adults and the Adoption of Healthcare Technology: Opportunities and Challenges

Sara Czaja, Scott Beach, Neil Charness, and Richard Schulz

3.1 Introduction

The population is aging at an unprecedented rate in both developed and developing countries. The number of people aged 65 and over worldwide was 506 million in 2008 and is projected to be around 1.3 million by 2040 (Kinsella & He, 2009). In the USA alone by 2030 there will be about 72 million people aged 65 and over who will represent 19.3% of the population. A critically important feature of population aging is the growth in the number of people aged 80 and older who represent the oldest old (Fig. 3.1). Worldwide the 80+ population is expected to increase by 233%. In the USA people age 80+ will number about 6.6 million by 2020 and will represent 35% of the older population by 2040.

The growth in the number of older people especially those who represent the *oldest old* has vast implications for the healthcare system as the likelihood of developing a chronic disease or disability, and the need for healthcare services generally

S. Czaja, Ph.D. (✉)
University of Miami Miller School of Medicine, Miami, FL, USA
e-mail: SCzaja@med.miami.edu

S. Beach, Ph.D. • R. Schulz, Ph.D.
University Center for Social and Urban Research, University of Pittsburgh,
121 University Place, Pittsburg, PA 15260, USA
e-mail: scottb@pitt.edu; schulz@pitt.edu

N. Charness, Ph.D.
William G. Chase Professor of Psychology, Florida State University,
1107 West Call Street, Room A205, Tallahassee, FL 32306-4301, USA
e-mail: Neil_charness@embarqmail.com

A. Sixsmith and G. Gutman (eds.), *Technologies for Active Aging*,
International Perspectives on Aging, DOI 10.1007/978-1-4419-8348-0_3,

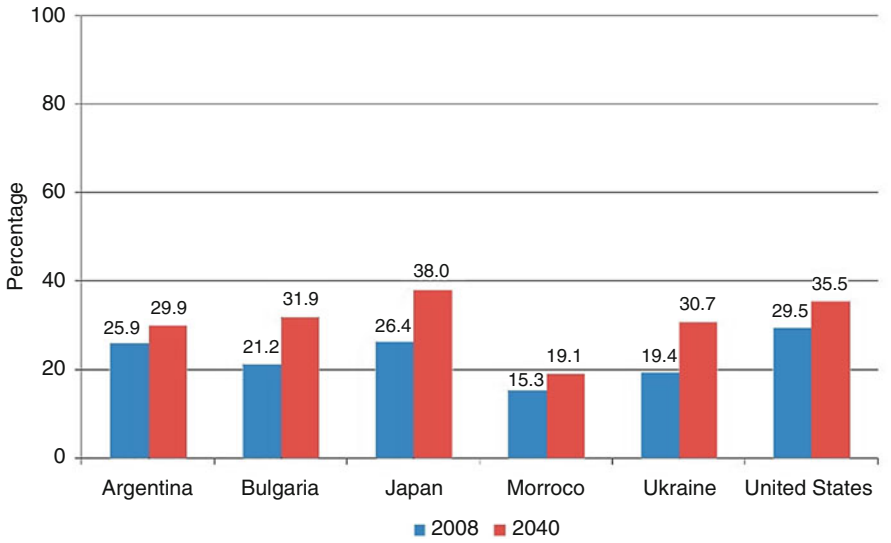

Fig. 3.1 Oldest old as a percentage of all older people: 2008 and 2040 (*Source*: An Aging World: 2008. U.S. Census Bureau, International Population Reports, P95/09-1. U.S. Government Printing Office, Washington, DC (2009))

increases with age. For example, within the USA, about 80% of older adults have a chronic condition such as heart disease, diabetes, or arthritis, about 50% have at least two conditions (Center for Disease Control and Prevention, 2010), and large numbers of older people have functional limitations that interfere with the performance of daily living tasks (Fig. 3.2). Further, about 5 million Americans aged 65 and older have Alzheimer's disease, and this number will increase in the coming years especially with the growth in the oldest old (Alzheimer's Association, 2010).

Clearly strategies are needed to ensure that older adults and families who are in need receive the care and services they require and to promote health, well-being, and independence among older people. Poor health is not an inevitable consequence of growing older. Although there is a greater propensity towards developing chronic conditions and disabilities with age, current generations of older adults are in many ways healthier than prior generations. In addition, many older adults lead active lives and are actively involved in the management of their health. As discussed below healthcare technologies provide opportunities for enhancing the ability of older people to be actively engaged in health self-management.

At the same time that the population is aging, there are marked changes occurring within healthcare systems. In this new environment, individuals and their families are expected to assume an increasing role in the management of their own health, perform a range of healthcare tasks, and interact with a vast array of medical devices and technologies within home and community settings. For example, electronic links between healthcare professionals and older patients provide healthcare providers with easier access to their patients and allow them to conduct daily status

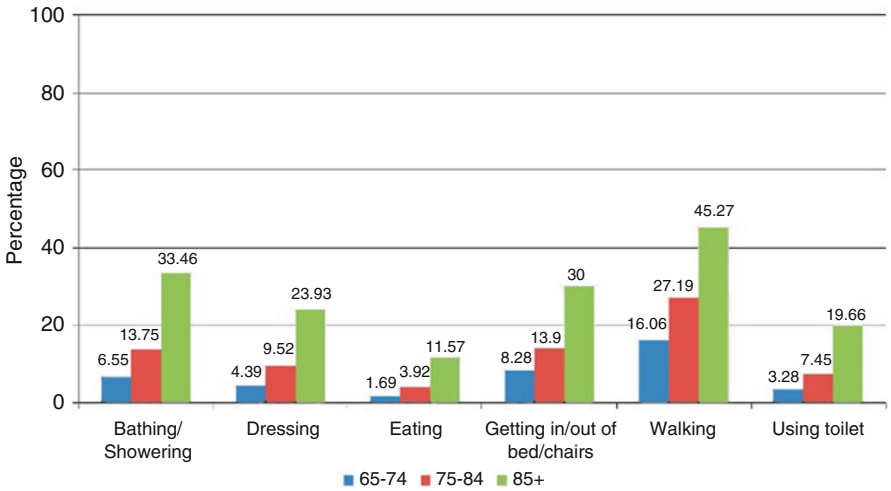

Fig. 3.2 Percentage of persons with disabilities in activities of daily living by age group: 2007 (*Source*: A Profile of Older Americans: 2010. Administration on Aging. U.S. Department of Health and Human Services)

checks or to remind patients of home healthcare regimes. Technology applications are also commonly used within home settings to monitor a patient's physical, emotional, or cognitive functioning. Current technologies can also facilitate the ability of caregivers to monitor older relatives who are in need of care and support. These applications offer the potential of allowing many people who are at risk for institutionalization to remain at home. In addition, with the rapid introduction of electronic medical records (EMRs), many of which have patient portals, patients will have access to varying degrees of their medical information, perform tasks such as communicate electronically with providers, schedule appointments, renew prescriptions, and access health management information through links to medical websites. There are also a myriad of health websites available that provide consumers with access to health information and services and the ability to buy medical supplies, equipment, and even medications/supplements. Technology also offers opportunities for increased social connectivity which can be extremely beneficial for many older people such as those who are isolated or live alone or geographically distant from family members. Social isolation is associated with poorer quality of life, life satisfaction, and well-being, poorer health status, and distress and mental illness (Cantor & Sanderson, 1999; Cobb, 1976; Dykstra, 1995; Ellaway, Wood, & MacIntyire, 1999; Ellis & Hickie, 2001).

Overall, technology holds the promise of improving access to health care for older people and empowering them to take an active role in health self-management. However, although the rate of technology adoption is increasing among older people, existing data indicate that there are still age-related gaps in usage. For example, in the USA in 2010 about 42% of people age 65+ were Internet users as compared to 78% of people age 50–64 and 87% of those 30–49 years old (U.S. Census Bureau,

2011). Older adults using computers and Internet tend to be better educated, white, have greater social resources, and fewer functional impairments than non-adopters. Home broadband adoption is also lower among older people. In 2010, only 31% of people aged 65+ had broadband access at home which limits the scope and potential of the online experience and the ability to use many health applications (Smith, 2010). Use of technology also tends to be lower among people with chronic conditions. According to recent data from the Pew Internet & American Life Project (Fox & Purcell, 2010), living with a chronic disease has an independent negative effect on someone's likelihood to have Internet access especially if they have more than one chronic condition. Further, although 82% of adults in the United States have a cell phone, only 57% of people aged 65+ years report cell phone ownership (Lenhart, 2010). Communication devices are increasingly becoming more integrated with computer network resources providing faster more powerful interactive services, and an increasing number of health services are becoming available for mobile devices. The wide deployment of technology within health care implies that lack of technology use will have increasingly negative implications and contribute to healthcare disparities. For the full benefits of health technologies to be realized for older people and their families, it is necessary to understand user characteristics, needs, and preferences in order to maximize the usefulness and usability of these technologies for these populations. This chapter will discuss the potential of healthcare technologies for older adults, factors that influence the adoption and use of these technologies, and strategies to enhance technology uptake. An emphasis will be given to health applications on the Internet and monitoring technologies given the broad use of these applications and their potential for improving the health and independence of older adults.

3.2 E-Health Applications and Older Adults

In the last decade the rapid growth in communication technologies and the Internet has created new possibilities for individuals to assume a more pronounced role in their own health and health care. In fact, recently the term *e-health* has emerged which refers to the interaction of an individual (e.g., consumer, patient, healthcare professional) with digital information and communications technologies such as the Internet and mobile devices to access or receive health information, guidance, or support on a health-related issue (US Department of Health and Human Services, 2011a, 2011b). There are numerous tools and resources that fall under e-health including social networks and support groups; online health information; online health self-management tools; and online access to personal health records.

One of the most common forms of e-health is health information seeking by consumers. A number of websites are available that provide consumers with information on illnesses/diseases, medications and treatments, healthcare providers, and health resources. Social networks and blogs related to health issues are also

becoming popular. Government agencies are also increasingly using the Internet to exchange information and for services. In the USA, 80% of Internet users and 57% of the total adult population search for health information online from health websites. The most common types of information searched for are information about a disease or medical problem, medical treatment or procedure, or information about doctors or other health professionals (Fox, 2011a). Seeking health advice or receiving support from peers online is also becoming a significant source of health information.

In general, although people with chronic conditions are less likely to go online than those without chronic conditions, those with chronic conditions that are online are avid seekers of online health information. Twenty-three percent of Internet users living with a chronic condition such as high blood pressure, diabetes, heart disease, or cancer indicate that they have gone online to find others with similar health concerns as compared to 15% of Internet users without a chronic condition. However, overall older adults and those with lower educational and income levels are less likely to look for health information online than are other groups (Fox, 2011b).

The Internet can be very beneficial to older adults as it provides them with the opportunity to become more informed and thus better prepared to discuss treatment plans with their physicians (Taha, Czaja, & Sharit, 2009), seek advice from others, for example, from other medical experts or organizations or through social networking sites directed at people with similar health issues, and explore the risks and benefits associated with decision options. The Internet may also be beneficial for family caregivers who are providing care for an older person with a chronic illness or disease such as dementia. Networks can link caregivers to each other, healthcare professionals, community service, and educational programs. Recent findings from an interview study of approximately 1,500 caregivers indicated that 53% use the Internet as a source of information about caregiving (National Alliance for Caregiving, 2009). The following section discusses some of the potential issues associated with health information seeking for older adults.

3.3 Issues Surrounding Online Health Information Seeking and Older Adults

Although the Internet holds promise in terms of improving access to healthcare and health information for older adults, to date many Internet-based health applications have been designed without consideration for needs, capabilities, and preferences of this user group. For example, the US government's Medicare.gov website is intended to support health-related activities, such as finding information and solving problems related to healthcare benefits. However, a recent investigation of the usability of this website revealed that, despite having had experience searching for information on the Internet, older study participants encountered greater difficulty and generally performed poorly using it, compared to younger

users (Czaja, Sharit, & Nair, 2008). We also conducted focus groups to gain insight regarding the health information needs of older adults and sources of health information and to determine if there are differences in perceptions and use of health information between Internet and non-Internet users (Taha et al., 2009). Overall, the Internet users had very positive perceptions about health information online and indicated that access to the information increased their ability to take care of themselves. For those participants who did not use the Internet for health information, the most common reasons for nonuse were related to lack of skill, concerns about security and the quality of the information, and perceptions that the Internet is too complicated.

One major concern within the e-health arena is the vast amount of information that is available to consumers. For example, in September 2011 if one typed the word dementia into the Google search box, there were 40,200,000 hits and arthritis resulted in 88,400,000 hits. This can be daunting for older adults, many of whom have limited Internet experience and limited knowledge of credible sources of information. The credibility of information on health websites varies considerably. Results from the Pew Internet & American Life Project (2008) indicate that most consumers do not consistently check the source and date of health information they find online. Other concerns related to the ability of consumers to integrate and interpret the wealth of available information. The content on many health-related websites is highly technical and difficult for nonmedical specialists to understand. Our data (Czaja et al., 2006) indicate that older adults often have difficulty interpreting information provided on health websites and often find the language to be difficult to understand. Information seeking is an activity that places demands on many cognitive abilities. One of our studies (Sharit, Hernandez, Czaja, & Pirolli, 2008) found that reasoning, working memory, and perceptual speed were significant predictors of performance of health-related Internet search. This is potentially problematic for older adults as these abilities tend to decline with age. Our data indicated that older adults who had better performance had higher cognitive abilities than those who performed at a lower level (Czaja, Sharit, Hernandez, Nair, & Loewenstein, 2010).

Clearly interventions are needed to enhance the accessibility and usability of Internet-based health applications for older adults. There are guidelines available that can be directed at making websites usable for older adults (Zaphiris, Ghiawadwala, & Mughal, 2005). For designers, however, adherence to these guidelines is not always straightforward, especially with guidelines that are general in nature and deal with issues related to the cognitive demands associated with websites. Clearly more research is needed to identify strategies and tools to help people effectively filter, organize, and integrate information. In addition, it would be helpful if designers had basic information on the needs and preferences of older adults and age-related changes in abilities that have relevance to the design of healthcare technologies. In this regard, designers should also adopt a user-centered approach to design and include representative samples of older adults in product usability evaluations.

3.4 Monitoring Technologies

3.4.1 The Potential of Monitoring Technology for Older Adults

Technologies that monitor behavior and communicate with professionals and family members offer great promise for enabling older adults to maintain independence by *aging in place* and to ultimately enhance quality of life. Such systems could, for example, know how well a person slept last night, identify potential health problems before they become serious or catastrophic, know whether they are able to carry out daily routines, and assure a daughter who lives in a distant city that they are doing well today. Various monitoring systems for older adults and their caregivers are already on the market, and many more are being developed.

Home-based monitoring technology for older adults offers a variety of potential benefits. The Center for Aging Services Technologies (CAST) categorizes these systems into three broad domains (1) safety, (2) health and wellness, and (3) social connectedness (Alwan, Wiley, & Nobel, 2007). Home-based safety monitoring technologies include *fall detection and prevention* systems, both push-button and accelerometer-based wearable (e.g., Life Alert) and sensor-based embedded environmental systems (e.g., QuietCare); *mobility aids* for wheelchairs (e.g., to enable stair climbing) and robotic walkers to enhance safe navigation; *stove use detectors* (e.g., Stove Guard); and *smoke and temperature monitors*. Health and wellness monitoring technologies include *wearable activity monitors* using accelerometers and sensors (e.g., Bodymedia); *non-wearable, embedded sensor activity monitors* to track activities of daily living (ADL), instrumental activities of daily living (IADL), and other behaviors (e.g., Healthsense); *hybrid wearable/environmental* systems with radio-frequency identification (RFID) readers and tagging of environmental objects to monitor ADL performance; *ambulatory monitors* to record and transmit physiological data (e.g., cardiac event and Holter monitors); *passive environmental non-wearable* systems like bed monitors for clinical sleep assessment; *medication compliance* systems that monitor intake and provide prompts and reminders; and *cognitive assessment/orthotics* devices.

Potential benefits of health and wellness monitoring for older adults include improved health outcomes and quality of life, empowerment and self-directed health, and prolonged independence, while informal caregivers may benefit from being more informed about their loved one's health, improved health-related communication, opportunities for prevention and early detection and intervention, and reduced burdens and strains of care. It should be noted that while these systems are becoming more commonplace, evidence for their actual impact on caregivers and older adults' health outcomes is generally weak (Alwan et al., 2007). Social connectedness monitoring is a relatively new area of application and involves the use of sensors to facilitate awareness and interaction between remote family members (e.g., INTEL's presence lamp). Older adults may benefit from improved quality of life via increased social interaction, and reduced isolation, with the potential for

improved health outcomes as a result, while informal caregivers can benefit from improved communication with their loved one.

A more recent development is the design and implementation of *smart home* applications. These involve integrated networks of sensors—which may include a combination of safety, health and wellness, and social connectedness technologies—installed into homes or apartments to simultaneously and continuously monitor environmental conditions, daily activity patterns, vital signs, sleep patterns, etc. over the long term. One example is the system being developed at the University of Missouri (*TigerPlace*) by Skubic, Alexander, Popescu, Rantz, and Keller (2009). The goal is to capture physical and cognitive behavioral patterns and develop algorithms to detect deviations from normal patterns in the hopes of early detection of health problems and prevention of health declines. The potential benefits of such technology are evident, although some would argue that the constant monitoring and "big brother" qualities of whole-home systems may outweigh any benefit and lead to low acceptance or abandonment of the technology. The next section discusses more general issues surrounding older adults' potential acceptance of monitoring technology.

3.4.2 Issues Surrounding Acceptance of Monitoring Systems by Older Adults

All technology, including the monitoring technologies discussed here, involves potential barriers to acceptance that must be overcome to facilitate widespread acceptance, adoption, and continued use. These include a broad range of user characteristics (socio-demographics, health status, social support, experience with and attitudes towards technology) and resources (sensory, cognitive, psychomotor); system characteristics (user interface, instructional support, aesthetics, engagement, functionality); and the fit between the user and the system. This section discusses a reduced set of the key potential barriers to acceptance of monitoring technologies by older adults. We start the discussion with the issue of privacy, which is certainly a potential stumbling block for technology that involves monitoring, surveillance, and potential sharing of data on a range of behaviors and vital signs with family, healthcare providers, and others. We present some of our own work in this area with surveys of disabled and nondisabled baby boomers and older adults, followed by discussion of a recently developed privacy framework that confirms and extends our work (Lorenzen-Huber, Boutain, Camp, Shankar, & Connelly, 2010). The section concludes with a discussion of the other key issues for the acceptance and adoption of monitoring technologies by older adults. These include perceived need for the technology by the older adult, perceived system usefulness, system demands, and the effects of monitoring technologies on social interaction and social connectedness.

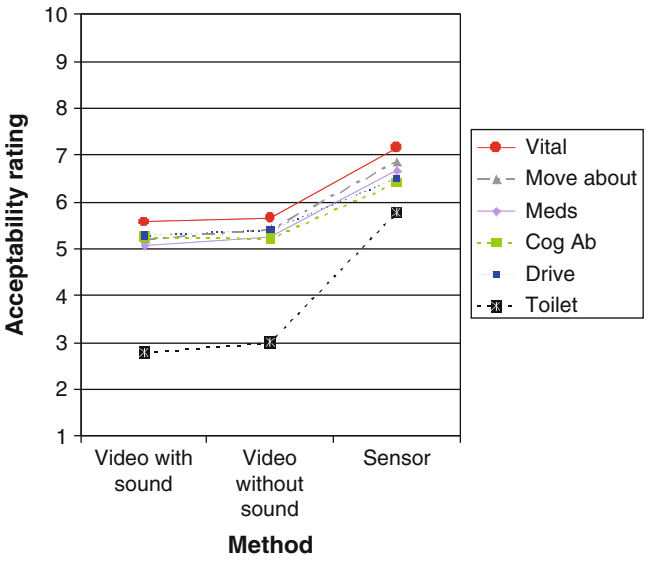

Fig. 3.3 Acceptability of recording information from different domains using varying methods

Privacy: Monitoring technologies can potentially create concerns about *informational privacy—what* type of information is recorded, *how* it is recorded, and with *whom* it is shared. In a recent national Web-based survey of 1,518 disabled and nondisabled baby boomers (age 45–64) and older adults (age 65+), our research group found variation in attitudes across these dimensions (Beach, Schulz, Downs, Matthews, Barron, et al., 2009; Beach et al. 2010). We varied what type of information was being recorded (vital signs, moving about the home, taking medications, cognitive abilities, driving behavior, toileting) and crossed this with three methods of recording (video with sound, video without sound, sensors) separately with the target recipient of the information (self, family, doctor, researchers, insurance companies, government). Figure 3.3 shows potential users were less accepting of the use of video cameras, either with or without sound, than of sensors (using a 10-point scale with 1=completely unacceptable and 10=completely acceptable). Note that the acceptability of recording toileting behavior via video was very low, although recording this highly sensitive activity with sensors was seen as moderately acceptable.

Figure 3.4 shows less acceptance of sharing information about toileting behavior and, to a lesser extent, driving behavior and that insurance companies and the government are least acceptable as potential recipients of health information, while family members and doctors are most acceptable. Also, note that sharing information about driving behavior is less acceptable outside of family contexts. The other major finding of the study was that both baby boomers and older adults reporting higher levels of disability were more accepting of having information recorded and

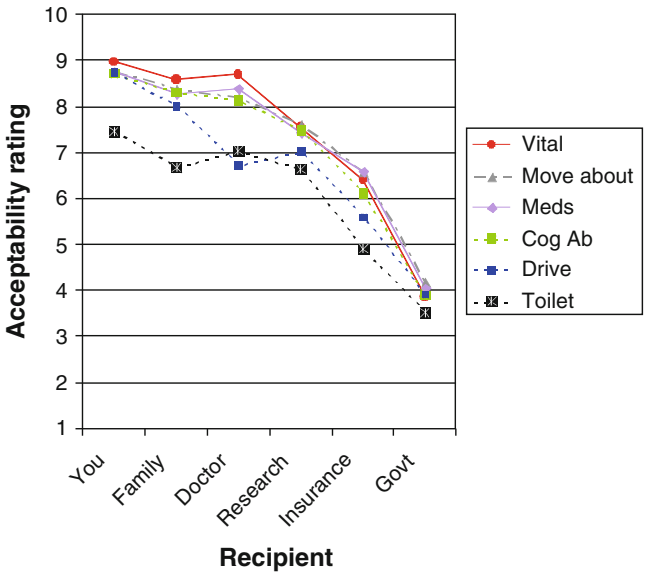

Fig. 3.4 Acceptability of sharing information from different domains with varying recipients

shared than those with lower levels or no disability. We found a dose–response effect where those reporting both ADL and IADL difficulties were most accepting, followed by those reporting only IADL difficulties, and followed by those who were nondisabled. The study provided empirical evidence of the implicit trade-offs between reduced privacy and improved health and suggested that such trade-offs may be more likely among those most in need of help (Beach et al., 2010; Beach, Schulz, Downs, Matthews, Barron, et al., 2009).

In a follow-up survey of 403 gerontology research registry and 217 wheelchair registry members aged 45 and older, our group explored privacy trade-offs and monitoring technology more explicitly and extensively (Beach, Schulz, Downs, Matthews, Seelman, et al., 2009; Beach et al., 2010). Figure 3.5 shows the percentages willing to accept home monitoring of varying levels of intensity and sharing information with varying targets in order to prevent going to a nursing home. Respondents were less accepting of video monitoring—especially when done in the bedroom and bathroom—than sensors, even if this monitoring would prevent institutionalization. Respondents were also less accepting of sharing information with insurance companies than with family or a doctor even if it helped prevent institutionalization. These findings suggest that some privacy trade-offs may just "not be worth it" for a significant subset of baby boomers and older adults. Lastly, the survey found that more disabled and more educated respondents were more willing to make privacy trade-offs but that assistive device use (primarily wheelchair) was not related to willingness to make these trade-offs.

Lorenzen-Huber and colleagues (2010) have recently proposed a framework for privacy, technology, and aging that confirms and extends our work. These authors

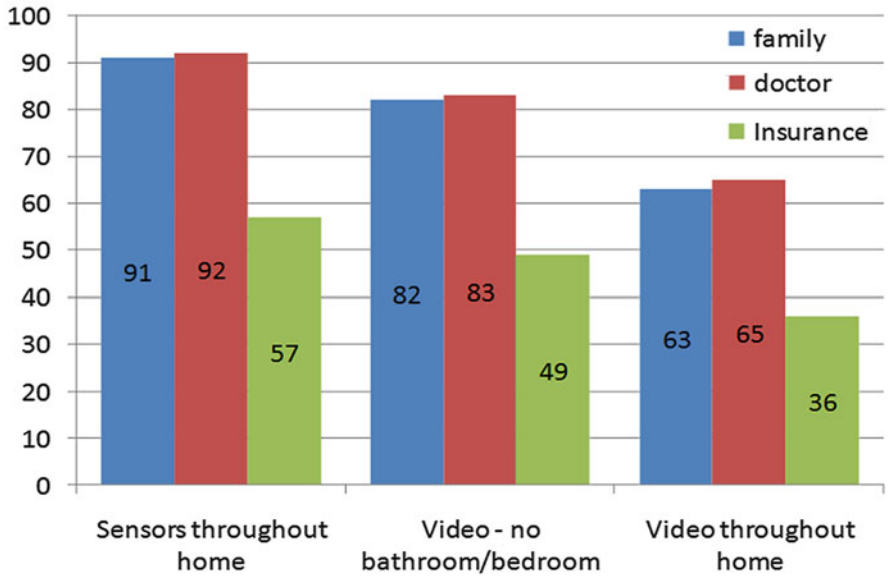

Fig. 3.5 Percent of respondents agreeing with different levels of home monitoring and sharing information with varying targets to prevent going to a nursing home

conducted focus group interviews with 65 older adults (age 70–85) who were allowed to observe and interact with various prototype technologies at Indiana University's Living Lab model home. The technologies ranged from the MD2 medication dispenser compliance system, to a *mirror motive* system that displays reminders and coordinates social engagement, to an *ambient plant* with sensors and lights to facilitate awareness between remote family members (eight total technologies). They found that older adult concerns about privacy were highly contextualized, individualized, and influenced by psychosocial motivations in late life. Factors that influenced perceived privacy included (1) the *perceived usefulness* of the technology (including awareness of their own perceived vulnerability or need for the technology), (2) *social relationships*, (3) *data granularity* (including level of granularity and data transparency), and (4) *sensitivity of activity*. Data granularity refers to the level of detail captured by the monitoring system—for example, full video versus obscured or ambient images from sensors. The researchers found that older adults were generally opposed to highly granular data collection like video, confirming our work cited above. Data transparency is concerned with what data are collected, stored, transmitted, or shared and with whom. Although they found that older adults were very naive about these issues, our work shows that concerns about privacy can vary when some of these parameters (what is recorded, how, and with whom it will be shared) are made clear. Their findings on sensitivity of activity—older adults were very concerned with being able to control the devices (i.e., turn them off), depending on what they were doing—mirror our findings that the acceptability of recording/sharing information differed by specific behavior (toileting and driving

less acceptable). The Lorenzen-Huber et al. (2010) framework also points to the interrelationships between privacy concerns and other key issues for the acceptance and adoption of monitoring technologies by older adults, including perceived need for the technology by the older adult, perceived system usefulness, system demands, and the effects of monitoring technologies on social interaction and social connectedness. We conclude this section with a brief discussion of each of these issues.

Perceived Need A fundamental issue in the acceptance of monitoring (and all) technologies by older adults is perceived need. A recurring finding in the research with older adults and technology is that many of these potential users simply do not think they currently need, and will probably never need, this type of assistance. For example, Barrett (2008), analyzing data from the *Healthy @ Home* survey sponsored by AARP using national Web panels of 907 older adults (age 65+) and 1,023 caregivers, found that seven in ten older adults say various safety and health and wellness devices may not be something they need, while eight in ten caregivers thought they would have some or a great deal of difficulty persuading the people they help to use the technology. In a more detailed secondary analysis of the *Healthy @ Home* data, Schulz et al. (2010) found that believing a device "would not be something I need" was a significant (negative) predictor of possible use of health and wellness technology. In addition, believing that a safety technology "would make me look like I need help" was also predictive of lower likelihood of use. Lorenzen-Huber et al. (2010) also noted that their focus group participants tended to say that while *other* older adults would benefit from monitoring technology, they did not perceive a personal need. This may be the most fundamental barrier to the adoption of not only monitoring but other quality of life technologies by older adults, and it certainly deserves further study.

Perceived Usefulness Closely related to perceived need is the perceived usefulness of the technology. Older adults are more willing to adopt and use technology that they feel will be useful in meeting their needs. This is a key aspect of many technology uptake and acceptance models (e.g., Davis, 1989) and is certainly applicable to monitoring technology. Older adults are much more willing to be monitored if they perceive it as providing clear benefits.

System Demands Another key set of factors is system demands, including things like the complexity of the system and resulting difficulty in learning how to use it and maintain it. There is a large literature showing that older adults are generally less comfortable with and less often use technology than their younger counterparts (e.g., Czaja et al., 2006). Our own work showed that only 52% of our baby boomer and older adult registry survey participants were willing to use technology that required 5–10 h of training (vs. 81% for 2–3 h), or about 1 h of maintenance per day (56% vs. 94% for a few minutes of maintenance per day), even if the technology could help them perform ADL tasks (Schulz et al., 2010). We did find that those who were more disabled were more willing to make these trade-offs. However, these findings reinforce the need for simple, intuitive user interfaces that require

minimal training of end users and other stakeholders. Another crucial system demand is the cost of the system. Multiple studies have shown that cost is perceived to be a major barrier to the potential adoption of technology for older adults and caregivers (e.g., Barrett, 2008; Schulz et al., 2010). However, a detailed discussion of this topic is beyond the scope of this chapter.

Social Connectedness The last issue we discuss is the impact of monitoring (and other) technologies for older adults on social interaction and connectedness. One of the most dramatic findings from our own work is that older adults are strongly opposed to systems or devices that reduce opportunities for social interaction, even if they would provide assistance with ADL or IADL tasks. Only 28% of the surveyed registry participants were willing to make such trade-offs (Schulz et al., 2010). Lorenzen-Huber et al. (2010) also found that the older adults in their focus groups were very concerned about monitoring technology intruding on their adult children's lives, that technology should never replace human contact, and that they should remain full participants in any exchange of data with family or healthcare providers. Finally, as noted in the introduction to this section, there are monitoring technologies that focus on maintaining and increasing *social connectedness*. All of this work reflects the fundamental desire for many older adults to remain socially integrated and connected and that technology that reduces these opportunities is not likely to be acceptable. Clearly there is a need for more research in this interesting area which has broad implications for a wide range of quality of life technologies.

3.5 Issues Regarding Stress with, Training for, and Acceptance of Healthcare Technology

As previously discussed, for healthcare technology to be useful and usable for older populations, the following issues need consideration: stress associated with initial use, training for use and for maintenance, and barriers to acceptance of technologies into a daily routine. As an example, consider the case of an older adult diagnosed with Type II diabetes, something that is occurring with increasing frequency in the population (Boyle et al. 2001; Mainous et al., 2007). The person is instructed by their physician to change their diet, to increase their exercise levels, and, in extreme cases, to use a glucose meter to monitor blood sugar levels. When first told about the diagnosis, how likely are they to understand and remember what they are being told? What kind of instruction will facilitate proper adherence to the treatment regimen? Finally, what are the barriers to integrating the treatment regimen into a daily routine? Also, who will teach them to use and maintain the glucose meter? As discussed in the following section, these issues can be very stress inducing which can ultimately interfere with a person's willingness or ability to engage in a new task or interact with a new type of technology.

Stress Classic models of stress and coping (e.g., Folkman, 1997; Lazarus & Folkman, 1984) emphasize the importance of the cognitive appraisal process in judging whether a situation will be perceived as stressful or not. A useful way to conceptualize stress effects is to consider the degree of match between the demands on the individual and the resources that they believe that they can bring to the task (e.g., Figure 1 in Charness, 2010). If the demands are in balance with the perceived resources, then there will be little experience of stress. If there is concern that demands are greater than resources, stress will be experienced in the form of physiological arousal (elevated blood pressure, heart rate) as well as in cognitive changes (increase in negative emotion and possibly increased workload when performing the task if someone is worried about their performance).

Importantly, long-term stress is associated with negative changes in health. For instance, the stress of caregiving for someone with dementia may result in increased morbidity and mortality (Schulz & Beach, 1999). But even short-term stress can interfere with someone's ability to perform a task correctly and may be differentially harmful to older adults. Stress can narrow the field of attention, making it more difficult for individuals to cope with the demands of a complex task. Not surprisingly, new technology, including healthcare technology, can evoke stress in a user, particularly when that user is an older adult unfamiliar with the technology. Though older adults are not averse to learning to use new technology if it is perceived to be usable and useful (Mitzner et al., 2010), they are less likely to use it compared to younger adults (Czaja et al., 2006) and more likely to experience stress when using it (Sharit & Czaja, 1994).

There is also evidence that older adults are more likely to experience an elevated physiological response to stressors than younger adults, at least when the outcome measures include heart rate, pulse, and blood pressure (Uchino, Berg, Smith, Pearce, & Skinner, 2006; Uchino, Holt-Lunstad, Bloor, & Campo, 2005), though this is not always the case (Dijkstra, Charness, Yordon, & Fox, 2009). A potential solution to older adult sensitivity to stressors, including the introduction of new healthcare technology, is to provide them with time to settle in with a new procedure and, more importantly, to provide them with the training and practice necessary to use the device or system properly. They also need access to technical support. Anxiety associated with a previously unknown situation may dissipate with appropriate education about the situation and some practice with the new task or device. It is also important to reassure the person that they will be capable of mastering the new activities and to provide sufficient time for them to learn. One possibility to consider is demonstrating device use with an age-matched model.

Training Unfortunately, much training for use of health-related technology is *just in time* training. That is, a device is introduced (prescribed) and the senior must immediately learn to use it without any further instruction or support. This type of just in time training can be quite stressful and lower a person's belief that they will be able to eventually use the device or system irrespective of the person's age. Take the case of someone newly diagnosed with diabetes. The emotional reaction that they have to the diagnosis is stressful by itself and can be expected to interfere with

their ability to attend to the healthcare professional's instructions about changing diet and exercise levels. At the same time this person has to think about accessing and using a new device, a blood glucose meter. Aside from an expected narrowing of perceptual and cognitive focus, it is also likely that repetitive or ruminative thoughts (Watkins, 2008) will reduce the cognitive resources available to process any instructions being given soon after the diagnosis. (This reaction can be conceptualized within the stress framework described above.)

So, training techniques should incorporate ways to reduce any emotional distress that the senior may be experiencing, possibly by training relaxation techniques (e.g., Dijkstra et al., 2009). Another factor worth considering is that older adults learn more slowly than younger adults (e.g., Charness, Kelley, Bosman, & Mottram, 2001), so sound training practice should take the slower learning rate into account, possibly by arranging for self-paced training. It is not yet clear what the best training methods are for older adults (e.g., Charness & Czaja, 2006) in part because few studies have investigated the upper end of the life span (those most vulnerable to acute and chronic health conditions), with most being concerned with older worker populations (e.g., Callahan, Kiker, & Cross, 2003). Aside from self-paced learning, learning in small groups seems to be differentially beneficial to older adults. However, training that used to be provided directly by the healthcare professional is increasingly being off-loaded to the client, via instruction sheets, manuals, and even video sources. It is a safe bet that such instructional materials will be distributed more frequently via the Internet. However, current cohorts of older adults are among the least likely users of the Internet, with only about 42% of those age 65 and over in the United States report using the Internet in the past year (Pew Internet and American Life Project, 2008).

Acceptance and Maintenance There are a number of macroscale factors influencing acceptance of health technology. Models of technology acceptance (e.g., the TAM model of Venkatesh & Davis, 2000) stress that acceptance of a new technology in a work environment depends on a potential user's beliefs about how useful the technology will be as well as on how easy to use it appears to be. This model can be applied to health technology with some minor modifications. The perceived importance of the device for health probably varies more than the perceived importance of a device for work (where you may have the option of leaving your job environment or even deciding not to adopt the device). You are more willing to use something if you are likely to die without it, for instance, a glucose meter for a Type 1 diabetic. Another factor is the cost of the device (money, time invested in use). In the absence of societal/governmental support for purchase, it may be too costly for an individual to purchase or lease a device. As in the technology acceptance model (TAM), a critical factor is its usability, how easily or comfortably the device can be deployed, used, and maintained. For instance, for someone with mild sleep apnea, a continuous positive airway pressure device may be so unwieldy and interfere so much with sleep initially that its use will be discontinued. Another factor that is not often considered (except perhaps by marketers) in acceptance is the aesthetics of the device, including any stigma associated with its use.

Obtrusiveness has been specifically identified as a potentially important factor in home telehealth (Hensel, Demiris, & Courtney, 2006).

Given that a device has been purchased, how likely is the user to persist with its use? One important factor is the user's attitudes toward the device. Models such as the theory of planned behavior (Ajzen & Fishbein, 1977) postulate that behavioral intentions follow from attitudes toward the behavior, subjective norms about the behavior (e.g., the opinions of family and friends), willingness to comply with those norms, as well as beliefs about one's ability to engage in the behavior (e.g., self-efficacy: Bandura, 1982). So, assume that a senior has been given a diagnosis and instruction on how to manage the disease process (e.g., for a chronic condition such as adult-onset diabetes). How likely is it that the senior will persist with the suggested routine? Of the factors in the Ajzen and Fishbein model, subjective norms and self-efficacy seem likely to play the biggest roles. For instance, subjective norms could be important in adhering to diet. If friends go along with the idea that a diabetic can cheat a little on desserts, they may do so at the party. The assistive device literature has identified both positive and negative factors in discontinuing use of a device. A summary with minor changes can be seen in Table 3.1, reclassified by perceived usefulness, usability factors.

Gitlin (1995) outlined some of the factors that have been identified for discontinuance by older adults. Factors include (1) improvement in the person's capabilities so that the device is unnecessary, (2) inability to use because the device depended on another device that has been discontinued, (3) lack of knowledge of how to use the device, (4) poor fit for the device to the user's environment, and (5) the device broke or was lost. For example, a complex telehealth device (such as videoconferencing equipment) is likely to fall prey to inter-device dependence issues and lack of knowledge problems. What the work on acceptance points out is that even if a device is initially perceived as useful and usable, and can be obtained at a reasonable cost, changing abilities and attitudes are potential barriers to incorporating health technology into a daily routine.

3.6 Conclusions

The growth in the number of older people, especially those who represent the oldest old, has vast implications for the healthcare system given the increased propensity towards illness and disability with advancing age. As discussed throughout this chapter, healthcare technologies hold promise in enhancing the ability of older adults and their families to access needed healthcare information and services and ultimately the ability of older people to live independently in the community. For example, home-based monitoring technologies offer numerous opportunities for increasing the safety, health and wellness, and social connectedness of older adults. These technologies also offer many benefits to healthcare providers and family caregivers. Internet-based health applications also provide opportunities for older adults and family members to be more involved in health self-management and to have greater access to resources and information and social support.

Table 3.1 Positive and negative factors in assistive device discontinuance

Negative factors in discontinuance	Positive factors in discontinuance
Usefulness	Usefulness
Never used or installed	Increased function makes it unnecessary
Seen as unnecessary	Replaced by an alternative solution
Negative views of device	Usability
Depression	Replaced by personal assistance
Failure to acknowledge/accept disability	Replaced by better equipment
Device selected without adequate consultation	
Lost device	
Usability	
Decreased function makes it unusable	
Device too difficult to use (size, weight, energy consumption)	
Unsafe to use	
Poor aesthetics	
Stigma	
Overly complex instructions	
Lengthy setup time	
Malfunction or failure of device	
Pain/discomfort in use	
Maintenance cost	
Device damages property	
Wrong device obtained	
Lack of sufficient training	
Difficulty accessing device	
Device requires personal assistance	
Device depends on another device	

Generally older people are receptive towards using these technologies especially if use of these devices, systems, and applications increases their potential to remain independent. However, as pointed out in our discussion, technology uptake is not ubiquitous among older people. There are a number of existing barriers to widespread adoption for current cohorts of older adults including large and diverse user groups with varying needs and abilities, lack of knowledge about the potential benefits of technology; low technology self-efficacy and anxiety; cost and accessibility; training opportunities; and system design characteristics. Many older adults are unaware of existing technologies, the benefits these technologies have to offer, and how to access these devices and applications. Further, many people do not have access to training and technical support and have some anxiety about their ability to use and maintain technology systems. Other concerns are related to issues regarding privacy, security, and reliability. Finally and importantly, system designers need to be aware of existing design guidelines for older users and adopt a user-centered design approach where older adults and family caregivers are actively involved in the design process. Clearly there is a need for more research in this area to answer questions regarding optimal system designs, training strategies, implementation processes, and cost-effectiveness issues.

Currently, the potential for technology to enhance the well-being and independence of older adults is not being actualized. For the full potential of technology to be realized for older adults and their families, the needs and abilities of older people must be considered in the design of technology systems and the design of implementation and training strategies. Unless older adults have full access to these healthcare technologies, they will be at an increased disadvantage in today's technology-oriented healthcare environment and the potential for age-related healthcare disparities will be increased.

References

Ajzen, I., & Fishbein, M. (1977). Attitude-behavior relations: A theoretical analysis and review of empirical research. *Psychological Bulletin, 84*, 888–918.

Alwan, M., Wiley, D., & Nobel, J. (2007). *State of technology in aging services*. Washington, DC: Center for Aging Services Technologies (CAST).

Alzheimer's Association. (2010). *Alzheimer's disease facts and figures*. Chicago, IL: Author.

Bandura, A. (1982). Self-efficacy mechanisms in human agency. *American Psychologist, 37*, 122–147.

Barrett, L. L. (2008). *Healthy@home research report*. Washington, DC: AARP Foundation.

Beach, S. R., Schulz, R., Downs, J., Matthews, J., Barron, B., & Seelman, K. (2009). Disability, age, and informational privacy attitudes in quality of life technology applications: Results from a national web survey. *Transactions on Accessible Computing (TACCESS), Special Issue on Aging and Information Technologies, 2(1),* Article 5.

Beach, S., Schulz, R., Downs, J., Matthews, J., Seelman, K., Barron, B., et al. (2009). *End-user perspectives on privacy and other trade-offs in acceptance of quality of life technologies*. Paper presented at the First International Symposium on Quality of Life Technology, Pittsburgh, PA.

Beach, S., Schulz, R., Downs, J., Matthews, J., Seelman, K., Person Mecca, L., et al. (2010). Monitoring and privacy issues in quality of life technology applications. *Gerontechnology, 9*(2), 78–79.

Boyle, J. P., Honeycutt, A. A., Venkat Narayan, V. M., Hoerger, T. J., Giess, L. S., Chen, H., et al. (2001). Projection of diabetes burden through 2050: Impact of changing demography and disease prevalence in the U.S. *Diabetes Care, 24*, 1936–1940.

Callahan, J. S., Kiker, D. S., & Cross, T. (2003). Does method matter? A meta-analysis of the effects of training method on older learner training performance. *Journal of Management, 29*, 663–680.

Cantor, N., & Sanderson, C. (1999). Life task participation and well-being: the importance of taking part in daily life. In D. Kahneman, E. Diener, & N. Schward (Eds.), *Well-being: The foundation of hedonic psychology* (pp. 230–243). New York: Russell Sage Foundation.

Center for Disease Control and Prevention. (2010). *Improving and extending quality of life among older Americans: At a glance 2010*. Retrieved from http://www.cdc.gov/chronicdisease/resources/publications/AAG/aging.htm

Charness, N. (2010). The health care challenge: Matching care to people in their home environments. In S. Olson (Rapporteur.), *The role of human factors in home health care: A workshop summary* (pp. 73–116). Washington, DC: National Research Council of the National Academies, National Academies Press.

Charness, N., & Czaja, S. J. (2006). *Older worker training: What we know and don't know*. AARP Public Policy Institute, #2006-22. Retrieved from http://www.aarp.org/research/work/issues/2006_22_worker.html

Charness, N., Kelley, C. L., Bosman, E. A., & Mottram, M. (2001). Word processing training and retraining: Effects of adult age, experience, and interface. *Psychology and Aging, 16*, 110–127.

Cobb, S. (1976). Social support as a moderator of life stress. *Psychosomatic Medicine, 38*, 300–314.
Czaja, S. J., Charness, N., Fisk, A. D., Hertzog, C., Nair, S. N., Rogers, W. A., et al. (2006). Factors predicting the use of technology: Findings from the Center for Research and Education on Aging and Technology Enhancement (CREATE). *Psychology and Aging, 21*, 333–352.
Czaja, S. J., Sharit, J., Hernandez, M. A., Nair, S. N., & Loewenstein, D. (2010). Variability among older adults in Internet Health information–seeking performance. *Gerontechnology, 9*, 46–55.
Czaja, S. J., Sharit, J., & Nair, S. N. (2008). Usability of the Medicare health web site. *Journal of the American Medical Association, 300*(7), 790–791.
Davis, F. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*, 319–339.
Dijkstra, K., Charness, N., Yordon, R., & Fox, M. (2009). Changes in physiological and self-reported stress in younger and older adults after exposure to a stressful task. *Aging, Neuropsychology and Cognition, 16*, 338–356.
Dykstra, P. (1995). Loneliness among the never and formerly married: The importance of supportive friendships and a desire for independence. *Journal of Gerontology: Psychological Sciences and Social Sciences, 50B*, S321–S329.
Ellaway, A., Wood, S., & MacIntyire, S. (1999). Some to talk to? The role of loneliness as a factor in the frequency of GP consultations. *British Journal of General Practice, 49*, 363–637.
Ellis, P., & Hickie, I. (2001). What causes mental illness. In S. Bloch & B. Singh (Eds.), *Foundations of clinical psychiatry* (pp. 43–62). Melbourne: Melbourne University Press.
Folkman, S. (1997). Positive psychological states and coping with severe stress. *Social Science & Medicine, 45*, 1207–1221.
Fox, S. (2011a). *Health topics*. Pew Internet & American Life Project. Retrieved from http://www.pewinternet.org/Reports/2011/HealthTopics.aspx
Fox, S. (2011b). *Peer-to-peer healthcare.* Pew Internet & American Life Project. Retrieved from http://www.pewinternet.org/Reports/2011/HealthTopics.aspx
Fox, S. & Purcell, K. (2010). *Chronic disease and the Internet*. Pew Internet & American Life Project. Retrieved from http://www.pewinternet.org/Reports/2010/Chronic-Disease.aspx.
Gitlin, L. N. (1995). Why older people accept or reject assistive technology. *Generations, 19*, 41–47.
Hensel, B. K., Demiris, G., & Courtney, K. L. (2006). Defining obtrusiveness in home telehealth technologies: A conceptual framework. *Journal of the American Informatics Association, 4*, 428–431.
Kinsella, K., & He, W. (2009). *An aging world 2008: International population reports.* Retrieved from http://www.census.gov/prod/2009pubs/p95-09-1.pdf
Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. New York, NY: Springer.
Lenhart, A. (2010). *Cell phones and American adults*. Pew Internet & American Life Project. Retrieved from http://pewinternet.org/Reports/2010/Cell-Phones-and-American-Adults.aspx
Lorenzen-Huber, L., Boutain, M., Camp, L. J., Shankar, K., & Connelly, K. H. (2010). Privacy, technology, and aging: A proposed framework. *Ageing International, 36*(2), 232–252.
Mainous, A. G., Baker, R., Koopman, R. J., Saxena, S., Diaz, V. A., Everett, C. J., et al. (2007). Impact of the population at risk of diabetes on projections of diabetes burden in the United States: An epidemic on the way. *Diabetalogia, 50*, 934–940.
Mitzner, T. L., Boron, J. B., Fausset, C. B., Adams, A. E., Charness, N., Czaja, S. J., et al. (2010). Older adults talk technology: Technology usage and attitudes. *Computers in Human Behavior, 26*(6), 1710–1721. doi:10.1016/j.chb.2010.06.020.
National Alliance for Caregiving. (2009). *Caregiving in the U.S: A focused look at those caring for someone age 50 or older*. Retrieved from http://www.caregiving.org/data/FINALRegularExSum50plus.pdf
Pewinternet. (2008). *Statistics pages.* Retrieved from http://www.pewinternet.org/Static-Pages/Trend-Data/Whos-Online.aspx
Schulz, R., & Beach, S. (1999). Caregiving as a risk factor for mortality: The caregiver health effects study. *Journal of the American Medical Association, 282*, 2215–2219.

Schulz, R., Beach, S., Matthews, J., Seelman, K., Person Mecca, L., & Courtney, K. (2010). Design preferences for technologies that enhance functioning among older and disabled individuals. *Gerontechnology, 9*(2), 79–80.

Sharit, J., & Czaja, S. J. (1994). Ageing, computer-based task performance, and stress: Issues and challenges. *Ergonomics, 37*, 559–577.

Sharit, J., Hernandez, M., Czaja, S. J., & Pirolli, P. (2008). Investigating the roles of knowledge and cognitive abilities in older adult information seeking on the web. *ACM Transactions on Computer-Human Interaction, 15*, Article 3.

Skubic, M., Alexander, G., Popescu, M., Rantz, M., & Keller, J. (2009). A smart home application to eldercare: Current status and lessons learned. *Technology and Health Care, 17*, 183–201.

Smith, A. (2010). *Home Broadband 2010.* Pew Internet & American Life Project. Retrieved from http://www.pewinternet.org/Reports/2010/Chronic-Disease.aspx

Taha, J., Czaja, S. J., & Sharit, J. (2009). Use of and satisfaction with sources of health information among older Internet users and non-users. *The Gerontologist, 49*, 663–673.

U.S. Census Bureau. (2011). *Information and communications*. Statistical Abstract of the United States: 2011. Retrieved from http://www.census.gov/prod/2011pubs/11statab/infocomm.pdf

U.S. Department of Health and Human Services. (2011a). *Health.Gov*. Retrieved from http://www.hhs.gov

U.S. Department of Health and Human Services. (2011b). *Nationwide health information network.* Retrieved from http://healthit.hhs.gov/portal/server.pt?open=512&objID=1142&parentname=CommunityPage&parentid=4&mode=2

Uchino, B. N., Berg, C. A., Smith, T. W., Pearce, G., & Skinner, M. (2006). Age-related differences in ambulatory blood pressure during daily stress: Evidence for greater blood pressure reactivity with age. *Psychology and Aging, 21*, 231–239.

Uchino, B. N., Holt-Lunstad, J., Bloor, L. E., & Campo, R. A. (2005). Aging and cardiovascular reactivity to stress: Longitudinal evidence for changes in stress reactivity. *Psychology and Aging, 20*, 134–143.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal case studies. *Management Science, 46*, 186–204.

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin, 134*, 163–206.

Zaphiris, P., Ghiawadwala, M., & Mughal, S. (2005). *Age-centered research-based web design guidelines*. CHI '05: CHI '05 Extended Abstracts on Human Factors in Computing Systems, Portland, OR, USA, 1897–1900.