Can **Emerging Technologies** Buffer the Cost of In-Home Care in Rural America?

By Nicol Turner-Lee

Artificial Intelligence, the Internet of Things, and ride-sharing apps may assist rural elders to age in place, as long as there is equitable online access.

My mother, who is in her seventies, recently fell and injured her back, sustaining a painful herniated disc. With three daughters who each live in different states, her road to recovery was challenging and oftentimes isolating for her, especially given the distance between us, our busy work schedules, and her limited mobility. She couldn't drive or cook, and even had some difficulty operating a television remote.

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Prior to the accident, my mother was an active woman, but her injury kept her confined to home, resulting in limited physical interactions with the people she often visited, including her siblings and friends. Thankfully, she now is slowly regaining her strength, but there were times in which she felt a range of emotions—from helplessness to loneliness—during her recovery process.

The Potential of Technology's Role to Support Isolated Older Adults

With older adults experiencing falls and other types of debilitating accidents more frequently than younger adults, existing and emerging technologies—from the Internet-of-Things (IoT), to artificial intelligence (AI) applications, to ride-sharing apps—all potentially can play a role in buffering associated setbacks and limitations. New technologies also can provide the appropriate interfaces, including voice and robotic assistants, for family members and other caregivers who need to balance their loved ones' care with managing responsibilities at their jobs and communications with other family members; this can be especially beneficial for those living in rural communities.

According to the Federal Communications Commission (FCC, 2015), an estimated 55 mil-

→ABSTRACT Older rural residents are geographically isolated and distanced from their medical providers, family members, and other caregivers. Technology is disrupting traditional models of care for such aging adults by helping to bridge connections between them. Artificial intelligence and the Internet-of-Things promote independence in older adults through self-driving cars, robotics, and voice assistants, and can assist in their healthcare through remote patient-monitoring. But these technologies will require reliable and affordable next-generation connections for older adults, along with legislation to address data privacy concerns with emerging health technologies. | **key words**: *technology, Internet-of-Things, artificial intelligence, broadband, rural aging*

lion people lack access to a high-speed broadband connection in the United States. Fourteen million of them live in rural areas.

Unfortunately, limited online access restricts the possibilities of emerging technologies, especially in healthcare. The applications, devices, and other online services enabled by high-speed broadband networks not only are assisting in the administration of healthcare services (e.g., billing and appointment scheduling), but also are improving doctors' ability to diagnose certain physical conditions in their patients. Emerging technologies, including AI and machine-learning algorithms, also are deploying customized healthcare solutions based on biometric data and the use of personalized data sensors, which aid in the transmission of critical patient data to medical practitioners.

Technology is disrupting traditional models of care for aging adults, which could provide support to elders who may find themselves alone in the wake of unexpected physical and social traumas. When older adults have access to a range of innovations, they can remain better connected to doctors, family members, and other caregivers, which is particularly critical for older adults who reside in remote rural areas.

In support of this foregoing premise, the Trump Administration recently released a March 2019 report, *Emerging Technologies to Support an Aging Population*, which "[identifies technological] innovations that have the potential to improve quality of life for all Americans, particularly those who live with physical or cognitive burdens due to aging or disability. Importantly, the report also identifies the research and development needed to bring these innovations to fruition" (National Science and Technology Council, 2019).

The cost of in-home healthcare is expensive, with very few options available for older adults seeking to improve the personal management of their care, or to find creative solutions for caregivers to remain involved in the process. A 2018 Genworth study found that the median national cost of in-home care was approximately $4,000 per month, and was about the same for assisted living arrangements (Genworth, 2018). The cost of nursing home care varied, ranging from $7,000 to $8,000 per month for a semi-private or private room, respectively. In the United States, alternatives to these options include co-housing and community living, which allow older adults to maintain a degree of independence and an easily accessible social network. However, some of these options may not be available in rural areas, where older adults could benefit most from independent living environments.

Expenses related to one's specific lifestyle also are factors in the cost of in-home care. In my mother's case, she has a dog that requires attention and walking, she needs prescriptions to be picked up at the local pharmacy, and she prefers to buy organic groceries. When an older adult decides to recover at home, these types of tasks have to be taken over by someone else. While family members may step up to shoulder a large portion of these, this also impacts their own families; these family members may have to take time off from work or tap into other supports to cover responsibilities such as child care. Physical and social traumas impact both the affected older adult and his or her caregiver(s). Such issues are more complex when one lives in areas with limited transportation options, particularly if the nearest healthcare provider is in another city or town.

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Given our nation's increasing aging population and the urgent need for supports and services to care for people as they age—and how technology can provide assistance with such care—this article will discuss three areas of

existing and emerging technologies—AI applications, IoT, and ride-sharing apps.

Artificial Intelligence

Artificial intelligence is not a novel concept. It has always referred to the ability of computers to problem-solve and complete other data-processing methods, which dates back to IBM's Watson supercomputer. Early AI was designed and implemented at the U.S. Department of Defense, which trained computers to mimic and mirror basic human reasoning. In that era, the projects undertaken by the Defense Advanced Research Projects Agency (DARPA) included automated street-mapping, development of intelligent personal assistants, and other automated processes intended to improve upon U.S. national security.

Today, AI's evolution very much reflects the growth of the Internet, as more advanced computing has enabled natural language–processing and deep learning, which pick up on the psychological and physiological cues of humans. Machine-learning algorithms, which are the computer models that process massive amounts of online data, also are making AI systems smarter and enabling them to support a variety of sectors, from retail to healthcare.

Modern day examples of AI include self-driving automobiles, robotics, voice assistants, remote healthcare aids, and other automated processes. AI in healthcare is transforming both the design and delivery of critical solutions, while taking on the management of specialized and routine care, such as appointment scheduling and virtual support systems for both doctors and patients. While robots may not be capable of walking a pet (yet), virtual voice and robotic assistants are reminding older patients to take their medications or confirming pill sizes to avert accidental misuse. AI systems also are starting to make predictions about other physical ailments based upon a patient's available medical data.

The voice-activated Amazon Echo has become one solution to promote the independence of older adults, while reducing their social isolation via its two-way exchange. A study by Carlsbad by the Sea (Mizak et al., 2017), a continuing-care retirement community in Carlsbad, California, found that 70 percent of study participants, who were mostly in their eighties, found voice-activated devices helpful, and 75 percent used these smart-home devices daily.

Advanced robots, such as Catalia Health's Mabu (tinyurl.com/j5u9ont), are helping medical practitioners to maintain conversations with older adults around their care, making it easier to narrow treatment options. AI-enabled virtual companions, such the ElliQ (elliq.com/), also are facilitating social exchanges between older adults and their family members.

The Internet-of-Things

Artificial Intelligence also is enabling new remote products and sensors, commonly referred to as the Internet-of-Things (IoT). By 2030, more than 500 billion devices will be connected to the Internet, according to Cisco (Cisco, 2019). The IoT will comprise the largest portion of these devices, particularly as they form a network of physical objects that contain embedded technology to communicate, sense, or interact with the environment and other networks.

As a network of connected devices, IoT is able to aggregate, analyze, and deliver insights into human and other environmental behaviors, which ultimately may help to drive more informed decisions and actions in a variety of areas, including energy management, education, and climate change.

For older adults, the Apple Watch and Fitbit are among many products that are able to detect inconsistencies in biometrics through remote patient-monitoring. AI-powered sensors from companies that include Xsens (Quintas et al., 2019), Kardian (kardian.com), and Qventus (Qventus, 2018) are improving the detection of falls among aging adults. Other products, such as ingestible sensors, are aiding in treatment adherence by generating a signal after medicine is taken,

which relays the data to a smartphone application and, eventually, to the medical provider.

Home-health sensing is another example of IoT applications for older adults, which can be particularly useful in managing chronic diseases. For example, microphones in smartphones are replicating spirometers that measure airflow in and out of lungs for patients with chronic obstructive pulmonary disease. Collected data are then used by doctors to monitor disease progression in patients in real-time.

Overall, AI, IoT, or a combination of both can aid remote diagnosis, foster adherence to prescribed interventions and medications, and even assist in the administration of medical services, from appointment scheduling, insurance management, and treatment portfolios, to patient monitoring.

Ride-Sharing Services and Self-Driving Cars

Internet-enabled ride-sharing services have become part of the solution for older adults who need to get to doctor appointments, tend to daily errands, and visit family and friends. Using a smartphone or other wireless-enabled device, consumers are able to engage these services, provided they have some form of financial collateral (e.g., a credit card or bank account). My mother relied heavily upon ride-sharing services to travel to her physical therapy appointments and, in some cases, we were able to call them for her and monitor trip routes.

Major commercial ride-sharing companies, including Uber and Lyft, have started creating programs geared toward older adults; this represents a major shift in their business models. Via, a ride-sharing service based in New York City, Chicago, and Washington, D.C., reported that in 2015, 27 percent of its riders were older adults (RideGuru, 2019). In addition to these services, an intermediary company called GoGoGrandparent (www.gogograndparent.com) helps elders use Uber and Lyft by arranging rides for them when they call the service, which simplifies the ordering process and makes it less device-dependent.

Some healthcare providers are partnering with ride-sharing services to transport patients. Last year, both Uber and Lyft teamed up with a variety of companies to integrate their services into the daily routines of hospitals, physician practices, and individual practitioners. In a recent deal with Allscripts, the nation's leading electronic health records provider, Lyft is positioned to reach an estimated 7 million patients, whose medical facilities will be able to call multiple cars simultaneously and send patients details about their ride via text messages. The cost of the ride will be covered by the medical provider.

'The connection between emerging technologies and the healthcare system is still somewhat nascent.'

Despite widespread use, some ride-sharing services are not always equipped with resources for elders with disabilities. Personal safety also can be a concern among older adults who use ride-sharing services; this population may be more susceptible to financial and information abuses and, even worse, physical violence. Further, affordability of these services can be a deterrent to their use, especially among older adults with limited income or for those who lack a smartphone or a credit card. Some rural communities also do not have a ride-sharing option because poverty limits residents' ability to own and maintain a car.

Looking ahead, self-driving cars will become the next-generation transportation solution for aging adults who are unable to operate a vehicle. Many of these cars will be designed with accessibility in mind, including wheelchair access and the necessary interfaces for the visually impaired. Similar to ride-sharing services, self-driving cars must also be safe, affordable, and easily accessible for older adults. Such innovations will allow aging adults to drive longer, helping them to be more independent in their

activities. They may also give rural residents the ability to travel longer distances to get to a primary or specialty care doctor, as long as they can afford the ride.

Other Considerations

Many of these digital technologies and their applications require access to smartphones and other Internet-enabled devices. Fortunately, 66 percent of older adults who are ages 65 and older have a smartphone. Among their top uses are sending and receiving text messages, emailing, getting directions or traffic information, downloading and purchasing apps, and visiting websites, according to AARP (Anderson, 2017).

Given this information, will it be easy or difficult for older adults to engage with emerging healthcare technologies? Hopefully, the answer is that it will be easy for them, especially as they see that these technologies can make for more efficiencies and can contribute to improved peace of mind when it comes to regular communications with caregivers and others on the care team.

Other considerations, however, must be top priority when encouraging more elders to get online. First, many of these coming-of-age applications will only work well with robust high-speed broadband networks. Next-generation 5G networks will be crucial in accommodating the increased demand and use of online applications, especially social service programs. Compared to 4G LTE, 5G networks are poised to bring higher bandwidths, lower latency, and increased connectivity to mobile broadband. Data will travel faster over wider coverage areas and have bandwidths projected to be ten times higher than 4G LTE, which will contribute to the faster transmission of data, images, and videos. This type of mobile connectivity will be strengthened through "small cell" infrastructure, which will densify 5G wireless signals and improve their movement through concrete buildings and walls.

Looking ahead, 5G networks must be affordable for older adults who increasingly rely upon their smartphones, other Internet-enabled devices, and sensors to protect and update their care with doctors and other providers. Industry leaders and policy makers must also ensure that these networks are widely available to older adults, regardless of where they live, so that they can benefit from AI in healthcare, self-driving cars, and other home health–sensing gadgets. It has been argued that next-generation mobile will become more widely available in urban areas, potentially leaving rural communities behind. With mobile becoming the leapfrog technology to enable emerging technologies, it is imperative that the infrastructure to carry these wireless-enabled technologies be available in more remote areas.

Second, many of these online applications collect data from older adults, whether it is location information for ride-sharing services or personal health statistics. When the online identity of older adults is breached, it can be hard to recover, especially for elders with limited online and offline support for contacting creditors. Given the recent infractions affecting consumers' online information, Congress is considering adopting federal privacy legislation, which would provide effective guards against bad actors who engage in fraudulent and deceptive practices.

The privacy concerns of elders must be melded into any new federal privacy legislation to ensure that they know how and where their information is shared and have some baseline protections on data use.

Finally, the connection between emerging technologies and the healthcare system is still somewhat nascent. Some insurance companies have not embraced payments or reimbursements for the use of any emerging technologies in care. And, some doctors remain skeptical of their use. Given these valid concerns, more research needs to be done to test digital products and services on older populations and, where they prove fal-

lible, errors need to be corrected. This will be a process, but it should not foreclose on the use of new and existing technologies by older adults.

Conclusion

The cost of in-home care will most likely steadily increase in an environment where healthcare costs are skyrocketing. However, the technologies mentioned in this article have the potential to at least facilitate meaningful connections between older adults in need of immediate and long-term support, as well as their caregivers. Modern day innovations are beginning to make it easier for doctors to interface with their patients and to do a much better job monitoring a variety of conditions. While the journey to equitable online access may not be smooth, it is important that deployment and use is widespread enough to enable online access for all older Americans in need of healthcare resources, especially those living in rural areas.

As my siblings and I employed many of these tools to support my mother's recovery, we were able to witness her progression from a walker to a cane. But, she is only one case. Collectively, the care of older adults can be challenging and elicit an abundance of emotions when families and caregivers must balance individual and family demands. In the best-case scenarios, emerging technologies, coupled with more robust broadband networks and responsible practices, can make caring for elders a little less stressful for everyone, irrespective of where one lives.

Nicol Turner-Lee is a Fellow at the Center for Technology Innovation at the Brookings Institution, in Washington, D.C.

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