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# Seniors at home

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As the percentage of our older population grows, more people need health care and assistance but there are fewer people to pay for it and perhaps not enough paid caregivers to deliver it. As an alternative to institutional care, "Aging in Place" means staying in one's own home even when age- or health related changes make it difficult to do so. Although a large majority of older Americans say they want to Age in Place, it is often more easily said than done. Today's care infrastructure, technologies, existing housing, funding sources, and the businesses and services available for Aging in Place are not being fully realized in order to achieve the promise most hope for as America ages. While steps are being taken to make Aging in Place easier, the real challenge is answering "What strides are required for Aging in Place to reach its promise?". This report aims to answer this question and present how technology can play a critical role in reaching its promise.

# 1. Introduction

The world is on the brink of a demographic milestone. Since the beginning of recorded history, young children have outnumbered their elders. The World health organization predicts that within the next few years 1the number of people aged 65 or older will outnumber children under age 5. Driven by falling fertility rates and remarkable increases in life expectancy, population aging will continue, even accelerate (Figure 1). The number of people aged 65 or older is projected to grow from an estimated 524 million in 2010 to nearly 1.5 billion in 2050, with most of the increase in developing countries.

<sup>&</sup>lt;sup>1</sup> Global Health and Aging - World Health Organization

## Figure 1. Young Children and Older People as a Percentage of Global Population: 1950-2050



The remarkable improvements in life expectancy over the past century were part of a shift in the leading causes of disease and death. At the dawn of the 20th century the major health threats were infectious and parasitic diseases that most often claimed the lives of infants and children. Currently, noncommunicable diseases that more commonly affect adults and older people impose the greatest burden on global health.

In today's developing countries, the rise of chronic non-communicable diseases such as heart disease, cancer, and diabetes reflects changes in lifestyle and diet, as well as aging. The potential economic and societal costs of noncommunicable diseases of this type rise sharply with age and have the ability to affect economic growth.

Reducing severe disability from disease and health conditions is one key to holding down health and social costs. The health and economic burden of disability also can be reinforced or alleviated by environmental characteristics that can determine whether an older person can remain independent despite physical limitations. The longer people can remain mobile and care for themselves, the lower are the costs for long-term care to families and society. Because many adult and older-age health problems were rooted in early life experiences and living conditions, ensuring good child health can yield benefits for older people. In the meantime, generations of children and young adults who grew up in poverty and ill health in developing countries will be entering old age in coming decades, potentially increasing the health burden of older populations in those countries.

With continuing declines in death rates among older people, the proportion aged 80 or older is rising quickly, and more people are living past 100. The limits to life expectancy and lifespan are not as obvious as once thought and there is mounting evidence from cross- national data that—with appropriate policies and programs—people can remain healthy and independent well into old age and can continue to contribute to their communities and families.

The potential for an active, healthy old age is tempered by one of the most daunting and potentially costly consequences of ever-longer life expectancies: the increase in people with dementia, especially Alzheimer's disease. Most dementia patients eventually need constant care and help with the most basic activities of daily living, creating a heavy economic and social burden. Prevalence of dementia rises sharply with age. An estimated 25-30 percent of people aged 85 or older have dementia. Unless new and more effective interventions are found to treat or prevent Alzheimer's disease, prevalence is expected to rise dramatically with the aging of the population in the United States and worldwide.

Aging is taking place alongside other broad social trends that will affect the lives of older people. Economies are globalizing, people are more likely to live in cities, and technology is evolving rapidly. Demographic and family changes mean there will be fewer older people with families to care for

them. People today have fewer children, are less likely to be married, and are less likely to live with older generations. With declining support from families, society will need better information and tools to ensure the well-being of the world's growing number of older citizens.

# 2. Aging in Place

# Segments, Needs & Challenges

Though various segments & sub-segments exist within the population, the aging population can be broadly segmented into the following groups, with unique needs and challenges.

- The Active Agers
- The Aging
- The Aged

# The Active Agers

Active agers are generally to be found within the age groups of 55 years and 70 years. They either hold active jobs, or have recently retired. Given, this background, they have resources at their disposal.

Active agers are also much more healthier than earlier generations because of sustained improvements in health care treatments that target not only disease, but also quality of life.

Many active agers are also seeing changes in their social circumstance. Apart from the traditional emptying of the family nest, divorce rates among the baby boomers has increased 2.5 times between 1990 and 20091,3.

Having said this, there are also trends that are changing how this segment will look like in a few years from now.

1. The demographic trends of increasing life expectancy is causing more people to continue to stay in their jobs longer, reducing the job market for younger people, while at the same time changing the behaviors in this segment 4.

#### At what age do you expect to retire?



Asked of nonretirees

Late 1995 result reflects an average of Nov. and Dec. polls

#### GALLUP'

The primary driver for this change is "affordability of retirement", with almost a 30% increase between 2005 & 2010 in the number of non-retirees expecting to rely heavily on social security5 (2015 Gallop)

2. More young people are staying at home either due to student debt, or the lack of middle class jobs increasing the financial stress on this age group2

# **Family Ties**

The percentage of 18-to-34-year-olds living with their parents is still climbing.



Despite these long-term trends, the current social, economic and health drivers are resulting in social behaviors, ranging from companionship, romance, supporting other agers in aging gracefully, and in exploring new experiences – particularly with travel being an often seen behavior.

### The Aging

"The aging" are typically much more vulnerable than active agers in living a daily life. Though "The ageing" do not need assistance with daily chores, they are beyond a point where they can lead active social lives. They also tend to start losing an immediate social circle, through death, disease and physical relocation.

They are especially vulnerable to minor accidents becoming life threatening, and live in a world that is very different (technologically) from what they are familiar with, often making it hard to seek help.

Adult children become the key decision makers in this segment. In more affluent homes, this segment causes some "reverse-migration", closer to where adult children are located

Also impacting this segment is the decreasing levels of "family support". The elderly support ratio is expected to decline from 7:1 in 2010 to 3:1 in 2050, where the elderly support ratio is the number of care givers per 80 year old (caregiver - 45 to 64 year old)

The majority of the needs in this segment relate to providing health care, a mentally stimulating environment and safety & security especially given the socio-economic challenges faced both by caregivers and the care-given.

#### The Aged

"The Aged" segment are critically dependent on assistance for daily chores. Either due to disease or old age, at this point in their lives, they cannot care for themselves independently.

The need of this segment centers on quality of life for the individuals concerned.

The challenges are balancing economic situations with the emotional, social and health issues associated with aging.

Though, there are many solutions that are used to address this segments requirements, all of them feel inadequate and sub-optimal. There are no easy answers, we guess because aging is hard on everybody

To better understand the driving forces behind current problems in senior care. We analyze the vast senior care industry by three segments.

- 1. Senior care housing options and industry dynamics.
- 2. Senior care services
- 3. Medical devices and current technical solutions for the elderly

# 3. Senior Care Housing Options

The housing options for senior's in the U.S is extremely diverse and offer varying degrees of care types and styles at different price points. Fig below depicts this complexity.



There a several different senior housing options that are each designed to meet the needs and personal preferences of senior citizens throughout the aging process. Meeting personal needs such as comfort, security, social opportunities, and health care persuade many seniors to opt for relocating versus aging at home. Basically long-term care housing options fall into three main categories based upon the level of care and types of services provided: Independent Living / Retirement Communities, Assisted Living Facilities, and Skilled Care / Nursing Homes. There are variations of these which might include combinations of two or even all three types of senior housing on same campus offered in Continuing Care Retirement Communities.

Independent Living may include senior apartments, residential care homes and retirement communities. Independent Senior Communities enable seniors to live among their peers however they must be able to care for themselves. Amenities vary from none to offering daily meals, recreational and social activities, transportation, 24 hr security and housekeeping services.

#### **Assisted Living**

Aside from independent living, which is simply living in a general community, there are two major categories of older adult housing. Active Adult is described as "lifestyle housing" (i.e., single- or multi-family housing organized around social and recreational activities) with amenities (i.e., clubhouse, recreational facilities, organized social activities) but no care or assistance service. Service-enriched is housing and care packaged together to meet assistance needed by older residents. This includes single- or multi-family, or (congregate) housing arrangements. There are several different senior housing options that are each designed to meet the needs and personal preferences of senior citizens throughout. Service-enriched housing is what most of us typically think of as "assisted living." For the most part, moves to service-enriched housing are not discretionary, typically precipitated by inability to live independently or difficulty with current living arrangements often related to a health crisis.

Service-enriched housing breaks down further into:

- Co-Housing
- Continuing Care Retirement Communities (CCRC)
- Assisted living communities
- Skilled care nursing home

These divisions reflect the amount of care provided. Service-enriched housing providers offer a defined set of services — theoretically matching resident needs. There is a disconnect, though, because the typical course of aging for many people, i.e., progressive need for more assistance, means that many living in service-enriched housing will soon be mismatched — requiring another move. Moving because your health changes is disorienting, disturbing, and undesirable. In some cases the option with even the minimum of services provides more than is needed. Unfortunately, it can result in residents who want to maintain involvement in some home tasks being forced to discontinue them because the structure of service-enriched housing they reside in can't accommodate such involvement.

The broadest service-enriched housing, Continuing Care Retirement Communities (CCRC) are housing and care facilities conceived to recognize that aging is individualistic and that some may experience the need for increasing levels of care. The graphic representation of CCRC is a series of concentric circles representing increasing levels of care from the outer ring of cottages, town homes, or apartments to the inner circle of skilled nursing.

#### Home and Community–Based Services

Many people receive care from family, friends, and public or private agencies in their homes. Existing networks provide home- and communitybased services for older individuals in most communities around the country. Many networks and services are associated with the Area Agency on Aging mandated by the Older Americans Act. Service providers, working in what is called the "Continuum of Care," meet all or nearly all the needs.





Though all the services may be available, Aging in Place is difficult because the services are not organized into an easily managed, systematic whole. Piecemeal development of home- and community-based services over a long period of time largely explains why the services do not always work in coordination with each other. Additionally, programming and funding have emerged from an array of congressional appropriations, state programs, nonprofit grants, private enterprise, and community initiatives. The service provider's inspirations and intentions, background, mission, and purpose are equally varied. Neither funding nor providers are developed for comprehensive care on an at-home basis.

Public funding for home- and community-based care comes from different departments, agencies, and levels of government, sometimes described as "silos" because operationally they are self-contained and vertical. The funding streams, delivery paths, and eligibility criteria vary so much they cannot always be used in integrated and comprehensive application. Federal programs from the U.S. Department of Housing and Urban Development (HUD) and Department of Health and Human Services (HHS) do not match in their program missions or language. State and local programs sometimes impose additional levels of qualification and eligibility.

Funding and services from non-profits and foundations are organized around missions, goals, and funding priorities. Private-pay providers organize their services around a skill set or resources they can manage well. This is fair because all of these provider organizations are meeting their purposes, charters, and goals to provide a program or service. However, none are mandated to provide the whole continuum to match client needs, which is the optimal situation for a service consumer.

# Industry Dynamics

Overall businesses around senior care housing is adapting to the overall demographics and societal trends. Market size estimates vary depending on types of providers and services included:

- IBIS sizes the U.S. senior housing market at \$60 billion, defined to include independent living facilities, assisted living facilities, and continuing care retirement communities.2 Nursing care, defined as skilled nursing facilities, nursing homes, and hospice centers, is estimated at more than \$128 billion.
- The National Center for Health Statistics estimates expenditures for "long-term care services" between \$210 and \$306 billion, which include a variety of settings in the home from a home health agency, adult day services centers, residential settings from assisted living communities, or in institutions from nursing homes.
- Investors AEW Capital Management and Newcastle Investment Corp. value the senior housing market at more than \$300 billion.

## Fragmented Industry

Despite a steady flow of mergers and acquisitions in recent years, the senior housing industry remains highly fragmented. According to one market share analysis, the top 25 independent living operators in the United States

represent an estimated 24.5 percent of all units, while the top 25 assisted living operators only represent 37.7 percent of all units. The top 25 nursing facility operators represent 22 percent of all beds. In another analysis, share of market was divided among non-REITs (21 percent share) and REITs2 (9 percent), with the remaining 70 percent of senior housing properties owned by "mom and pops" (i.e., defined as owners of 15 or fewer properties).

Large operators are looking to participate at each vertical across the continuum of care, from independent living to assisted living to memory care and skilled nursing, as well as offer ancillary services which might include outpatient therapy, pharmacy, home health, and hospice, among others. According to data compiled by Provider Magazine, more than 80 percent of the top 25 nursing facility operators also provide assisted living and more than two-thirds offer independent living. Other services offered include outpatient therapy (80 percent), pharmacy (40 percent), home care (52 percent), and hospice (76 percent).

# 4. Senior Care Services and For hire services

Another challenge that family members and senior's face in determining to stay at home is based on level of service that will be available to them as they age. Families need to gather information and then weigh complex issues/alternatives and make decisions about care needs and providers. Without competent decision-making, family members can get worn out simply trying to navigate and organize providers, services, and funds. Long-distance caregiving is even more onerous. In many cases, services are used inefficiently or are unavailable. Private geriatric care management, which can assist families with care decisions and planning, is available in some areas. Costs for this service, however, can be prohibitive for some.

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<sup>&</sup>lt;sup>2</sup> Real estate investment trusts

It is important to understand that some individuals experience acute episodes of illness as well as chronic progressive conditions that result in ongoing changes and the need for varying amounts of care to accommodate these changes. Needs change episodically but continually, so the service package needs to change in order to use service resources efficiently. Care must be ramped up during an illness, but can be reduced a few weeks later. Determining that change has occurred, the effect of that change, and who may now be the right provider, as well as contracting for services with that provider is challenging. Confusing and uncoordinated state, county, or federal funding eligibility requirements can exacerbate the situation. Varying eligibility among programs and funding sources may push a client into a funding gap as their needs change. Too often — whether due to a lack of information or eligibility the best possible tool, service, or intervention is impossible to employ.

Another way to categorize the problems service-enriched senior segments care face suffer is "overcare" and "undercare."

- Overcare housing and care is connected in facilities often with too much service and cost meaning waste of resources, and reduced self-esteem and learned helplessness for the client.
- Undercare in the community or in home care, clients often fall through cracks, and/or have difficulty finding, arranging, and managing services and assistance.

Apart from this mismatch in senior care needs and availability of care, there are other industry dynamics that are shaping the senior care landscape. The current health care system is already overwhelmed by demands for geriatric care. Those specializing in the care of older adults cannot meet the current demand let alone the projected needs for eldercare.

Below are the key statistics that highlight this crisis.

- More than one million additional direct-care workers will be needed by 2018, according to the latest employment projections.
- There are only 7,029 certified geriatricians practicing in the U.S. roughly half the number currently needed, and falling.
- By 2020, the nursing workforce is expected to drop 20 percent below projected requirements

Family caregivers are also an important part of the senior care service structure and without an investment in the eldercare workforce, even more stress will be placed on family and other informal caregivers. Due to smaller family sizes, the divorce rate, and geographic relocation – the next generation of older adults may be less able to rely on their families for caregiving.

In this report we will address how technology can address some of these issues exploiting the existing two sides market dynamics of the senior care industry.

# 5. Technology solutions



Four aging in place technology categories today

The Four technology categories for aging in place are:

**Safety and Security**: These includes products such personal emergency response systems, security systems and home monitoring systems . The market size for these types of solutions is estimated to ~2 billion with major player being ADT security services, Nortek/Numera Ever There and GreatCall. The standalone nature of these devices mean they offer limited benefit and are already seeing increasing competition from smartphones and wearable's that are more general purpose and connected. By 2019, most PERS resellers will offer more subtle mobile devices, including watches, combine the transactional PERS activity with predictive analytics – helping to prevent future injury and the penalty of rehospitalization.

**Communication and Engagement** : For baby boomers and younger, life is unthinkable without e-mail, chat, web surfing, Facebook, Smartphones, video games, Skype, and texting. Yet the majority of seniors age 75+ may be unaware or less familiar with these 24x7 ways to be in touch and in the know. Many may find their devices too complex, in constant need of patches and upgrades – and they rightly worry about data security and protecting themselves from fraud and identity theft. In general email and online portals are still more appealing to older users due to familiarity however social media sites like Facebook and twitter are beginning to gain traction.

**Health and Wellness** : The risks associated with obesity and lack of exercise only worsen with age. Companies like Quell for pain relief, MedMinder for medication dispensing, and Thrive365 for pre-diabetes have done well and started to gain some traction. But some technologies have undergone public questioning – Fitbit became the target of a class action suit in January and cognitive fitness technology efficacy claims have been questioned by the FTC. Online weight loss tools have proven popular – MyFitnessPal and its 120 million users were acquired by UnderArmour in 2015 and WeightWatchers has been on a fitness/workout tech buying spree. For chronic disease management, vendors like Medtronic or AliveCor offer systems for tracking chronic diseases like diabetes or congestive heart failure. However, remote patient monitoring technology has not benefited from studies that indicate little difference in outcomes.

Learning and Contribution: In 2006, Joseph Coughlin of MIT's AgeLab applied "Maslow's Hierarchy of Needs" to Aging in Place. This seminal document noted that once the basic needs of communication, safety, and health are addressed, people have both the need and capacity to continue to learn, stay active in and knowledgeable about society, contribute to it through volunteering and continued work, leaving a legacy of stories, not just money, for those who love them. Seniors can sort among online programs and auditable courses found through sites like SeniorNet.org, Osher Lifelong Learning Institutes, AARP TEK, OATS or WorkReimagined.AARP.org.

# 6. Incumbent technology solution for aging in place

#### Staying sharp with brain training games

The past decade has seen the development of the so-called "Digital Brain Health" – technologies and methodologies are aimed at better monitoring and enhancing cognition across the lifespan. Senior living and Healthcare is the 2nd largest customer segment (1st is general consumer), \$315M today, growing to \$1.8B by 2020. For adults over 50, "staying mentally sharp" out ranks Social Security and physical health as the top priority and concern. "Brain-training" is a relatively new field of neuroscience but over 200 companies are working on products with varying degrees of results.

Cognifit is a healthcare company that develops such online cognitive assessments and brain training computer programs. The company was founded by Professor Shlomo Breznitz who has over 30 years of experience developing computer programs to improve mental acuity. In 2003 a patent was assigned to Cognifit that was described as, "A method for testing and/or training cognitive ability, including the steps of testing a preliminary cognitive level of a user and receiving results representative therefrom. According to the results, the cognitive level may then be broken up into separate discrete cognitive skills, and one or more tasks may be created, each task related to each of the separate discrete cognitive skills. The one or more tasks may then be presented to the user and so that a current cognitive level of the user is retested, and results representative therefrom are received. This process may be repeated at least one time." Cognifit main program, MindFit, is installed in retirement and assisted living facilities. Cognifit is described not as a game but

as a brain training program design to improve memory and attention span. First the program measures 14 different skill areas, and then provide targeted training for each area that continually adjusts to an individual's changing acuity. According to the company, the program was able to improve cognitive abilities of their users by up to 40%.

Lumos Labs, founded in 2005, launched Lumosity.com in 2007 and has as of today over 70 Million members for a revenue of \$24 Million. Lumosity is also an online program consisting of games claiming to improve memory, attention, flexibility, speed of processing and problem solving. But there is limited independent evidence that these games are effective and the company's claims for them have been found to be misleading by the United States District for the Northern District of California, leading to a \$50 million settlement. The commission found that Lumosity's marketing preyed on consumer's fears about age-related cognitive decline, suggesting that games could stave off memory loss, dementia and even Alzheimer's disease, without providing any scientific evidence to back its claims.

Lumosity and CongniFit are just 2 representative companies out of hundreds aiming for the "brain training" segment. This is a new field addressing a very valid concern of growing dementia among seniors but the underlying science is still new and the products still immature. As these products go mainstream with consumers and healthcare providers, Big Data and cloud based applications will enable a better evaluation of their efficiency and one can expect major improvements. Better personalization of the brain health solutions is another avenue to be looked into.

## Wearable technology at the rescue of seniors

Wearable technology has seen a large number of products on the market over the past months and some wearables can help elderlies and their families with their everyday life.

Tempo can keep seniors safe by notifying if something is wrong. It is worn as a wristband and aims to predict the early signe of ill health. The BodyGuardian Sensor performs cardiac ECG and rhythm monitoring. A body worn sensor allows individuals to remain active an independent while their heart rate and general health are being monitored. The patient data is wirelessly delivered to the Preventive Care Platform, a cloud-based mHelath

platform that collects real-time data from devices and delivers information to physicians

CarePredict focuses on safety in the home. Worn on the wrist, it combines motion and location sensors to detect behavior. The software then figures out what the activities are and transmits data wirelessly through a hub to be analyzed on the company's servers. Most important, during the first week, it learns what the person's normal activity patterns are and sends an alert via text message, email, or an app, to be introduced soon, if it senses a change. Lying down in the living room one afternoon might indicate a nap, but spending the whole weekend in bed could mean something more serious and require follow-up.

BeClose has a different approach. A caregiver just places sensors around the house to track normal routines. To keep privacy for them no cameras are involved. BeClose can detect if a senior hasn't gotten out of bed for a longer period of time or they skipped a meal and notify the caregiver by text, email or phonecall with something is out of ordinary,

UnaliWear addresses the segment of seniors not really familiar with technology. There are no buttons to press, you just have to speak into the device. It is a wristband that gives simple direction on how to get home and reminds seniors to take medication. It also provides with on-call emergency assistance. Voice activated assistance will connect to an operator who will confirm if emergency assistance should be dispatched on location. If help is activated and no one responds, the emergency contact or medical assistance will be contacted immediately. Unaliwear has artificial intelligence capabilities that learn the wearer's lifestyle and determine when something out of the ordinary happens. If someone takes an unusual route, the system can ask whether the person needs directions. Should the individual head the wrong way, a medical operator can be alerted.

These are again just a few examples out of crowded field of wearables aimed at the senior market. Coupling these devices with Cloud, AI and Big Data will undoubtedly lead to more innovation over the coming years.

#### Active biosensors for Seniors

Monitoring isn't the only us of the wearables for elderly-focused wearables.

Seniors have tendency to fall and injure themselves. Active Protective can help them in this area. This smart garment detects a fall before they hit the floor. It uses accelerometers to determine falls and crashes are in progress and then deploys wearable airbags in textile in order to protect hips from braking – hip fractures have big occurrence in the older population.

WalkJoy is aimed at helping seniors with neuropathy who have trouble maintaining balance and walking. Individuals who suffer from the nerve problem—most of whom are older—lose feeling in their feet and sometimes calves and knees and, as a result, find it difficult to determine where their foot is in space, leading to frequent falls. The device, which fits right below the knee with a Velcro strap, contains a variety of sensors able to detect velocity and the angle of the foot. With that data, the system fires on the heel as it strikes the ground, causing the motor system to revive and sending appropriate messages to the brain. As a result, the wearer can walk. The Long Beach, CA-based company's co-founders began developing the product five years ago; they started selling it at the end of last year, after getting FDA approval.

# Challenges in technology adoption within senior care industry

Technology adoption within the senior care industry has been slow to several factors; the highly fragmented nature of the industry prevents the creation of a truly end-to-end platform. There are also regulatory hurdles and channel complexity that increase the cost of deploying new technologies in this space . Lastly there has been limited focus on user experience for these solution and has resulted in sub-par experiences for seniors. The senior care ecosystem has a number of stake holders that ranges for the caregivers to the senior's themselves and technology deployment has to take those complexities into account when they are design solutions for seniors.

A recent report done by Philips healthcare and Geogetown University identified how technology factors into the caregiving relationship. The study showed that caregivers are unintentional barriers to technology adoption by the older adults or seniors in their care. The needs of both consumers are, at times, competing: caregivers are primarily focused on the physiological and safety needs of their care recipient, while care recipients prioritize staying socially connected and engaged. In this context, the research revealed that seniors are being underexposed to new technologies despite their openness to trying them. They are underutilizing technology that could not only enrich their lives, but also enable them to be more independent and feel socially connected.

The study also reveals that some caregivers are unconsciously disregarding enrichment as a goal in their care recipient's lives, instead focusing on the functional and practical duties of each day. Caregiving becomes a threshold event – one that transitions the relationship into a transactional one with the focus on a series of tasks to be accomplished.

# 7. What robotics could bring to the future of senior care

There are applications areas where robotics can make a difference for seniors: monitoring, assistance, and social support.

# Monitoring

Monitoring means watching over seniors and alerting them, family, or health care providers when a senior is in trouble or could be in trouble. There are many examples of such technology from the simplicity of FitBit (<u>https://www.fitbit.com/</u>) and similar technologies all the way through very sophisticated home automation systems and robots. These technologies provide an exciting look into the future, capable of augmenting or perhaps replacing continuous nursing checkups on the health of the elderly.

In their April 2012 journal paper, "A review of wearable sensors and systems with application in rehabilitation" (<u>http://www.jneuroengrehab.com/content/9/1/21</u>), Patel et. al. discuss both

wearble sensors and remote monitoring technology and their benefits thereof:

"Wearable sensors have diagnostic, as well as monitoring applications. Their current capabilities include physiological and biochemical sensing, as well as motion sensing [6,7]. It is hard to overstate the magnitude of the problems that these technologies might help solve." They cite in their paper systems that go as far as being full body sensors such as the Smartex system shown at right.

"Remote monitoring systems have the potential to mitigate problematic patient access issues. Nearly 20% of those in the US live in rural areas, but only 9% of physicians work in rural areas [8]." They show one such class of systems they refer to as "ambient" monitoring technology shown at right, a host of sensors placed throughout the home to monitor senior well-being.





From their 2014 article in http://deloitte.wsj.com/cio/2014/07/28/usingsensor-technology-to-lower-elder-care-costs/, consultants Anni Ylagan and Andre Bierzynski discuss "numerous medical alert systems ... that make it possible for seniors to call for help using small electronic communications devices typically worn as a bracelet or pendant. While these devices can be helpful in the event of a fall or a home emergency like a fire, their capabilities are limited." They go on to discuss how researchers "are experimenting with more advanced smart sensor networks that provide remote caregivers realtime insight into the health and well being of in-home patients." As examples, they cite research teams led by Diane Cook, Ph.D., of Washington State University and Nirmalya Roy, Ph.D., of the University of Maryland, who "are exploring how to retrofit homes with sensor networks that monitor a resident's behavior and activity levels. These sensor-enabled homes use machine learning to recognize behavior patterns such as eating, sleeping, and movement, and then identify and report any signs of illness or cognitive degeneration to caretakers and physicians via the Web or mobile networks."

In his January 2016 article, <u>http://www.homecaremag.com/aging-place-features/january-2016/how-technology-will-impact-home-health-care</u>, Dr. John R. Patrick states that robots "will take on a wide and significant role in home health care in the years ahead. There is a shortage of nurses in health care." As an an example of a monitoring "robot," he cites "AliveCor[,] an FDA-approved heart monitor that attaches to the back of an iPhone. The consumer simply holds two fingers from each hand on the back of the iPhone, and in 30 seconds, the AliveCor device takes the equivalent of a single-lead electrocardiogram (ECG). The device saves the ECG data in the iPhone..."

In her January 2016 article, <u>http://www.homecaremag.com/aging-place/january-2016/17-disruptive-tech-ideas-senior-industry-needs</u>, Carol Marak cites a number of industry leaders describing how they see technology disrupting the home health care industry with respect to monitoring:

- "Kathy Birkett, Senior Care Corner: I would develop a wholehouse automation technology solution ... An intelligent sensor would monitor the health and safety of the person and make a report when the senior's situation met designated parameters, thus maintaining everyday privacy."
- "Joy Loverde, The Elder Industry: Proactive wellness wearables that have an education component. People are motivated when

they see results. The device could measure fat, calories, weight, sugar levels and blood pressure."

- "Gjenes Belamide, Bay Alarm Medical: I would build a 100 percent guaranteed working fall detection system worn like a watch."
- "Michelle Jeong, Reminder Rosie: ... LifeAssist's latest product, Circura (a connected day-to-day care management app), removes the hurdles by offering an actual end-to-end care platform to connect anywhere and to any device."
- "Rhonda Caudell, Endless Legacy: ... With cameras around the home, the same person can get an environmental and identify safety issues.

The trend here is a combination of technologies:

- Wearables: devices seniors have on their persons that monitor their biological and emotional well-being and are connected to healthcare workers remotely via wireless technology.
- "Static" (aka "ambient") monitoring "robots" placed throughout the home that monitor a senior's well-being.
- "Dynamic" monitoring robots that can move around the home monitoring the well-being of the seniors, and as we will discuss later, perhaps interacting with them as a means of alleviating loneliness.

All three types of technologies will in the future make their way into the lives of seniors as a means of monitoring their well-being.

# Assistance

Assistance means providing care in some manner to assist seniors in everyday living. Related to monitoring, where monitor is more passive, "assistance" means active care – robots performing actions to help the well-being of seniors.

The most publicized/well known of assistance is perhaps automated transportation such as the self-driving car. In her January 2016 article, <u>http://www.homecaremag.com/aging-place/january-2016/17-disruptive-tech-</u>

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#### Sutardja Center for Entrepreneurship & Technology Technical Report

<u>ideas-senior-industry-needs</u>, Carol Marak cites these senior health care leaders on their position for transportation on how it might work:

- "Anthony Cirillo, The Aging Experience:
  - Senior transportation is one of the biggest issues facing elder care. Being isolated and socially deprived has consequences. While Uber and others have stepped up, a complete solution is lacking.
  - One call, email or text to a central hub should be able to activate transportation solutions in a geographic area and seamlessly pay for it, while assuring safety and quality."
- "Tim Murray, Aware Senior Care: Develop Autopilot car technology."

Clearly, self-driving vehicles will revolutionize senior life. May companies are actively working on this technology, such as Google, NVIDIA, Samsung, and a host of other high tech companies. In addition, most of the auto manufacturers are working toward this end.

#### In his 2010 article

(<u>http://www.gizmag.com/twendy-one-robot-elderly/14496/</u>), Darren Quick indicates that Japan, a country that "faces a rapidly aging population," has deep "concerns about how the elderly will be cared for in their twilight years. Japan being Japan



has turned to robotics with researchers developing robots to assist the elderly with everything from exercise and independent living to shopping." He goes on to describe "Twendy-One", a robot "designed to co-exist with humans and assist with nursing care and housekeeping."



A more subtle and interesting "active" technology was cited by Laurie M. Orlov in her March 2012 article, <u>http://www.homecaremag.com/top-10-</u> <u>technology-devices-seniors</u>, regarding **TabSafe (**<u>www.tabsafe.com</u>). This is a "medication management system reminds, dispenses, alerts and posts information on compliance, inventory and other health information that is accessible from any Internet

capable device." The TabSafe device dispenses medication, allowing "medication ... inserted by the pharmacy, homeowner or caregiver into a

cartridge [to provide] one tablet or dose of more than one to be released at a time."

In her May 2015 article in the Huffington Post (<u>http://www.huffingtonpost.com/2014/05/28/robots-care-for-elderly\_n\_5331956.html</u>), Nicole Edine discusses "The 6 Robots That Will Wash And Feed Us When We're Old." These ideas take us down the path of effectively having automated servants in the near future. She cites



Assistance bots implies "dynamic" like with the "monitoring" bots, but as said, with an active characteristic that will not only monitor a senior's wellbeing, but can take an active role in making their well-being and style of living more comfortable.

# Social Support

Social support means helping seniors tackle the problem of loneliness and isolation that comes with aging and less mobility.

In her March 2012 article, http://www.homecaremag.com/top-10-

technology-devices-seniors, Laurie M. Orlov cites BeClose (<u>http://www.beclose.com/</u>) as an example. Using "discreet wireless sensors placed in the home, BeClose tracks an elderly loved one's daily routine. Caregivers are able to check on them at any time using a private, secure web page. If there are any disruptions, remote caregivers will be alerted by phone, e-mail or text message."



In his 2015 article, <u>"Robot Love: Making Robots that are More Human"</u>, Steve Keeping of Mouser Electronics notes, "[one] strategy to rein in the healthcare budget is to encourage seniors to accept routine treatment at home by trained caregivers rather than in hospitals by expensive medical

professionals." "As some researchers are eager to suggest, robots could provide the answer by stepping (or rolling) in to replace human caregivers."

For example, "homecare robots such as Giraff, created by Swedish company Giraff Technologies AB" have been under development for some time now.

"The Personal Robots Group at MIT's Media Lab have ... robots that can make stronger social and emotional connections." They have "developed a range of robots including one called Nexi that can blink, shrug, and make facial expressions (Figure 2)."

"Aldebaran, a French company primarily owned by Japanese telecom firm SoftBank, is among the first to develop a cyberconscious robot." "The firm created Pepper (Figure 3), an interactive robot that ... is able to detect human emotions and choose the ideal way to communicate with the person. The robot listens to voices and analyzes body language and can modify language and gestures to adapt to a given situation."

"OMRON's global research and development group has developed the OKAO Vision system, which can recognize different faces through analysis of facial features."

More recently, in her January 2016 article, "http://www.homecaremag.com/aging-place/january-2016/17-disruptive-techideas-senior-industry-needs, Carol Marak cites

Steve Hays from Artower Advisors: "A humanoid robot that can assist with all ADLs and display empathy" as something that would "transform the [senior care] industry."

Social support robots are perhaps the last piece of the robotic puzzle, perhaps being the most technologically sophisticated piece due to the inherent

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nature of the problem: intelligently interacting with seniors and perhaps replacing human contact while alleviating senior loneliness.

# 8. Conclusion

In conclusion, the aging in place market is not served optimally. In the current industry, seniors very often fall in either a "overcare" situation or an "undercare" situation due to a combination of unfit solutions, financial constraints or family environment. The care industry is also extremely fragemented due to low barriers to entry and state and local regulations that are not well harmonized.

The overall landscape is ripe for disruption and consolidation incumbents are poorly positioned to solve the overwhelming needs. As technology evolves, disruptive changes shall occur in the three areas needed to keep seniors in their homes, centering on care: physical, mental, and dayday

# 9. References

- 1. <a href="http://www.cnn.com/2012/06/24/living/baby-boomer-divorce/">http://www.cnn.com/2012/06/24/living/baby-boomer-divorce/</a>
- 2. <u>http://blogs.wsj.com/economics/2015/11/23/more-young-adults-live-with-</u> <u>their-parents-now-than-during-the-recession/</u>
- 3. <u>http://www.theguardian.com/lifeandstyle/shortcuts/2015/nov/24/silver-</u> separators-over-50s-divorce-splitting-up-children
- 4. <u>http://www.gallup.com/poll/182939/americans-settling-older-retirement-</u> <u>age.aspx</u>
- 5. <u>http://www.gallup.com/poll/182921/nonretirees-expect-rely-social-security.aspx?utm\_source=Economy&utm\_medium=newsfeed&utm\_campaig\_n=tiles</u>