Chapter

The Evolution of Elderly Telehealth and Health Informatics

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Abstract

Many elderly individuals experience memory loss and often dementia as they age. This causes problems for the elderly due to diminished skills and increase in medical problems and natural decline. The Veterans Health Administration (VHA) introduced a national home telehealth program, Care Coordination/Home Telehealth (CCHT). Its purpose was to coordinate the care of veteran patients with chronic conditions and avoid their unnecessary admission to long-term institutional care. Such programs are cost-effective. Long-term care insurance companies are likely to cover these services. Home care and nursing home corporations are following the VHA's lead. We have recently witnessed significant advances in technology. Internet and mobile applications have opened a new world, providing information and opportunities for individuals to learn more information about illness and at a much faster rate. Smart home technology has evolved. Elderly patients often encounter difficulties using these technologies. Despite the advances in telehealth and telemedicine and the evolution of the technology, many individuals cannot afford the treatment or the technology. These same individuals and families are part of the digital divide, and they have not embraced the new technology. Federal programs have been developed and implemented to help this portion of the population.

Keywords: National Home Telehealth Program, Internet applications, Smart Home Technology, Telemedicine, Health Informatics

1. Introduction

As individuals age in the United States society, they receive benefits once they reach 65 years of age. They are considered senior citizens and receive many discounts from corporations as well as Social Security and Medicare financial benefits. The older individual frequently slows down mentally and physically. Many elderly individuals experience memory loss and often dementia as they age. This causes problems for the elderly due to diminished skills and increased medical problems and natural decline.

In the last 20 years, we have witnessed significant advances in technology. Internet and mobile applications have opened a new world, providing information and opportunities for individuals to learn more information about illness and at a much faster rate. Elderly patients often encounter difficulties using these technologies. Younger people adopt new technologies much easier, with much shorter learning curves. Internet and mobile applications are written by younger people and

are more frequently used by them. The applications are not rewritten to make it easier for elderly people to use. Every day the elderly person encounters new problems such as physical ailments. The provost at a large public university stated "Every day I find a new problem or disability that I will have for the rest of my life" [1]. The technologies to resolve these problems are written by younger people who have many applications on their phones. The elderly person often does not have the interest to install these applications on his or her phone or to use the application. The elderly view such technologies as challenges rather than the benefits that they are designed to produce.

In this paper, we will examine how the elderly will adopt health information technology and the barriers to such adoption. We will then discuss the emergence of smart home technology and how it will be implemented in the homes of older adults. We will explore how caregivers will be trained and the impact of such training on the adoption of telehealth technology by the elderly. The groundbreaking work of the Veteran Administration with their introduction of Care Coordination/Home Telehealth (CCHT) will be discussed in detail. The hospital at home model introduced by Johns Hopkins University Hospitals will be explained. The evolution in health informatics and telehealth will also occur in nursing home corporations and home care companies. The rationale for such expansion will be explored. Recent technology advances in smart homes will be further discussed. The authors will then describe how an elderly person should go about implementing telehealth technology in his or her home and the efforts of academic institutions to develop training programs for caregivers and home care professionals.

2. Challenges to health information technology (HIT) adoption by older adults

Advances are being made in the implementation of the electronic health record (EHR), speech recognition, and telemonitoring with elderly patients in their homes. The electronic health record helps the elderly person keep track of their healthcare problems, such as which problem was treated by which health professional, when treatment occurred, and the outcome of those treatments.

EPIC software, a major electronic health record vendor in the United States, produces *MyChart* patient portal for all its patients and educates them on its use while in the hospital [2]. EPIC is the EHR system for many large healthcare organizations such as Cleveland Clinic, Geisinger Health System, and the Mayo Clinic. Other software vendors offer similar EHR chart products. Every year the elderly person will have outpatient visits to many different professionals, primary care, cardiologists, dentists, physical therapists, chiropractors, podiatrists, etc. Although each of these professionals has their own specialized EHR systems, the different vendors are building links to allow the systems to transfer information between different EHR systems. This is termed *interoperability*. The US federal government is constantly helping EHR vendors to make their systems communicate in a streamlined fashion. Fast Healthcare Interoperability Resources (FHIR) [3] is a standard to help achieve healthcare information systems' interoperability. FHIR uses HL7 messaging standards which are widely implemented by the healthcare industry and have been deployed internationally for decades. HL7 Version 2 health information exchange standards are a popular choice of local hospital communities for the exchange of healthcare information, including electronic medical record information [3].

Today's healthcare providers have a primary focus of improving elderly patient outcomes. Each healthcare facility faces a need to choose strategies that are most suitable to ensure provision of information system and communication technology

[4]. One of the key priorities for governments and healthcare providers around the world is postponing disability and dependency in later life [5]. Hospital-based patient portals have the potential to better inform and engage elderly patients in their care. MyChart is an electronic healthcare record portal that allows elderly patients online access to their medical records. These records are secured to provide privacy for the elderly patient. Bedside mobile tablets are now available to elderly patients while they are inpatients. These tablets allow real-time views of their results. It also has the capability of communicating with the nursing staff via electronics. These coordinated care networks are designed to drive higher-quality care as well as give the elderly patient a sense of control over their healthcare.

Healthcare is now being aimed toward focusing on meaningful use of care by engaging the elderly patient through online access and bedside tablets, allowing coordination of their own care. This focus is directly related to future impact of such involvement with the patient knowledge, elderly patient knowledge, and how such engagement will affect the delivery of care. Lack of communication often leaves the elderly patients unclear as to why tests are being ordered and why specialists have been consulted; such tools will allow the open forum for real-time questions to be asked. The purpose of these tools is to resolve communication gaps between the healthcare team and the elderly patients. The term e-patient was coined long before the advent of Internet to describe patients who take an active role in their health and healthcare by being equipped, enabled, empowered, and engaged [6]. Although e-patient is a pioneering concept, this concept will be explored through transformational and innovative methodology of healthcare technology.

Communication and compliance have long been challenges to the healthcare system especially with the elderly demographics. Maintaining a comprehensive continuity of care between providers and elderly patients has been an important challenge to hospital settings and the healthcare teams. Elderly patients today are more complex than ever for a multitude of reasons. These elderly patient populations often have multiple active disease processes, undergo numerous tests, and receive complex treatments during any hospital stay. This complexity has been found to have incomplete comprehensive care and less optimal engagement in their care [7].

Electronic healthcare systems have changed and continue to evolve in all aspects of healthcare and the delivery of our care. As with any change, this initiative has caused excessive excitement, anxiety, resistance, and conflict in every aspect of the healthcare setting especially with the elderly. To successfully implement, manage, and lead toward use of electronic healthcare records, leadership must work directly with the clinical, administrative, and technical people in their organization along with special training to teach the elderly generation how to utilize this technology. Nursing theories provide a foundation for supporting and managing the enormous degree of change experienced by the healthcare system and the people within any healthcare system [6]. Currently there is no single comprehensive, generally accepted theoretical, or conceptual model of health or nursing informatics [6]. Some of the key components in theory-based learning principles can apply to both the healthcare team and the elderly patient-centered care. Each learner is an individual with their own approach to learning, meaningful information to support retention; active engagement and participation also support long-term retention; conceptual learning is enhanced with concrete realistic examples; learning is enhanced when the teaching includes cognitive, affective, and psychomotor domains in concert; and learning is contagious. These are all examples of theory-based learning for both healthcare and elderly patients [6]. Educators need to be cognizant of their patient population to utilize the age-appropriate approach when teaching the elderly patient.

Many hospitals have incorporated the education and teaching of the use of MyChart into their discharge process. After visit processes are no longer just an act of handing the patient a discharge paper to sign, which are strategic and purposeful. This is especially important for the elderly patient population. Most organizational healthcare teams have daily patient flow rounds. These rounds are designed to establish needs of the patients to include reporting of which patients have signed up for the use of MyChart. The discharge process has the independent codes for the patients printed on the discharge papers. The nurse spends time educating and teaching the elderly patient population how to sign up for the use of MyChart. Once these patients are signed up, they continue to teach them how to set up their post-discharge appointments with their healthcare teams. They are shown how to look up results from laboratory work, the reconciled medication list, future appointments, future screening testing that is necessary, and any essential needs that may be pertinent to the elderly patient. The nursing staff is trained to assess the cognitive level of comprehension of their patient in their teaching. The nurse must determine if the patient understands or needs reinforcement. This piece of education is integrated into the patient's permanent charting. Often the elderly patient has a caregiver of some sort accompanied with them to support the teaching of this elderly patient population. This is very important during the educational discharge process of the elderly. The entire process is a patient-centered care coordination related to the elderly patient population. This training on bedside tablets by the staff member occurs when the patients are in the hospital. This knowledge of how to use the technology can be more easily transferred to the patient in his or her home once the patient is discharged.

The use of MyChart and/or any other EHR is considered one of healthcare's performance measures. The key performance indicator (KPI) report is printed out monthly to give a score card for the performance measures. This metric is a well-defined performance measurement used to monitor, analyze, and optimize healthcare processes to increase patient satisfaction and patient quality care. The use of this score card is to determine if the organization is meeting targets that are set up for the EHR in the system. These reports give a scorecard of the activation rate and percentage, the patient satisfaction rate with the access, and the domestic utilization related to the use of MyChart or electronic information technology. There is no data to determine age demographic yet with the KPI scorecard.

Another modality linked to the MyChart capability is the MyChart Evisit. An Evisit is an online visit available through MyChart with a primary care provider. This is a fast, affordable, and secure way to receive an online diagnosis and treatment plan for common medical conditions. It allows the elderly patient to remain in their home and still manage their healthcare needs. All communication related to the Evisit occurs in writing. There is no video, visual, photo, or verbal contact between the elderly patient and the primary care provider. This modality allows the elderly patient to seek medical advice for low acuity conditions. The patient fills out an available questionnaire about their symptoms and submits to a provider. There is a general charge of $36 for the Evisit. Many insurance plans cover the Evisit; however, the coverage does vary. The Evisit is designed for nonurgent conditions. If the provider feels the condition requires an emergency room visit or in-person visit, they will cancel the Evisit and notify the patient via online MyChart.

Here are some of the common conditions that are available for an Evisit:

Acute eVisits	Chronic condition follow-up eVisits
Sinus, cold, and/or cough	Seasonal allergies follow-up
Back pain	Insomnia follow-up

Acute eVisits	Chronic condition follow-up eVisits
Diarrhea	Hypothyroid follow-up
Urinary problems	Hypertension follow-up
Heartburn	IBS follow-up
Headache	Osteoarthritis follow-up
Rash	Diabetes follow-up
Vaginal discharge	Migraine follow-up
Pink eye	

The direct patient access via patient portal, MyChart, is designed to improve patient engagement with the elderly population. It is believed that through this access the elderly patients will feel a sense of ownership of their results and patient care. The ability to view results is another modality available through MyChart for the elderly patient population. It is thought that if elderly patients can view results prior to visiting their physicians, it would allow time to absorb and prepare with valid questions regarding their healthcare. One goal that is noted is that making abnormal test results available to the elderly patient population would improve patient safety by increasing the likelihood of elderly patients following up on the abnormal results [8]. This is believed to increase compliance with this elderly patient population which will have a direct impact on nursing and patient care. The approach of delivering the patient portal direct access is to manage the process that may result in more effective and efficient healthcare delivery system [6]. This technology described is to assist in nursing practice to accommodate in education and teaching methods for the elderly patients. This education and teaching is designed to directly impact the patient care for the aging patient population through increased compliance and knowledge regarding their medical condition.

When dealing with any healthcare records, there is always the ethical consideration to be considered. Electronic medical records are beneficial in a multitude of ways; however, security and confidentiality are of upmost importance regarding the data. The patient has the right to have their information. This information is only to be released to unauthorized persons with the consent of the individual. Of course, there must be consensual documentation for participants to be included in any kind of research or study performed. Data integrity refers to the accuracy and consistency of stored and transmitted data that can be compromised when information is entered incorrectly or deliberately altered [6]. Privacy and confidentiality are at the forefront of concerns when it comes to electronic healthcare records. Despite regulatory requirements and governed control of records, major issues related to privacy and security need to be addressed prior to nationwide interoperable EHR being fully implemented [6]. Patient portals will be secured by security and pass codes that only patients will have access to. There is the thought that the elderly patient population will be apprehensive about the fact that if they can have mobile access to their information, so may the public. This apprehension related to privacy of healthcare information is one of the challenges that healthcare providers need to be forthright about when dealing with the elderly patient population. There is still the ambivalence of protection of information with the elderly. Despite this barrier, healthcare providers maintain the initiative to educate and bring the elderly on board with new technology and the benefits to this patient population.

Some elderly patients use healthcare standard systems like Microsoft HealthVault since it provides a platform in which the individual can merge their healthcare information [9]. The purpose of electronic health records is to provide a

vehicle where all the patient's records can be stored. Each of his or her providers can identify all the treatments and results that the patient has received. Since interoperability between such EHR systems has not been achieved, the patient often turns to HealthVault to combine all his or her records. Since the elderly person visits many providers, he/she or a family member can use HealthVault to merge their EHR records. Health information technology programs are written and used by young people. The elderly use technology less frequently and are not as familiar with the options and health information technology processes. In addition to electronic health records, the elderly will need to learn several pieces of this new health technology. Elderly who have used computers in their recent work life are more likely use HIT in retirement [10]. Lack of trust in HIT systems is often a major barrier. Numerous passwords and unfamiliar HIT procedures may also cause problems for the elderly and reduce usage.

For 60 years, the elderly population has relied on professionals for healthcare. Elders were asked to rank information received according to their level of trust. Health information on the Internet ranked behind clinical HIT sources and magazines and newspapers [11]. Elders are vulnerable to scams and abuse, especially with financial and healthcare and prescription drugs [12]. Wild et al. [13] found that older adults in home settings will accept surveillance and sharing of health information if it can be used by their physicians to preserve the elderly person's health. The network of sensors monitors the condition of the subject under supervision and sends the information to a distant healthcare facility over the Internet [14], or it can automatically call for EMS in case of an emergency. Some physicians are strongly encouraging their staff members to take the time to help the elderly person learn how to access health information data and use telehealth and telemedicine technology. Many organizations and practices offer additional training for staff members related to HIT but are especially aimed toward providing the necessary tools to educate the elderly population.

Interoperability among different treatment protocols and standards is also critical for the consistent operation of the system. In addition, precise and accurate measurements of key health parameters are vital for a reliable health monitoring system. The advancement of miniaturized and inexpensive sensors, embedded computing devices, and wireless networking technologies is paving the way for the utilization of remote health monitoring systems. Remote health monitoring allows unobtrusive, ubiquitous, and real-time monitoring of physiological signs without interrupting the daily activities of individuals.

Patients are now able to remain in their familiar home environment and enjoy their normal lives with friends and family while their health is being monitored and analyzed from a remote facility based on the physiological data collected by different on-body sensors. The system can perform a long-term health trend analysis, detect anomalies, and generate alert signals in case of an emergency. The problem may be that the elderly person must remove these sensors to complete some activities of daily living such as showering or bathing and then may forget to put the sensors back on. This is a burden that each elderly person who has sleep apnea experiences each evening even though the technology has been in place for several years and the sleep apnea process is well known to the elderly person.

By most estimates, the average trip to the emergency room (ER) in the USA costs $1500 to $2500. Recent research from the Centers for Disease Control estimated the number of trips per year to be 136.3 million [15]. The CDC's research also showed that the number of injury-related visits to the ER was 40.2 million, meaning that the other nearly 100 million visits might have been avoided with preventative care. A visit to a doctor's office costs significantly less on average than a trip to the ER, so the USA and other countries are desperately trying to find a way to cut down

on the number of avoidable ER trips made each year. The cost of such visits can be further reduced using telemedicine and telehealth.

3. The emergence of smart home technology

"*One of the possible solutions is the development of smart medical homes that can measure patient health and alert both the individual and a medical professional if a problem arises. These homes—and the individuals themselves—can be outfitted with machine-to-machine (M2M) medical devices that use sensors to monitor patient health and can transmit information to healthcare workers. So, what would a smart medical home look like? One feature might be to have the individual connected to a wearable device that monitors glucose levels for a diabetic patient. Even the person's sneakers could be outfitted with sensors that function as gait monitors to measure changes in walking patterns, stumbling and falling. Over time such devices would detect a limp or shuffle that could be a symptom of a more serious illness or injury. As these kinds of products become staples of the home environment, they will occupy a larger piece of the total M2M market. Recent market analysis from Juniper Research, for example, projects the smart wireless healthcare and fitness device services market will reach $1.8 billion by 2019*" [16]. Because home-based M2M medical devices monitor critical vital signs, they must be supported by reliable wireless connectivity and have the capacity to transmit data steadily and quickly.

"Long-Term Evolution (LTE) has been recently introduced. Because LTE is a cellular connection rather than Wi-Fi, a patient can be monitored anywhere there is LTE coverage" [17]. This flexibility allows them to enjoy their independence without worrying about staying connected. A 4G LTE certainly fits the bill, but for many years the technology was considered too expensive and consumed too much power to be viable for these kinds of devices. That paradigm is now shifting, with the advent of low-power 4G LTE chipsets that conserve power and battery life by controlling data flow. These chipsets make the prospect of building 4G capability into devices more financially feasible for manufacturers and will, ultimately, increase adoption of connected medical technology. On top of the potentially massive economic benefits these new-age homes may provide, they will also help at-risk individuals avoid medical scares and give their families peace of mind. In other words, the smart medical home concept is moving forward and 4G LTE will help push it along. For this technology to be implemented, the elderly person will have to embrace this technology. Herein lies the problem, the elderly person will have to learn how to implement the technology and how to use it effectively. Caregivers will need to be trained so that he or she can help the elderly learn about the technology, implement it, and use the technology on a daily basis. For example, sleep apnea technology is used effectively by the elderly population on a daily basis.

4. Caregivers help the elderly

Numerous Internet and mobile applications have been recently developed which target caregivers for care coordination [18]. If the patient suffers from dementia, there are tools which focus on improving caregiver's ability to help the person to reduce their care burden [19]. The needs of the caregivers are quite different than those of the elderly. The caregiver may be better able to use the technology than the elderly client. The elderly client may be able to be taught how to use the HIT by the caregiver. This will depend on the training program available to the caregiver and the elderly person. As HIT expands, such teaching may grow into a large part of the

caregiver's work in the near future. Teaching the elderly person to use the Internet for health information resulted in the elderly being willing to use the Internet more often [20]. Barriers to decision-making using HIT, information, and communication issues are modifiable [21]. Technology may be the means for the elderly to overcome those barriers [22]. The authors of this paper envision the emergence of laboratories at universities and private business where these skills are taught and certification courses are offered. Home care companies and nursing home corporations will more than likely lead the way and help train the caregivers as well as the elderly themselves. This training will also provide some burden relief of the caregivers and reduce caregiver burnout.

5. Veterans Health Administration (VHA) introduces Care Coordination/Home Telehealth

> *"Between July 2003 and December 2007, the Veterans Health Administration (VHA) introduced a national home telehealth program, Care Coordination/Home Telehealth (CCHT). Its purpose was to coordinate the care of veteran patients with chronic conditions and avoid their unnecessary admission to long-term institutional care. CCHT involves the systematic implementation of health informatics, home telehealth, and disease management technologies. It helps elderly patients live independently at home. CCHT is now a routine service provided by VHA to support veteran patients with chronic conditions as they age. CCHT patients are predominantly male (95%) and aged 65 years or older. The VHA uses strict criteria to determine patient eligibility for enrollment into the program. The VHA staff assesses how well its CCHT programs meet standardized clinical, technology, and managerial requirements"* [23].

> *"The VHA trained 5000 staff to provide CCHT. Routine analysis of data obtained for quality and performance purposes from a cohort of 17,025 CCHT patients showed the benefits of a 25% reduction in numbers of bed days of care, 19% reduction in numbers of hospital admissions, and mean satisfaction score rating of 86% after enrollment into the program. The cost of CCHT was $1,600 per patient per annum, substantially less than other NIC programs and nursing home care"* [23].

Here is the cost analysis of the expected benefit of the VHA CCHT program:

1. $225/day × 17,025 patients × 365 days = $13,981,781,000
2. 25% reduction = $10,486,335,000
3. Savings due to using CCHT = $3,495,446,000
4. Saving per patient $3,495,446,000/17025 patients = $20,531 per patient

The projected number of people over 65 in the USA is 46 million [24].

Let's be conservative and assume that 30% of the elderly (65+) are in need of treatment and can benefit from programs such as CCHT: The Veterans Health Administration estimates that 75,000, or about 50%, of its total patient population, could be cared for with home telemedicine technologies [23]. However in our analysis below, we will use 30%.

5. 46 million × .30 = 13.8 million people.

6. Savings from treating these 13.8 million people using CCHT is 13.8 × $20,531 = $2,833,278,000.

7. Estimates of CCHT savings = $2.833 billion.

The detailed reader may quarrel with the numbers, but it is evident that significant savings can be gained by implementing CCHT.

The VHA's experience is that an enterprise-wide home telehealth implementation is an appropriate and cost-effective way of managing chronic care patients in both urban and rural settings. This positive experience has set the stage for other governmental agencies and private home care and institutional organizations to develop and implement similar services for the elderly. The question is what percentage of the elderly can be trained to use telehealth technology and remain in their residence? 50 or 30 or 10%?

For veterans who have a health problem like diabetes, chronic heart failure, chronic obstructive pulmonary disease (COPD), depression, or post-traumatic stress disorder, getting treatment can be complex and inconvenient. For some, especially older veterans, conditions like these can make it difficult for them to remain living independently in their own home and make it necessary for them to go into a nursing home where their symptoms and vital signs (pulse, weight, temperature, etc.) can be checked frequently. Having this information means providers and nurses can change medications or other treatments and prevent serious health problems from developing.

Now there are new technologies that make it possible to check on symptoms and measure vital signs in the home. Special devices (home telehealth technologies) can do this and are easy to use for some elders. Home Telehealth (HT) can connect a veteran to a VHA hospital from home using regular telephone lines, cellular modem (these act as doors for transmission of information), and cell phones (using an interactive voice response system).

The VHA has found that not every patient is suitable for this kind of care. VA patients must be evaluated and trained. But, for those that are suitable for this kind of care, Home Telehealth can help them to remain at home and live independently. The VHA is hiring staff nurses to be home telehealth specialists. The VHA has demonstrated that Home Telehealth can be a cost-effective alternative to full-time residence in a nursing home. The VHA has demonstrated this technology for veterans.

Private nursing home corporations are following the VHA's lead offering the same technology to nonveterans. Private patient home services are financed by many different methods: long-term care insurance, Medicaid for eligible patients, limited Medicare for short periods, and private pay.

Here is a statement from a popular long-term care insurance company policy:

> *"MedAmerica [25] will provide Daily Benefits at 100% of the actual charges incurred up to the Maximum Nursing home Benefit amount shown in your Schedule of Benefits for Qualified Long-Term Care Services provided by a Nursing Home while you are a resident.*
> *If you are Benefit Eligible, MedAmerica will provide Daily Benefits at 100% of the actual charges incurred up to the Maximum Assisted Living Facility Benefit amount shown in your Schedule of Benefits for Qualified Long-Term Care Services provided in an Assisted Living Facility.*

If you are Benefit Eligible, MedAmerica will provide Daily Benefits at 100% of the actual charges incurred up to the Maximum Home Health Care or Adult Day Care Benefit amount shown in your Schedule of Benefits for Qualified Long-Term Care Services provided in a Home Health Care or an Adult Day Care Facility that are:

1. *Home Health Care or personal care attendant services including such things as: personal hygiene, performing Activities of Daily Living, managing medications and other related support services.*

2. *Adult day care*

3. *nursing services*

4. *Physical, occupational, respiratory and speech therapy*

5. *Homemaker services including light work, household tasks, preparing meals, doing laundry and other incidental household tasks that do not require the services of a trained aide or attendant."*

Although the authors of this paper are not lawyers, it appears to us that MedAmerica and other long-term care insurers will cover the cost of HIT and HT as well as assist the caregivers in the elder's home.

Several **c**ommercial vendors are offering similar telehealth products. Listed below are a few examples:

1. Live Expert is advertised as the "next-generation home healthcare system and remote patient monitoring" [26].

2. HoneyCo, based in Nashville, offers a one-stop shop for the smart home, taking products off the shelf and assembling them into a single, easy-to-use software-hardware platform [27].

As stated above, Home Telehealth technology provides a telemedicine tool for patients to take an active role in the management of their chronic diseases. HT works by allowing patients to transmit vital health data from their home to physicians' offices and, in turn, receive health coaching from their providers based on the clinical data they transmit. A home telehealth system generally consists of a standalone hub device that collects physiologic data from peripheral devices and connects the patient to the provider via interactive/audio/video capabilities. HT tools include audio and video conferencing capabilities, allowing remotely located healthcare professionals to interview, observe, and educate the patient. In addition, HT tools assist in the use of the peripherals or other medical devices. Once again most elderly individuals and couples will need assistance to implement and use this technology daily. The VHA has demonstrated that this can occur and is occurring for eligible and willing veterans. This telehealth technology is transferable to the general population.

Advanced HT tools have the ability to show full-motion video, which can be used to provide patient education. HT tools include audio and video conferencing capabilities, allowing remotely located healthcare professionals to interview, observe, and educate the patient. In addition, HT tools assist in the use of the peripherals or other medical devices.

Despite the large number of health information technologies available in the marketplace, the current installed base of devices still remains relatively small,

particularly in light of the immense target population of chronically ill patients. The majority of devices currently in use are still part of pilot or demonstration projects [28].

6. VA expands telehealth services again with T-Mobile's 70,000 lines

1. *"The US Department of Veterans Affairs and T-Mobile announced that T-Mobile would be adding 70,000 lines of wireless service to increase telehealth services in the VA network and expand services to veterans, especially those in rural areas [29]. The expanding network will connect veterans at home and at VA facilities, such as community-based outpatient clinics (CBOCs), with VA clinicians within the VA network.*

2. *This adds to VA's push this year to extend telehealth to distant veterans in rural areas through initiatives such as with T-Mobile and the Spok Health – Standard Communications partnership to expand the Spok Care Connect messaging service to more VA healthcare systems. The VHA (Veterans Health Administration) has long been the largest user of telehealth services in the US. Until recently, their emphasis has been on store-and-forward and clinic-based patient consults, but finally Home Telehealth (HT) is being supported. Reportedly, only 1% of veterans used Home Telehealth, while 12% used other forms of telehealth. The VA was among the earliest users of remote patient monitoring/home telehealth, dating back to 2003 and even earlier, with companies such as Viterion and Cardiocom.*

3. *While most of the news about VA has been about their leadership changes and their difficulties around EHRs, their 'Anywhere to Anywhere' program was finalized in May 26, 2018. This allows VA practitioners to provide virtual care across state lines to veterans, regardless of local telehealth regulations.*

4. *T-Mobile is already the lead wireless provider to the VA. The 70 K line addition is part of the carrier's $993.5 million five year contract with the US Navy."* The impact of this telehealth expansion will not only facilitate the use by veterans but will lead the way for the private sector to implement telehealth, especially in rural areas.

7. The hospital at home model, Johns Hopkins University Schools of Medicine and Public Health

The VHA, along with other major hospital systems, is exploring methods to discharge patients and continue treatment in the patient's home. The following section depicts the work done at Johns Hopkins on the hospital at home project.

The *hospital at home model* was developed by the Johns Hopkins University Schools of Medicine and Public Health. The framework has been adopted by a number of hospitals around the country, including Veterans Affairs and integrated delivery systems with Medicare Advantage Plans. This model was designed to care for acutely ill patients within their homes. The primary target population is elderly patients with multiple chronic conditions and acute illness or those experiencing exacerbations of their chronic conditions and requiring acute hospital care. Treating patients in the home can save money, reduces the risk of health threats for the

patients (especially for this at-risk population), and opens up hospital beds for other patients.

In 2012, the hospital at home program treated more than 1000 patients throughout the country. These patients are at low risk of clinical deterioration with proper care and are not likely to require highly technical, hospital-based procedures. Hopkins' initial research focused on frail, chronically ill, elderly patients who required acute hospital admission for one of the following reasons: (a) community-acquired pneumonia, (b) heart failure exacerbation, (c) chronic obstructive pulmonary disease exacerbation, and (d) Cellulitis Complex Care Management Program.

This program overview is part of a series describing innovative approaches to caring for complex patients. Funded by the California Health Care Foundation, these overviews are the result of a national scan highlighting programs active in the field that have demonstrated success. "*After their national demonstration study, Hopkins added several other conditions, including: Deep vein thrombosis (DVT); Pulmonary embolism (PE); Dehydration/volume depletion; and Complicated UTI/Urosepsis. The program does not include patients on dialysis. Patients do not have to have a caregiver. The process of patient identification differs among the adoption sites. Patients can be identified using electronic health records, physician referrals, or other methods, such as emergency department (ED) referral*" [30].

Johns Hopkins found that implementation of the program on a wide scale has been limited by the incorrect assumption that hospital care is safer and bypasses payment issues with Medicare. Currently, there are no payment codes for hospital at home care in fee-for-service Medicare. Thus, implementation of the hospital at home model has been limited to Medicare managed care, integrated delivery systems, and Veterans Affairs health systems. A challenge of the model is the difficulty in serving patients across a broad geography. Successful implementations of this model have limited the geography to a 20- or 30-mile radius from the hospital.

The VHA Clinical Research Study of 2007 [23] and the Johns Hopkins hospital at home model have more than adequately demonstrated that such elderly health informatics systems can be effective for at least 30% of the elderly population. We think the training of the patients in the hospitals and the caregivers along with having physician's staff support facilitating the efforts will be instrumental in the elderly embracing this technology. The elderly population are now much more inclined to own and use cell phones than in previous years. They use the Internet to bypass the cable companies and stream television programs on their 4K televisions. Consumer cellular and other phone companies have carved out a business by focusing on the elderly.

8. Nursing home corporations and home care companies

As technology evolves and becomes commonplace, will the large nursing home corporations such as Shepherd of the Valley, Ohio Living—Park Vista, Windsor House, Wesley Village, and Copeland Oaks Retirement Community—and several other corporations across the USA see this as competition? Or will they embrace this new technology and make HIT and HT part of their array of services? Will the home care companies see this as an opportunity to expand their healthcare role? The authors of this paper believe that both the nursing home companies and the home care companies will embrace this technology, lead the way, and offer these services to their clients. We expect that retirement communities will build telehealth technology into their single-family homes and the hospitals will also build such technology into the retirement apartments located adjacent to the hospitals. The

evolution of this technology is just now starting to surface at a growing rate in the elderly population. It is believed as the upcoming years improve upon and master this technology that eventually it will become expected from all patient populations and especially the elderly.

9. The technology that will be functional in smart homes

"Smart homes, which incorporate environmental and wearable medical sensors, actuators, and modern communication and information technologies, can enable continuous and remote monitoring of elderly health and wellbeing at a low cost. Smart homes may allow the elderly to stay in their comfortable home environments instead of expensive and limited healthcare facilities. Healthcare personnel can also keep track of the overall health condition of the elderly in real-time and provide feedback and support from distant facilities" [31]. The elderly may require frequent, immediate medical intervention, which may otherwise result in fatal consequences. Such emergency situations can be avoided by monitoring the physiological parameters and activities of the elderly in a continuous fashion [32]. In most emergency cases, the elderly seek in-patient care, which is very expensive and can be a serious financial burden on the patient if the hospital stay is prolonged [33].

Remote health monitoring in a smart home platform, on the other hand, allows people to remain in their comfortable home environment rather than in expensive and limited nursing homes or hospitals, ensuring maximum independence to the occupants [34]. In recent years, the Internet of Things (IoT) has gained much attention from researchers, entrepreneurs, and tech giants [35] around the globe. The IoT is an emerging technology that connects a variety of everyday devices and systems such as sensors, actuators, appliances, computers, and cellular phones, thus leading toward a highly distributed intelligent system capable of communicating with other devices and human beings. The dramatic advancements in computing and communication technologies coupled with modern low-power, low-cost sensors, actuators, and electronic components have unlocked the door of ample opportunities for the IoT applications. The smart home with integrated e-health and assisted living technology is an example of an IoT application that can potentially play a pivotal role in revolutionizing the healthcare system for the elderly. The full details of this technology are beyond the scope of this paper, but the reader can find significant detail in the previously referenced sensors article [31].

Older adults with complex care needs want to live as independently as they can for as long as they can and limit stress on family and other caregivers. Telehealth strategies offer the potential to improve access to care and the quality of care while reducing strain on caregivers. For healthcare systems, home telehealth may help address the challenge of rising costs. Though limited today, home telehealth is likely to be implemented more widely as policy makers reduce regulatory barriers and providers focus on improving telehealth strategies to meet the needs of families.

The care of older adults with frailty, chronic disease, or significant disabilities who live in the community is a major challenge for both health systems and families [36]. This care can be sometimes rewarding yet simultaneously difficult for family caregivers to manage because of the lack of coordinated care and because of caregivers' competing obligations. As the nation ages, the number of frail older adults with functional and cognitive impairments who require assistance from others will increase. Consequently, planning for the care of people with complex chronic conditions has taken on greater urgency. Providing higher-quality and more cost-effective care for older adults with complex conditions will require models of care that, among other things, better integrate healthcare and social services and

improve supports for family caregivers. To help achieve these goals, telehealth services are increasingly included as a component of community-based care for chronic conditions, mental health, and even palliative care. Through telehealth, providers can deliver a wide range of diagnostic, therapeutic, and care management services, as well as services to support caregivers, such as communication tools with clinicians, services that otherwise would be delivered in a healthcare setting or through in-person home visits. Telehealth has the potential to be an effective tool for improving access and continuity, improving outcomes, and lowering costs. Can the elderly population afford such expense? The answer is yes for a large percentage of the elderly. *Forbes* magazine [37] in March 2018 stated that elderly Americans in the 75+ age group had a mean net worth of $692,100. The typical net worth of the average retiree 65 years and older is $264,750.

The 2016 Federal Reserve Consumer Finance Survey purports there is a national shift toward wealth within the elderly population. There was an upward trend toward the incomes in those over age 75. The report also shows that the increase has occurred rapidly over a 30-year period. This leaves the senior population in the position to create financial support for their families. This fact has created a respect for America's elderly in their ability to support generations of children and grandchildren. The new reality for the elderly in Americans is that they are much more affluent than even those in their 50s. Comparing the data against that of the incomes of the 1950s, the wealth has reversed from the younger Americans to senior citizens [38]. The poverty level for seniors began improving in the 1960s and grew to be equal in wealth to other age groups by the 1980s.

10. Technology implementation is influenced by the "digital divide"

There are still some elderly that experience poverty [39, 40]. There are many that do not have access to the Internet and thus the many online services available for health prevention and promotion. There is some technological division that exists for the poor and rich. Those educated and higher-income seniors are significantly more inclined to have electronic and Internet resources to provide access to a large menu of software programs to manage health issues. There are many challenges in today's society for those who are not technologically skilled. There is a correlation between low income and low access to technology. There is also a direct link to the challenged socioeconomical population and increased physical impairments. This increase in patient impairments provides an even greater need to introduce this technology to such economically challenged elderly populations.

- According to the 2012 Pew Report "Digital Differences," only 62% of people in households making less than $30,000 a year used the Internet, while in those making $50,000–74,999, that percentage jumped to 90.

- Smartphones have helped bridge the divide, as they provide Internet access to populations previously at a digital disadvantage. Pew reports that, among smartphone owners, "young adults, minorities, those with no college experience, and those with lower household income levels" are more likely to access the Internet primarily through their phones.

- There are still gaps in high-speed Internet access. Only 49% of African Americans and 51% of Hispanics have high-speed Internet at home, as compared with 66% of Caucasians. Internet speed has important effects on

media access, especially when it comes to streaming video, so this gap is significant.

A pilot program took place during the Obama Administration whereby the United States Department of Housing and Urban Development (HUD) worked with private businesses and nonprofit agencies to provide Internet assistance to low-income families. The ConnectHome Project brought light to the marked division in those who have easy access to Internet services and the income barrier that exists for many vulnerable groups, including the elderly. The pilot gave 38 communities the special Internet access services. There are many business and organizations that have expectations that the consumer has Internet access. This creates many access barriers for those who lack understanding or income to have Internet access.

The company Comcast has created an impact by providing low-cost Internet hardware and services. There have been over 2 million low-income Americans that have been assisted. The company has committed to offering training and support to assist with the Internet and computer literacy, making the technology purposeful for the people. The company identified any child in the school system who is eligible to receive free or reduced lunch would also determine that these families are qualified to get the assistance. The family will receive the service but also the broadband receiver. There are some that argue governmental involvement is crucial with the Internet divide. Without the support, there would be a larger division by blocking many Americans from educational or employment opportunities. The holistic approach to the problem seems to be creating a positive impact on the barriers that inhibit many from access. The question is Will AT & T, Spectrum, and other Internet providers provide specialized services to the elderly to facilitate the use of not only the Internet but also telehealth and health informatics technology?

11. Implementing telehealth technology in the patient's home

Telehealth and telemedicine are innovative technologies that deliver healthcare to the patient population. Telemedicine is the practice of medicine via technology to deliver healthcare at a distance. It enables the physician in one location using telecommunications infrastructure to deliver care to a patient at a distant site. Telehealth refers broadly to electronic and telecommunication technologies and services used to provide healthcare and services at a distance. The difference between the two is one where Telehealth refers to a broader scope of remote healthcare services than that of telemedicine.

Patients and caregivers have concerns related to the security, dependability of Internet connection, privacy protection, and how this assessment will be performed. These are all very valid concerns that have been addressed via secure and dependable Internet connection, custom-configured hardware and peripherals, custom software (electronic medical records (EMR)). One of the main vital must haves for Telehealth/Telemedicine is to secure an Internet connection. This is largely due to the involvement of consultations from a distance. Efforts are being made to build a stronger broadband infrastructure throughout the USA. The National Broadband Plan was initiated in 2010 by the US government to help ensure that all communities will have access to broadband service by 2020. "Broadband-enabled health information technology (IT) can improve care and lower costs by hundreds of billions of dollars in the future decades…." [41]. There have been billions of dollars in funding to support the National Broadband Plan by the congress. Healthcare providers are responsible for their own Internet connections.

There are technology grants available to some providers, especially those in rural and underprivileged areas.

> *"The University of Arkansas for Medical Sciences (UAMS) and the Arkansas e-Link team was awarded $102 million by the National Telecommunications Information Administration (NTA) in 2012. This was in alignment with supporting a statewide $128 million broadband infrastructure to serve community institutions across Arkansas. The Arkansas e-Link teams have installed and/or upgraded broadband, interactive video units and public access personal computers all over the state. There have been roughly 3900 community institutions, 61,000 businesses and has reached more than 185,000 underserved families impacted from the Arkansas e-Link infrastructure" [41].*

Patient privacy laws remain managed much in the same way they do with an in-person visit to a facility or provider in a face-to-face visit regarding telehealth/telemedicine. Prior to the initial clinical consultation, patients are educated and informed on how their data will be managed. They are asked to sign a consent form that explains the format for which information will be used and accessed.

The customized software is required to be encrypted, and the software must meet HIPAA Federal security standards and guidelines when using the telehealth/telemedicine hardware. Patients are educated and taught to use additional security efforts for any mobile devices that they should use such as phones and/or tables. These security efforts are mainly password security to their device and the ability to remotely disable mobile devices that are lost or stolen. The Health Insurance Portability and Accountability Act (HIPAA) was passed in the USA in 1996. The HIPAA is to protect a patient's right to privacy in both face-to-face visits and teleservice consultations. All healthcare providers are legally bound by this law.

Telehealth/Telemedicine consultation custom-configured hardware includes carts, desktop/laptop computers, and tablets. Carts are used for clinical and educational purposes and are typically portable systems. The clinical carts are utilized to deliver patient care. The educational carts are used for training, meetings, interviews, etc. Each of the carts is designed to be customized to meet whatever the specific needs and specialties may include. They include Codec which is used to encrypt the patient data. The carts also generally have a monitor, camera, keyboard, and remote control. They also have a PC to store patient information. This includes the capability to view live images as well as take pictures to store and forward to other healthcare professionals if care is needed to be delivered everywhere. The customization is available for all needs of any Telehealth/Telemedicine providers. They are designed to use tools, called peripherals, to assess patient needs. There are cameras available for visualization needs such as dermatology or radiology. Some other peripherals include items such as vital sign monitors, digital stethoscopes, probes, spirometers, etc. Most consultations are done via desktop computers or a laptop computer. HIPAA-compliant software must be used for encryption and privacy to install on all devices that are utilized for Telehealth/Telemedicine purposes. Usually when dealing with an acute situation or emergency, then tablets, such as iPads, are used in other healthcare areas. This mobile technology enables an immediate connection between the patient population and healthcare professional regardless of location. Tablets are also intermittently used to monitor conditions and consult with their healthcare team. The authors of this document envision a growth of technical specialists who will aid the elderly and train the caregivers in implementing and maintaining this technology in good working order.

Custom software (electronic medical records) is designed to deliver a digital patient record that is forwarded to other healthcare professionals and facilities.

Encrypted data is delivered to ensure security and privacy for the patient. There are several companies in the market that develop software to customize to meet the needs of the Telehealth/Telemedicine patient and providers.

Future technology is growing to the point of more mobile apps and self-monitoring devices that will feed information directly to a patient's digital record and automatic notifications to a healthcare team if issues develop. As Telehealth/Telemedicine services become more utilized and accepted, the technology will continue to develop to meet the needs of the patient and healthcare provider as well as cost-effectiveness.

12. Conclusion

The Veterans Health Administration in their national home telehealth program, Care Coordination/Home Telehealth demonstrated that the care of veteran patients with chronic conditions can be delivered in the patient's home. Up to 50% of the veterans can avoid their unnecessary admission to long-term institutional care. Such programs are cost-effective. Long-term care insurance companies are likely to cover these services. Home care and nursing home corporations are following the VHA's lead. Significant advances in the Internet and mobile and telehealth technology have opened a new world, providing information and opportunities for individuals to learn more information about illness and at a much faster rate. Smart home technology has evolved.

However, the elderly often encounter difficulties using these technologies. Caregiver training programs are evolving based on the VHS-CCHT model. Universities across the USA are working with home care and nursing home corporations, utilizing private as well as federal and foundation funding to develop telehealth training centers. The projected gain is that nonveterans will be able to achieve similar success rates as the veterans have and avoid their unnecessary admission to long-term institutional care.

Despite the advances in Telehealth and Telemedicine and the evolution of the technology, many individuals cannot afford the treatment or the technology. These same individuals and families are part of the digital divide, and they have not embraced the new technology. Federal programs have been developed and implemented to help this portion of the population. The learning curve of new technologies for the elderly population is changing. The knowledge gap will continue to close as the United States government supports more initiatives regarding health-related technology and its relationship to improved outcomes for the elderly.

Conflict of interest

The authors declare no conflict of interest.

Notes

The authors would like to recognize the authors of primary Ref. [42] because after reading this article, we were able to understand what was happening in the field of elder care and develop our own article.

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