INNOVATION AND TECHNOLOGY FOR THE AGEING

Craig A Lehmann, Jean Marie Giacini, Professor Dianne Davis[*]

1. Introduction

"A nation's capability and ability to accelerate its socioeconomic development process and gain competitive advantage depends very much on the extent to which it can develop, use and sell information, knowledge and technology in one form or another. There is now consensus that in what is increasingly becoming a highly competitive information-driven world economy, development without information and communications technology (ICT) is not possible."[1]

No one would argue the profound impact ICT has had on the world in that it enables immediate and seamless communication via telecommunication and the Internet. The creation of the World Wide Web by the European Center for Nuclear Research by Tim Berners-Lee in the late 1980s introduced "simplicity" into the process of probing, accessing and sharing information, making it accessible to many more individuals.[2]

As of December 2010, there were approximately 266,848,493 websites available on the World Wide Web.3 Worldwide Internet connectivity has been enormous over the past decade, specifically in Asia (a 44 percent increase) and Europe (a 22 percent increase). It is estimated that 2 billion individuals, worldwide, use the Internet.[4] As a result of the Internet having common simple standards and a language that is universal, it has become the choice of communication throughout the world, providing individuals with simplified and low-cost communication. These attributes have changed the world and will continue to do so. Whether an individual is communicating from their home personal computer (PC), cell phone or tablet, access is simple, cost effective and changing the way we live. ICT has removed the barriers for social communication. Today it is common practice to use ICT to keep in touch with relatives and friends whether they reside in the next town or another country. Communication via email, texting and websites (e.g., Google, Facebook, Skype, etc.) has created user-friendly formats for social connectivity.[2]

While the United States (U.S.) has advanced the role of ICT significantly over the decades, there are still challenges ahead. A recent report from the U.S. Department of Commerce states that only 60 percent of U.S. households have broadband Internet service, leaving much of rural America disconnected.[5] The *New York Times* article, "Digital Age Is Slow to

[*] **Craig A Lehmann**, PhD, CC (NRCC), FACB, is Dean of the School of Health Technology and Management and Professor of Clinical Laboratory Sciences; **Jean Marie Giacini**, BS, is Assistant to the Chair Health Sciences School of Health Technology and Management Medicine Stony Brook University Stony Brook; **Professor Dianne Davis** is Founding President of the International Council for Caring Communities (ICCC), www.international-iccc.org

Arrive in Rural America" suggests broadband access is a "critical utility" that Americans should not live without for a variety of reasons, not all of them social. It goes on to say, "Affordable broadband service through hardwiring and/or cellular phone coverage could revolutionize life in rural parts of the United States. People could pay bills, shop and visit doctors online. They could work from home and take college classes. Increasingly, interacting with certain branches of government can be done only online. And sometimes, a lack of cell phone or email access can have serious consequences (e.g., natural disasters, emergency alerts, etc.)."[5]

Many aged citizens in the developing world, living in remote areas (in some cases as much as 70-80 percent of the total population), with little or no electricity or connectivity are unable to benefit from the many benefits of ICT. These variables hinder the utilization of ICT, which in turn limits many areas of growth (e.g., economy, education, social and healthcare). While connectivity barriers are serious inhibitors of ICT, ethnographic assessments are just as important. It is essential for outsiders (e.g., researchers and stakeholders) to invest in learning and understanding cultural phenomena as they relate to the meanings of certain things within a community system.[6] Otherwise, deployment and diffusion of ICT will be unsuccessful and potentially jeopardize communities' health and wellbeing**.**

The rapid use of ICT in both developing and developed countries, has made it a practical and versatile tool that can provide solutions for present-day social and economic issues. Keeping this in mind, the International Council for Caring Communities (ICCC), a not-for-profit organization (NPO) with United Nations Special Consultative status, along with the United Nations' Economic and Social Council (ECOSOC) explored this topic, with a specific focus on ageing. Together they brought it to the attention of government officials and decision-makers to help achieve the eight Millennium Development Goals (MDGs) that were agreed to in September 2000 by all 147 Heads of State. The challenge was to incorporate the powerful use of ICT as a means of addressing the implementation of the MDGs; the solution was an "out of the box" approach.

In 2007, ICCC, realizing a global knowledge gap existed, was inspired to apply the power of information and communications technology and established the "Age of Connectivity: Cities, Magnets of Hope... Imagining the Possible" initiative to "cross-pollinate" initiatives between the developed and developing worlds, building on lessons learned to accelerate opportunities and the application of new services. Within the framework of UN-HABITAT and with other UN partners, three High-Level Working Sessions were held in October 2008, November 2009 and June 2010. These working sessions gathered a non-traditional group of decision-makers and experts from government, international organizations, local authorities, the private sector, academia, and health organizations to explore the use of ICT to enhance community, health, wellbeing and quality of life. One of many recommendations coming from these working sessions was to address information "gaps" and identify successful projects from all corners of the world.

The affordability of mobile technology, miniaturization of e-health technology, Bluetooth access, ease of operation, advances in software options, sophistication of peripherals, and growing menu of point-of-care testing (POCT) is ideal for addressing information gaps and managing the chronic diseases of an ageing world population, in particular for homebound or remote patients who want to age in place in their homes and communities. The authors of this chapter will provide an overview of present and future ICT applications that could

benefit ageing populations, as well as ongoing demonstration projects from around the globe.

2. Challenges and Opportunities

Challenges and **opportunities** exist in every aspect of the ageing experience. Each includes present and future innovative practices. The **challenge** is to bring them to fruition, as many are complex, but not insurmountable. In most countries of the world, the elderly do not enjoy a decent status in society.[7] One of the major **challenges** before us is the world's rapidly ageing population. "The number of people 60 years or over was 600 million in 2000, triple that of the 1950s. In 2009, the number of people aged 60 or older surpassed 700 million, and 12 countries had more than 10 million older people: China (160 million), India (89 million), the United States (56 million), Japan (38 million), the Russian Federation (25 million) and Germany (21 million). It is projected that by 2050, there will be 2 billion people aged over 60 on the planet, implying that their number will triple over a span of 40 years."[8]

With every passing year, ICT offers many **opportunities** to improve the ageing process in the areas of health, social, education, economics and more. Along with a major role for ICT in the public health arena (e.g., mobile technology) comes the ability to offer health interventions, and education and preventive strategies that address the global challenges of the digital divide (those who have and those who do not).

Some of the healthcare **challenges** in these remote regions are a lack of diagnostic technology; inability to consult with other healthcare professionals; delayed treatment; inadequate referral systems; poor access; and limited clinic hours. Barriers to ICT can be very challenging, particularly in rural areas where there is no continuous power and connectivity; for example, 70-80 percent of individuals in India and Africa live in rural areas with no connectivity. Other barriers are even more complex:

- **Economics:** developing countries cannot afford to build ICT infrastructures; many potential end users (approximately 48 percent) make 2-4 dollars a day; cost of producing technologies is expensive; profit margins for low-cost technology are not an incentive for manufacturers
- **Education:** lack of general and/or technical education; in need of management and repair personnel with technical ICT training.
- **Language: l**ow levels of literacy; variations of language; increased costs for manufacturers (due to multiple variations of language throughout a country).

Opportunities for creating simple diagnostic technologies are abundant (e.g., blood-pressure cuffs, electronic stethoscopes and handheld ultrasounds with 3D data sets with conventional 2D scanners). Another is the increasing utilization of mobile phones for both developed and developing countries, which has reached 5.3 billion, with China and India leading the pack.[9] It is estimated that at least 5,000 health-related smartphone apps are now available to consumers to assist in their healthcare,[8] education, business ventures and entertainment. When a product is easy to use and inexpensive, such as mobile ICT, everyone in a community benefits, particularly the aged, many of whom are already facing additional challenges (e.g., chronic illness, isolation, poverty, illiteracy, etc.).

While many developing countries lack ICT infrastructures and legal and regulatory environments that encourage investment and deployment, partnerships between governments, NGOs and private companies can now offer mobile phone technology to provide electronic health records (EHRs); for example, using EHRs, a small hospital in Rwanda serving 35,000 individuals can retrieve the medical records of pregnant women from an online database.[10] EHRs are able to hold pertinent patient health information such as medical history, radiology, diagnostics, current medications and POCT.

In addition, low-power EKG monitors, drug-quality screening, solar-power dye-type sensors and low-cost off-grid wireless networking are some ICT applications that can easily be adapted for the aged in developing countries. Most require minimal instruction; therefore users do not need to be formally educated (e.g., community health workers (CHWs). Prior research has found impressive benefits from healthcare interventions that utilize community-based care including increased access to care, especially in underserved populations. The addition of EHRs and e-health into team models of healthcare delivery is an underutilized opportunity that can link underserved and remote regions to primary and specialty care. Such connectivity could serve as the catalyst for a comprehensive healthcare platform for the ageing population that provides a compatible infrastructure that disseminates information from a variety of digital health outputs.

Realizing the importance of global innovations in mobile ICT, the U.S. Agency for International Development (USAID) has supported "Open-source software that addresses communication and visualization challenges during crisis situations through mapping and crowd sourcing allowing citizens to submit crisis information through SMS (Short Message Service) technology, email or through the Web."[11,12] SMS technology supports health hotlines, speed of care, literacy and preventive education, virtual support groups, real-time reporting of health data, referrals, and surveillance data to alert governments and healthcare providers of potential public health outbreaks.

The power of SMS is also evidenced by a recent collaboration between mPedigree and Hewlett Packard in West Africa. In the study, consumers utilized SMS messaging alerts to help detect counterfeit medications. All medication bottles contained texting codes linked to a free SMS number. Once the code was transmitted, the service alerted consumers of a drug's authenticity.[8] Another pilot study in South Africa which also utilized SMS (by SIMpill®), improved drug compliance and treatment for tuberculosis.[14] A medication bottle equipped with a SIM card and transmitter device monitored medication compliance simply by whether or not the user opened the medication bottle on schedule. Information was monitored by a central server, which alerted patients and/or caregivers of noncompliance. The device also monitored medication refills and sent email messages directly to pharmacies and clinicians.

Advancing this concept, Proteus Biomedical Inc. developed "body-powered ingestible technology" fueled by digestive sensors made from food ingredients, which are activated by stomach fluids after swallowing. Once activated, the sensor creates an ultra-low-power private digital signal detected by a microelectronic recorder configured as either a small bandage-style skin patch or a tiny device inserted under the skin. The detector date- and time-stamps, decodes and records information such as type of drug, dose, and place of manufacture, and also measures and reports physiologic parameters such as heart rate,

activity, and respiratory rate. Detector data can be combined at the server level with other telemetered parameters such as blood pressure, weight, blood glucose, and patient-generated feedback. Sensors are manufactured at "wafer scale" on silicon and are therefore extremely economical to produce, costing a few cents per sensor in large quantities."[15]

Mobile ICT is also promoting economic growth by helping communities compete in local and global marketplaces (e-commerce). Improving socioeconomic development, particularly in developing countries, is due, in large part, to improved access to timely information (easing the burden of information-seeking, which is extremely difficult in remote locations). With mobile technology literally in hand, farmers negotiate crop prices (e-agriculture), fishermen locate rich fishing spots (via satellite mapping), migrant workers use mobile banking (e-banking) and governments offer citizens the ability to register land, and educational, health and voting opportunities (e-government).[13] ICT can also increase job opportunities by reducing the need for unnecessary travel to better perform one's job (particularly in the case of disability). The Center of Excellence for Technology and Innovation in Favor of Persons with Disabilities (CETID) in Brazil continues to establish noteworthy collaborations with many public, private and not-for-profit sectors. Such collaborations are developing assistive technology that promotes rehabilitation and social and economic inclusion of people with disabilities, which encourages individuals to maintain viable roles within their communities.[16]

As affordable and conducive as mobile technology has become for developing countries, an understanding of lessons learned and challenges from past ICT research projects is essential. An ethnographic study in Mumbai, India, where an automatic teller machine (ATM) was built and introduced to the community suggests that the "Real challenge (when building and deploying ICT) is creating technology for developing markets, to fit the specific needs and requirements that may not match those of the developing world."[16] In other words, ICT should not be designed with a "one size fits all" approach. Rather, it should be designed in conjunction with the preferences, concerns, norms, customs, literacy levels, etc., of its anticipated audience and/or community; for example, Mitsubishi Electric Research Labs (MERL) has designed Combadge, "A mobile, asynchronous, voice-messaging device that supports intermittent connectivity (an enormous challenge for remote areas), and uses completely speech-based interface that could potentially transcend the illiteracy issue."[16] Responsive solutions like this reduce barriers for deployment and diffusion and are critical to relationship building within communities.

The next grand **opportunity** for the ICT on the world stage was the announcement from HRD Minister Kapil Sibal to make a 35-dollar tablet available to all Indian students.[17] The announcement was followed by an open letter from the not-for-profit organization "One Laptop Per Child Project" to share open access of all of their technologies, along with their experience with two million laptops in more than 40 countries.[18] The integration of these two creative enterprises will literally change the lives of students around the world. It also serves as a model for affordable technology that can advance education, independence, personal health and social knowledge for an ageing world.

3. Residence Adaptation of ICT for Independent Living

Independence is a very strong desire amongst the aged, one that certainly dwells in their minds as they age. Everyone wants to age in a place where they feel comfortable for as long as possible. The loss of independence can be due to many factors; for example, health issues can be gradual (e.g., chronic disease, dementia) or immediate (e.g., stroke). Loss of independence can also come from economics (e.g., loss of job, savings, investments, etc.), community (e.g., isolation) and/or connectivity (e.g., social networks).

It is not uncommon to hear news of an elderly person found in their home days after suffering a fall. Those diagnosed with dementia sometimes forget to eat or to carry out daily routines (e.g. hygiene, medication regimens, etc.), or may wander from the safety of their homes. Residence adaptation of ICT is crucial in providing the aged opportunities for independent living. Presently, ICT provides a variety of residential services that enhance the process of ageing in place (e.g., smart-home technology). Smart homes are custom designed based upon the needs of residents. Today's smart homes are equipped with wireless sensors (placed on light switches, home appliances, entrance doors, etc.) which monitor movements and/or patterns of residents. Some homes provide voice prompts by family members, who may not be present, to remind residents to take medications, naps, meals, or exercise. Family members who do not live in close proximity to the home can receive information (via a website) about their loved one's recent activities and health status. In Europe, the smart-home market is expected to triple between 2005 and 2020."[19]

A rise in social networking is also encouraging ageing populations to remain independent and proactive in many areas of residential life. A 2010 report from the Pew Internet and American Life Project reports that social networking among those aged 50 and older in the U.S. has almost doubled (up from 22% in April 2009 to 42% in May 2010). Amongst seniors ages 65 and older there was a 100% jump in utilization (from 13% to 26%). The report also states that one in five seniors uses the Internet to connect with others who may have similar health concerns for information and support. For those with chronic illness, there is a slight increase in utilization (one in four).[20] This new ICT phenomena has been referred to as "Peer-to-Peer Healthcare."[21] Information-seeking behavior will undoubtedly be on the rise in the coming years as seniors have access to global communities (in many cases family members from their homeland), all from the comfort of their own homes. A driving force will be the ability to seek out health information (e.g., protocols, clinical drug trials, and alternative treatments perhaps not currently approved in the U.S. market) from around the globe.

Other driving forces that promote ageing in place are computers like the Pzee® and Telikin®. Both were designed with the wants and needs of seniors in mind. By taking into account limitations and physical hardships (e.g., visual perception, hand-motor function and dexterity, cognitive and perceptual abilities) and technical abilities, seniors can navigate quickly and efficiently through specific applications, rather than become distracted in a sea of unwanted technical jargon and information. Both computers boast user-friendliness, offer Wi-Fi, large icons and buttons, photos, face-to-face video (e.g., Skype), Internet (e.g., Facebook), and email.[22,23] The Pzee offers full software and hardware support, self-corrects 90 percent of problems (that would virtually shut down any other computer) and is considered unbreakable.[22] ICT such as these provide seniors the opportunity to take online

courses, seminars, and even run a home business. Other drivers that enhance residential living are ICT systems that manage and monitor home heating (e.g., temperature), home security (e.g., home intrusion), and personal finances (e.g., savings, checking accounts).

ICT for the aged comes in many different shapes and sizes. It is hard to imagine a communication wristband, cane, or any wireless health monitor, for that matter, offering the aged personal security while traveling outside of the home. Yet such technology is already entering the marketplace.[24,25] Some of these unobtrusive devices enable wearers to make calls or send an SMS in a crisis situation to caregivers or emergency service personnel. Others offer a Global System for Mobile Communications (GSM) module, GPS (Global Positioning Service) for mobile navigation, and transfer of health information (e.g., vital signs). Presently health information can be deposited directly into a patient's HER, from wherever the patient is (e.g., hospital, home or community), for immediate access by health providers. According to Kalorama Information, an independent market researcher, wireless patient monitors such as these are the fastest-growing medical device (demonstrating a 23 percent increase during 2008-2010) in the United States. According to the report, the main drivers for growth are rapidly ageing world population, chronic illness, cost savings, caregiver shortages, error reduction and increasing use of EHRs.

The following table highlights some international research in vital-sign monitoring, activity monitoring and alert systems, and wellness and rehabilitation for the advancement of ICT and independent living.

Table 1 – Examples of International Research Utilizing ICT

Examples of International Research Utilizing ICT
Vital Sign Monitoring:
1.) MyDoctor@Home-Telcom, Italy: Monitors Cardiac, Diabetic or Lung Ailments **Information: http://www.gsmaembeddedmobile.com/upload/resources/files/embTIM1010lores.pdf** **2.) Telstra Glucose Meter, Australia: Mobile phone application for diabetics measuring glucose.** **Information:** http://www.mobilemarketingmagazine.co.uk/content/telstra-launches-mhealth-solution-diabetes-sufferers **3.) Telefonica, Spain: Monitors vital signs and offers questionnaires from home.** **Information:**http://www.gsmaembeddedmobile.com/upload/health_resources/files/emb_tele_10_10_hi_res.pdf
Activity Monitoring and Alert Systems:
1.) Telefonic, Spain: Remote patient tracking, activity monitoring and emergency system. **Information:**http://www.gsmaembeddedmobile.com/upload/health_resources/files/emb_tele_10_10_hi_res.pdf **2.) Buddi, United Kingdom: Alarm system equipped with GPS and mobile network connectivity.** **Information:** http://www.buddi.co.uk/ **3.) Intel and General Electric Health, USA: Technology devices focused on chronic disease management, independent living and extended care using smart sensors.** **Information:http/gartner.co/displayDocument?ref=seo&id=1419336** **4.) Lifecomm, USA: Mobile tracking, fall detection and emergency alert.** **Information: http://wwwlifecom.com**
Wellness and Rehabilitation:
Telefonica, Spain: Designed for patients who are recovering after an injury or operation. Patients are provided with a touch screen kit in their home and doctors can remotely assign exercises for patients. **Information:**http://www.gsmaembeddedmobile.com/upload/health_resources/files/emb_tele_10_10_hi_res.pdf

Retrieved from Mobile Health for Independent Living, Landscape Report, AARP, February 2001

4. Innovative Practices for Developed Countries

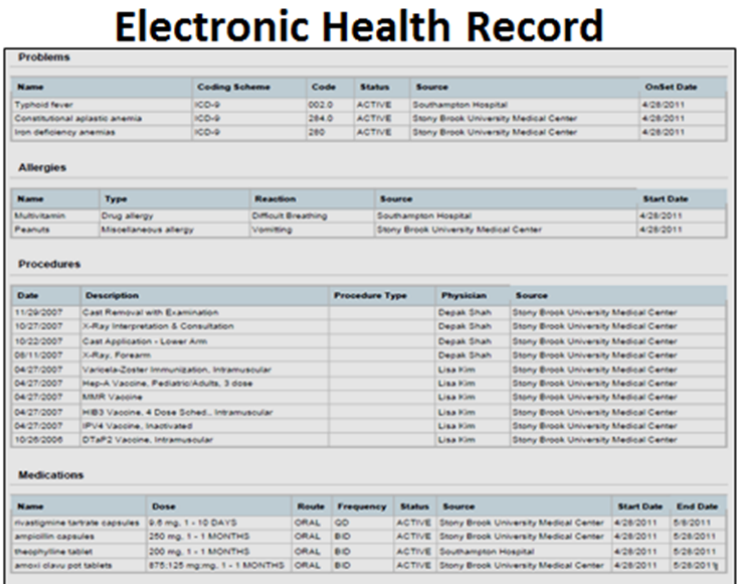
4.1. Regional Health Information Organization

A critical component of healthcare is communicating accurate health information where and when it is needed and to the correct healthcare providers. This is especially true for the ageing population, as they have many chronic diseases, interact with numerous healthcare providers, and require assistance and management (e.g., medication, mobility, rehabilitation, etc.). Because of this, and other reasons, New York State (N.Y.S.), in 2006, embarked on a mission to create a Regional Health Information Organization (RHIO)/Health Information Exchange (HIE). Stony Brook Medical Center at Stony Brook University, Stony Brook, New York was among the first pioneers to create a robust RHIO/HIE for Suffolk County Long Island (population 1,493,350) in N.Y.S.

Over the years, N.Y.S. and others have invested heavily to create an information exchange system to improve quality and efficiency, thus creating an affordable healthcare system. N.Y.S. has the third-largest population (> 19,500,000) in the country. The healthcare system comprises more than 230 hospitals, 30,000 physicians and other health professionals (e.g., nurses, physician assistants, respiratory therapists, etc.).[27] An article in the *Annals of Internal Medicine* in 2009 indentified 197 potential RHIOs in the country that could facilitate HIE. The study revealed that only 179 were valid, and out of the 179, only 75 were operational and could facilitate an HIE.[26] Presently, there are 62 counties in N.Y.S. that are connected to one of twelve functional RHIOs. These twelve RHIOs presently serve about 40 percent of the State's population. The State is presently connecting all of the RHIOs via a Statewide Health Information Network for New York (SHIN-NY). This infrastructure will create an information highway providing patient data when it is needed to the appropriate healthcare providers in the State.[27]

A major **opportunity** that RHIOs/HIEs bring to the aged is, first and foremost, individual ownership of their health information. For the first time, seniors can decide whom they want to have access to their healthcare information. Typically, the more we age, the more we require serious healthcare interventions (e.g., knee and/or hip replacements, cardiac or kidney disease, etc.). All of these require specialists, maybe specific hospitals, medications, and sometimes a trip to the ED. The healthcare needs of the aged characteristically require a diverse group of healthcare professionals (e.g., physicians, physical therapists, gerontologists, etc.). Today's ICT is providing each of them an EHR, as well as other vital information for treating patients. See Table 2 below.

Table 2 – Electronic Health Records



Electronic Health Record

Problems

Name	Coding Scheme	Code	Status	Source	OnSet Date
Typhoid fever	ICD-9	002.0	ACTIVE	Southampton Hospital	4/28/2011
Constitutional aplastic anemia	ICD-9	284.0	ACTIVE	Stony Brook University Medical Center	4/28/2011
Iron deficiency anemias	ICD-9	280	ACTIVE	Stony Brook University Medical Center	4/28/2011

Allergies

Name	Type	Reaction	Source	Start Date
Multivitamin	Drug allergy	Difficult Breathing	Southampton Hospital	4/28/2011
Peanuts	Miscellaneous allergy	Vomiting	Stony Brook University Medical Center	4/28/2011

Procedures

Date	Description	Procedure Type	Physician	Source
11/29/2007	Cast Removal with Examination		Depak Shah	Stony Brook University Medical Center
10/27/2007	X-Ray Interpretation & Consultation		Depak Shah	Stony Brook University Medical Center
10/22/2007	Cast Application - Lower Arm		Depak Shah	Stony Brook University Medical Center
08/11/2007	X-Ray, Forearm		Depak Shah	Stony Brook University Medical Center
04/27/2007	Varicela-Zoster Immunization, Intramuscular		Lisa Kim	Stony Brook University Medical Center
04/27/2007	Hep-A Vaccine, Pediatric/Adults, 3 dose		Lisa Kim	Stony Brook University Medical Center
04/27/2007	MMR Vaccine		Lisa Kim	Stony Brook University Medical Center
04/27/2007	HIB3 Vaccine, 4 Dose Sched., Intramuscular		Lisa Kim	Stony Brook University Medical Center
04/27/2007	IPV4 Vaccine, Inactivated		Lisa Kim	Stony Brook University Medical Center
10/26/2006	DTaP2 Vaccine, Intramuscular		Lisa Kim	Stony Brook University Medical Center

Medications

Name	Dose	Route	Frequency	Status	Source	Start Date	End Date
rivastigmine tartrate capsules	9.5 mg, 1 - 10 DAYS	ORAL	QD	ACTIVE	Stony Brook University Medical Center	4/28/2011	5/9/2011
ampicillin capsules	250 mg, 1 - 1 MONTHS	ORAL	BID	ACTIVE	Stony Brook University Medical Center	4/28/2011	5/28/2011
theophylline tablet	200 mg, 1 - 1 MONTHS	ORAL	BID	ACTIVE	Southampton Hospital	4/28/2011	5/28/2011
amoxi clavu pot tablets	875.125 mg;mg, 1 - 1 MONTHS	ORAL	BID	ACTIVE	Stony Brook University Medical Center	4/28/2011	5/28/2011

The EHR provides precise pieces of health information such as past diagnoses, procedures, allergies, medications, etc., and other essential information when diagnosing and treating patients. As a result, the aged no longer have to write down all of their medications and bring them to each healthcare encounter. Each healthcare provider will have an accurate electronic summary of a patient's daily pharmaceutical intake and surgical procedures that may have occurred years ago.

Presently, any new healthcare event (e.g., a new healthcare provider or hospital admission) requires individuals to request paper files from past and/or present encounters. Very few patients show up at the ED with their medical records in hand. Inaccurate drug documentation or a missing health history can impede progress and prompt a variety of unnecessary tests. RHIOs and HIEs can help ensure that healthcare providers have the correct patient information right at their fingertips.

4.2. Connecting the Medical Home to the RHIO/e-Health

In 1967, the American Academy of Pediatrics (AAP) recognized the need for a central repository (e.g., the medical home) for children's medical records, to help alleviate fragmented delivery and care.[28] At the same time, general internists called attention to a primary-care model of delivery, this time for adults with chronic illnesses.[29,30] In 2002, the AAP amended the medical-home model to also include a community-based primary-care setting that integrates quality and evidence-based standards in providing and coordinating family-centered health promotion in wellness and acute and chronic condition management.[31]

Support for the medical-home model continues to grow. Now, forty years later, since the AAP's first call, they are joined by the American Academy of Family Physicians (AAFP), the American Osteopathic Association (AOA) and the American College of Physicians (ACP) (n= 333,000 U.S. physicians).[32] They describe the medical home as, "Encompassing care that is

facilitated by registries, information technology, health information exchange and other means to assure that patients get the indicated care when and where they need and want it in a culturally and linguistically appropriate manner." Collectively they recognize the need for a systems approach to healthcare that offers a multidisciplinary team of providers to deliver, "Care that is coordinated and/or integrated across all elements of the complex healthcare system and the patient's community."[32]

When POCT is introduced to communities through a medical home connected to a RHIO/HIE, physicians, allied health professionals, nursing homes and assisted-living communities can better manage patients, perform community screenings/education for early disease detection, and improve patient compliance. RHIOs/HIEs can assess changes in clinical physiology (e.g., blood pressure) before a patient experiences a life-threatening event, eliminating the likelihood that the emergency department (ED) will be their entry point into the U.S. healthcare system.

Illnesses such as chronic obstructive pulmonary disease, congestive heart failure, obesity, dementia, depression, osteoarthritis, Parkinson's disease and stroke create a strong context for RHIOs/HIEs, EHRs and the medical home. Forty-seven percent of Americans support an increase in government funding and incentives to support the adoption of EHRs by providers and insurance plans,[33] as well as recent demonstration projects encouraging research-to-market devices for diagnostics and monitoring. Many believe ICT is an essential component to improve patient care, performance measurement, communication and patient education in the medical-home model.[34] A "technology-friendly" medical home represents a new paradigm in accessing health promotion, disease prevention and treatment strategies and offers available opportunities for an ageing world.

4.3 United States and United Kingdom/Medical-Home Demonstration Projects

Like the rest of the world, ageing citizens in the United States (U.S.) and United Kingdom (U.K.) are about to utilize healthcare systems in an unprecedented manner. Topping many national healthcare agendas these days is how to keep ageing citizens as healthy as possible, for as long as possible. And, for those already presenting with chronic illnesses, the goal is finding alternative practices that reduce soaring costs and provide quality care. Both the U.S. and the U.K. have ongoing medical-home demonstration projects that will, hopefully, offer possible solutions to the current healthcare climate.

In the U.S., 125 million people, or almost half of all Americans, are living with a chronic condition. By the year 2020, the number will increase to an estimated 157 million. According to the Centers for Medicare and Medicaid Services (CMS), the U.S. spent $2.5 trillion on healthcare in 2009, or $8,100 per person. Compare that to the similar figures of $26.9 billion and $141 dollars spent in 1960.[28] Most striking is that only five percent of the U.S. population is responsible for 50 percent of these costs.

Over the years, public health in the U.S. has become systematically underfunded and separated from clinical care, leaving clinical interventions under the auspices of medicine and medical institutions, whereas health promotion and disease prevention has became the domain of public health.[35] Some would argue that this chasm has promoted erroneous health spending due to the shift away from primary care and public health.

Responding to escalating costs, which employee wages and economy can no longer subsidize, a rapidly ageing population, and a shortage of primary-care physicians, CMS put forth a comprehensive, three-year Medicare Medical-Home Demonstration Project. The large-scale project, also referred to as the Advanced Primary-Care Model, is ongoing and will test patient-centered medical homes consisting of medical practices (n=400), physicians (n=2,000) and Medicare beneficiaries (n=400,000).[36] The goal, "Is to reduce unjustified variations in utilization and expenditure across delivery systems; improve the safety, effectiveness, timeliness, and efficiency of healthcare; increase the ability of beneficiaries to participate in decisions concerning their care; increase availability and delivery of care that is consistent with evidence-based guidelines in historically underserved areas; and reduce overall utilization and expenditures under the Medicare program."[37]

The U.K., like the U.S., is taking a proactive approach to ease healthcare spending, but on a much larger scale. The U.K. is now considered a world leader in healthcare ICT research and home-based ICT. Between approximately 1.6 million and 1.7 million people in England utilize some form of remote monitoring.[38] In 2009, the U.K.'s Department of Health launched the Whole System Demonstrator (WSD) program. This two-year demonstration project is dedicated to, "Strengthen the evidence base for the effectiveness of *telecare* and telehealth services." It consists of three sites, 6,000 participants, 238 General Practice Practices and is believed to be the largest randomized control trial of this type to date in the world. Some technology used in this project was recordable reminders, bed sensors, epilepsy sensors, enuresis sensors, fall detectors, extremes detectors (which monitor high and low temps in kitchen), flood detectors, carbon monoxide detectors with audible warnings, and GPS personal tracking systems with a built-in emergency panic button that can be triggered by wearers. A safe was also included to store keys for easy access by caregivers, providers, and/or emergency personnel, as well as pagers, medical dispensers, and movement sensors.[39]

5. Future Prospects for ICT and Ageing

5.1. Information/Knowledge/Learning Society

To date, efforts to include the ageing population in the "information/knowledge/learning society" have been limited. Research indicates that when ICT is used as an enabling tool all generations benefit, and quality of life improves. Responding to the approaching "age quake," the International Council for Caring Communities launched its "Connect the Generations" program to stimulate innovative solutions. A special ICT Student Design Competition designed to support and implement the U.N. World Summit for the Information Highway harnesses the creative talents of university students and focuses their energy and attention towards integrating older persons into the fabric of the community, to fully include them in all social, cultural, and productive activities. The results have fostered practical research among the next generation of ICT designers and developers, and provide a unique opportunity to stimulate new thinking. Globally, it showcases meaningful solutions to enhance the quality of life for all ages.

5.2. Meaningful ICT Solutions for the Ageing World

Future prospects for ICT and ageing are exciting. The landscape is diverse and changing and will continue to be so for years to come. There is little doubt that Voice over Internet Protocol (VoIP) has the potential of becoming the next phone service for the world. The ability to make calls via high-speed broadband Internet connection offers substantial cost savings as most individuals utilize their computer to make VoIP calls both nationally and internationally (e.g., Skype). This technology is ideal for the aged as it is inexpensive, provides video connectivity and is simple to use.

Voice recognition software also assists the aged in a variety of areas. The primary focus of the software is to eliminate utilizing a keyboard or mouse, which could help the aged remain connected for a longer period of time. Those who do not type, or who have hand or finger ailments (e.g., arthritis) will still have the ability to write letters, emails, etc., to stay connected to friends and family.

As if taken right off the pages of a science fiction novel, Virtual Human Agent Technology has created virtual humans, which can support ageing populations. Virtual human agents (VHAs) "Recognize speech, respond to questions and generate verbal and nonverbal behavior" to help the aged to carry out day-to-day activities. When sensors or cameras are placed inside the user's home, researchers and VHAs monitor users and offer assistance and/or emergency management if necessary. Virtual human characteristics can be pre-selected by users for personality type and gender in order to assure more comfortable and pleasant encounters.[41]

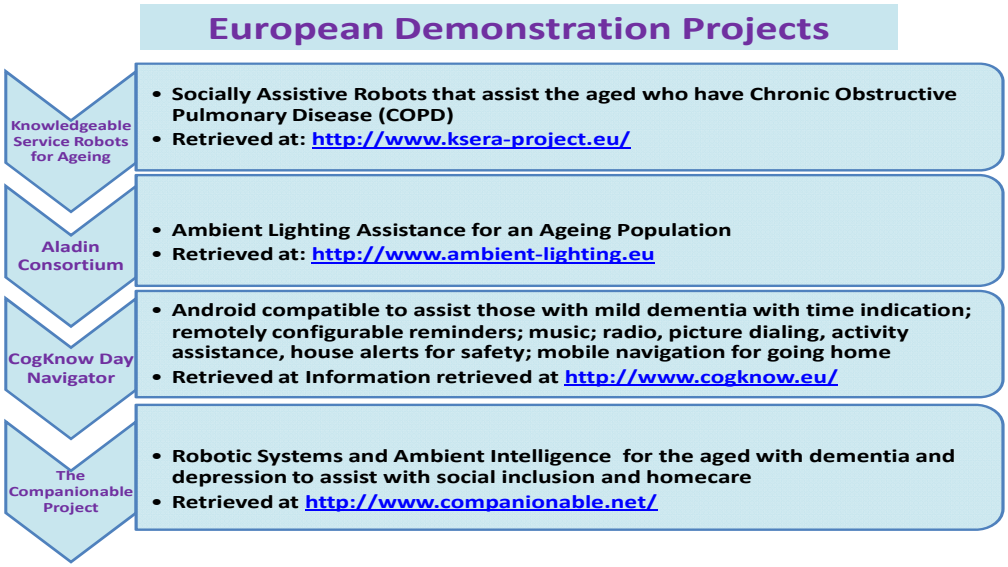
The Presenccia Project, a partnership between g.tec, an Australian medical engineering company, and 14 international universities has made the impossible possible.[42,43] Their efforts have produced a virtual reality (VR) smart home that introduces Brain Computer Interface (BCI). The BCI aids users in turning on light switches and televisions, opening doors, controlling robots, etc. Electroencephalogram (EEG) equipment placed on the user's head recognizes thought patterns, makes appropriate connections, and responds by carrying out their wishes. Researchers are enthusiastic that the BCI and VR environment will have an enormous impact on education, training and rehabilitation. Examples include training disabled individuals to use electronic wheelchairs, amputees to use prosthetic limbs, or rehabilitation for cardiac and stroke patients. The study also includes "thought-provoking typing." Such technology enables a person to simply look at letters on a grid that they want to be typed. The BCI technology is currently leaving the VR environment and is now being placed in a real smart home. The study is expected to conclude in 2013. The impact that BCI technology could have for the aged population is limitless. If the second half of the study is as impressive as the first, the aged will experience levels of independence never before dreamed of.

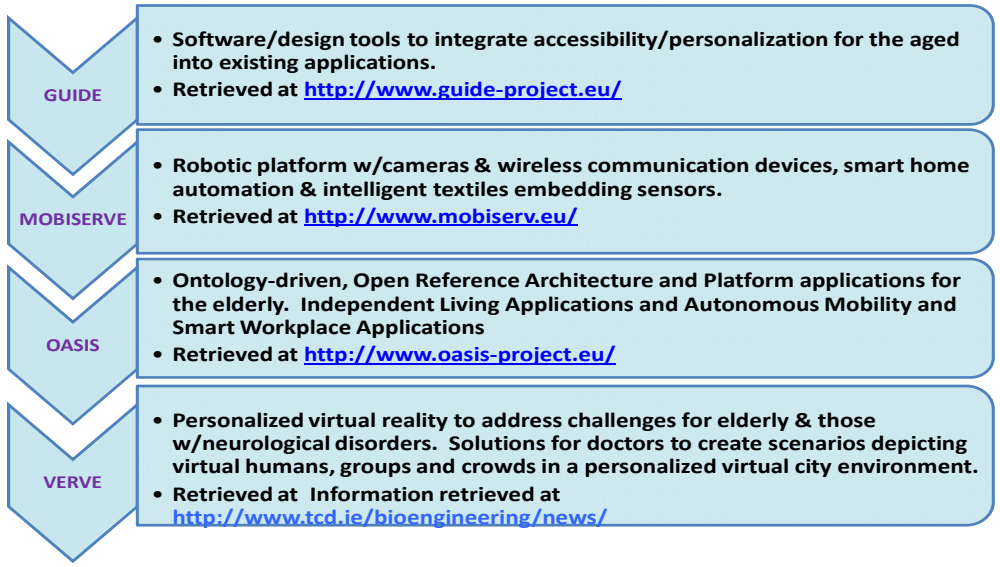
Although still in the development phase, Microvision's Mobile Device Eyewear provides multimedia applications and high-speed data networks that could increase independence for years to come. The mobile eyewear provides see-through glasses (resembling standard eyeglasses) that enable wearers to see their surroundings and simultaneously view multimedia applications. Because mobile phones have small screens, which often make them difficult to use for many aged individuals, the glasses come equipped with large fonts, provide GPS directions as you walk, as well as a variety of other opportunities (e.g., movies,

videos, email, etc.). The glasses are easily attached to one's mobile device (e.g., phone, tablet, etc.) by a wire or wireless connection.[40]

The following tables outline promising European Demonstration Projects such as the Presenccia Project, which will conclude within the next few years. The future prospects for ICT and ageing will undoubtedly rely heavily on the results of these projects, as they are likely to be major drivers for future research. Technology transfer and replication on a national scale is essential to help eliminate fragmented ICT markets and to enable future projects and stakeholders to bring about the next phase of Web connectivity.

Table 3 – European Demonstration Projects





6. Concluding Remarks

There is no doubt that ICT is the enabler for communication, independence and healthcare reform and will serve as the nucleus for global change. The fact that the world's population of individuals aged 65 years and older will reach 1.55 billion by 2050 makes them a very viable market.[44] This market can easily be segregated into two primary markets: developing and developed countries. Access to the Internet is key to the future of developing countries. For the most part, the digital divide is no longer between developed and developing countries; it is between urban and rural areas in developed and developing countries (as most urban areas around the world have access to telecommunication facilities).

As highlighted in this chapter, as individuals age, two concerns arise: independence and healthcare. Aged individuals in developed countries have virtually immediate access to ICT and, at the same time, pressure from governments and/or third-party payers to utilize ICT to reduce costs where appropriate. These are two major reasons why e-health was predicted to be almost an $8 billion market for the U.S. and Europe in 2012.

Ageing populations in developed countries will continue to benefit from ICT in the years to come; however, growth could become stagnant because of issues that are still not resolved, such as reimbursement, privacy, security and standardization of regulatory policies.[45] The aged who reside in developing countries will also benefit from ICT, but with restricted functionality (e.g., utilizing cell phones for EHRs) due to the lack of connectivity, electricity and other factors.

In 2010, the world saw a 40 percent rise in ageing individuals with chronic conditions who were living longer. Healthcare systems will need to reconstruct primary care and community health. Fortunately, the timing could not be better. Technologies such as e-health, RHIOs, and POCT can create digital health systems[46] for an ageing world. The Internet, social media and ICT products such as those outlined in the chapter will continue to play a vital role in keeping the aged productive, mobile and engaged in the world around them.

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