Innovative and Technology for the Ageing

Craig A Lehmann, PhD, CC (NRCC), FACB
Dean School of Health Technology and Management
Professor of Clinical Laboratory Sciences

Jean Marie Giacini, BS
Assistant to the Chair Health Sciences
School of Health Technology and Management
Medicine
Stony Brook University
Stony Brook, New York, 11704-8200

Dianne Davis, PhD
Founding President of the International Council for Caring Communities (ICCC)

Introduction

"A nation's capability and ability to accelerate its socio economic 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 Communication Technologies (ICTs) 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.

While the United States has advanced the role of ICT significantly over the decades, there are still challenges that lay 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.[2] 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., economic, education, socialization and health care). 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 it relates to the meanings of certain things within a community sytem.[3] Otherwise, deployment and diffusion of ICT will be unsuccessful and potentially jeopardize the health and wellbeing of communities**.**

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. Specifically for homebound or remote patients who want to age-in-place in their homes and communities.

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 can address the global challenges of the digital divide (those who have and those who do not).

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.[4] One of the major challenges before us is the rapidly ageing population of the world. "The number of people 60 years or over was 600 million in 2000, triple that of the 1950. In 2009, the number of people 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) By 2050, 2 billion people over 60 are projected to be alive, implying that their number will triple over a span of 40 years."[5]

Some of the health care challenges in remote regions are a lack of diagnostic technology; inability to consult with other health care 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. Others are far 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 is 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: low 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 hand held 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.[6] It is estimated that at least 5,000 health-related Smartphone apps are now available to consumers to assist in their health care,[5] 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, with EHRs, a small hospital in Rwanda serving 35,000 individuals can retrieve the medical records of pregnant women from on on-line data base.[7] EHRs have the ability to contain pertinent patient information, such as medical history, radiology, diagnostics, current medical interventions and point-of-care-testing.

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 health care 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 health care 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 health care platform for the ageing population that provides a compatible infrastructure that disseminates information from a variety of digital health outputs.

Realizing the importance for 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.[8,9] SMS 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 health care 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.[5] Another pilot study in South Africa which also utilized SMS (by SIMpill®), improved drug compliance and treatment for tuberculosis.[10] 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."[11]

Mobile ICT is also promoting economic growth by helping communities compete in local and global marketplaces (e-commerce). Improving socio-economic 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).[12] ICT can also increase jobs 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 create 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 that encourages individuals to maintain viable roles within their communities.[13]

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. 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.

Residence Adaptation of ICT for Independent Living

Independence is a very strong desire of the aged, one that certainly dwells in their mind 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, carry out daily routines (e.g. hygiene, medication regimens, etc.) or may wander from the safety of their home. 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 ones recent activities and health status. In Europe the smart home market is expected to triple between 2005 and 2020."[14]

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 50 and older in the U.S. has almost doubled (up from 22% in April 2009 to 42% in May 2010). Of 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).[15] This new ICT phenomena has been referred to as "Peer to Peer Health Care".[16] 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 in 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 Wifi, large icons and buttons, photos, face-to-face video (e.g., Skype), Internet (e.g., Facebook), and email.[17,18] 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.[17] ICT such as these provide seniors the opportunity to take on-line 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.[19,20] 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 EHR from wherever the patient is (e.g,, hospital, home, or community) for immediate access by health providers.

Technology Creating a New Health Care System

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 health care in 2009, or $8,100 per person. Compare that to the similar figures of $26.9 billion and $141 dollars spent in 1960.[21] 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 become the domain of public health.[22] Some would argue that this chasm has promoted erroneous health spending due to the shift away from primary care and public health.

One of the biggest challenges facing the United States is how to provide national health care to the poor, elderly or disabled. A critical component of sound health care is communicating accurate health information where and when it is needed and to the correct health care providers. This is especially true for these segments of the population, as they have many chronic diseases, interact with numerous health care providers, and require assistance and management (e.g., medication, mobility, rehabilitation etc.). In response, New York State developed what is known as a Regional Health Information Organization (RHIO)/Health Information Exchange (HIE) created by Stony Brook Medical Center at Stony Brook University, Stony Brook, New York. Stony Brook University was among the first pioneers to create a robust RHIO/HIE in New York State. Over the years, New York State and others have invested heavily to create an information exchange system to improve quality and efficiency, thus creating an affordable health care system.

A major opportunity that RHIOs/HIEs bring to the aged is, first and foremost, individual ownership of their health information. The electronic health record generated provides precise pieces of health information, such as past diagnosis, 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 health care encounter. Each health care provider will have an accurate electronic summary of a patient's daily pharmaceutical intake and surgical procedures that may have occurred years ago. While developing countries have the opportunity to develop robust RHIO/HIEs, developed countries are not excluded from such opportunities through the use of phones and SMS for heath interactions.

There is no doubt that ICT is the enabler for communication, independence and health care reform and will serve as the nucleus for global change. Given that the world's population for individuals 65 years and older will reach 1.55 billion by 2050 makes them a very viable market.[23] This market can easily be segregated into two primary markets: developing and developed countries. Access to the internet is the key for 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 individuals age two concerns arise: independence and health care. 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 has been 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 through 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.[24] 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 others.

In 2010 the world began a 40-year growth of ageing individuals with chronic conditions and longevity. Health care 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[25] for an ageing world. The Internet, social media, and ICT products, like the ones outlined in the chapter, will continue to play a vital role in keeping the aged productive, mobile and engaged in the world around them.

Future Prospects for ICT and Ageing

To date, efforts to include the aging 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 innovate 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, as well as provide a unique opportunity to simulate new thinking. Globally, it showcases meaningful solutions to enhance the quality of life for all ages.[26]

Future prospects for ICT and ageing are exciting. The landscape is diverse and changing and will continue doing 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. Technology transfer and replication on a national scale is essential to help eliminate fragmented ICT markets and for future projects and stakeholders to bring about the next phase of Web connectivity

Conclusion

The ICT market can easily be segregated into two primary markets: developing and developed countries. Access to the internet is the key for 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 demonstrated in this chapter, as individuals age two concerns arise: independence and health care. 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 has been predicted to be almost an $8 billion market for the U.S. and Europe in 2012.

References

[1] Dzidonu, C. (2010, April) An analysis of the role of ICTs to achieving the MDGs. The Division for Public Administration and Development Management of the United Nations Department of Economic and Social Affairs. URL: http://unpan1.un.org/intradoc/groups/public/documents/UN-DPADM/UNPAN039075.pdf Published April 2010. [last accessed January 2013].

[2] Severson, K. Digital Age Is Slow to Arrive in Rural America. The New York Times. URL: http://www.mediamobilizing.org/updates/digital-age-slow-arrive-rural-america Published February 17, 2011. [last accessed December 20, 2011].

[3] Wikipedia. Ethnography. Wikipedia. URL: http://en.wikipedia.org/wiki/ [last accessed December 1, 2012].

[4] Ianculescu, M., Parvan, M. Becoming a digital citizen in an aging world. *International Journal of Education and Information Technologies.* 2011; 5:182-189.

URL:http://www.naun.org/multimedia/NAUN/educationinformation/19-701.pdf [last accessed January2013]

[5] Walsh, B. Mobile Health for Independent Living. AARP. URL: http://www.aarp.org/technology/innovations/info-02-2011/mobile-health-independent-living-11.html Published February 2011. [last accessed December 2012].

[6] mobiThinking. Global mobile statistics 2012 Home: all the latest stats on mobile Web, apps, marketing, advertising, subscribers, and trends. mobiThinking. URL: http://mobithinking.com/mobile-marketing-tools/latest-mobile-stats#mobilesecurity. [last accessed November 2012].

[7] Kimani. M. Better health at the click of a button: Information helps Rwandan clinics reach out. *Africa Renewal.* 2008;22(5). URL*:* http://www.un.org/africarenewal/magazine/april-2008/better-health-click-button [last accessed on December 2012]

[8] Burns, C. (2010, June 16). Mobile development projects: A sampling. Office of Women in Development Bureau for Economic Growth, Agriculture and Trade. U.S. Agency for International Development. USAID. URL: http://pdf.usaid.gov/pdf_docs/PNADS558.pdf. Published June 16, 2010. [last accessed December 2012].

[9] Verclas, K. USAID's Development 2.0 challenge on mobile innovation: and the winner is UNICEF/Columbia University. USAID. URL: http://mobileactive.org/usaids-development-2-0-challenge-mobile-innovation-and-winner Published January 8, 2009. [last accessed November 22, 2011].

[10]Barclay, E. Text messages could hasten tuberculosis drug compliance. *The Lancet*. 2009;373:16-16. doi: 10.1016/S0140-6736(08)61938-8

[11] Proteus Biomedical. (2011). Technology [web advertisement]. URL: http://www.proteusbiomed.com/technology/. [last accessed November 25, 2012].

[12] The World Bank Group. Embracing the developmental power of ICT: ICT revolution in developing countries. The World Bank Group. URL: http://web.worldbank.org/external/default/main?menuPK=6454478&theSitePK=5929282&piPK=64911825&pagePK=7278674&contentMDK=22839789. Published February 23, 2011. [last accessed December 2012].

[13]International Council for Caring Communities. The Center of Excellence for Technology and Innovation in Favor of Persons with Disabilities (CETID). URL: http://www.international-iccc.org. [last accessed on December 21, 2011] and IGNOU. Rajiv Gandhi International Prize for Azim Premji. URL: http://www.indiaeducationreview.com/news/ignou-confers-rajiv-gandhi-international-prize-azim-premji-0 [last accessed December 2012].

[15] Madden, M. (2010, August 27). *Older adults and social media*. Retrieved on December 6, 2011 URL: http://www.pewinternet.org/Reports/2010/Older-Adults-and-Social-Media/Report.aspx

[16] Comsti, T. (2011, September 20). *Fox shows how internet is changing health care*. Retrieved on December 7, 2011 from: http://www.pewinternet.org/Media-Mentions/2011/NIH-Mind-the-Gap.aspx

[17] PRWeb. (2010, June). Senior computer developed especially for the aging population. Retrieved on December 4, 2011 from: http://www.prweb.com/releases/2010pzeecomputer/06seniorcomputerrelease/prweb4110474.htm

[18] Telekin. Retrieved on December 15, 2011 from: http://www.telekin.com/

[19]T-Mobile. (2009, March 19). Communication wristbands not only for senior citizens. Retrieved on November 29, 20011 from: http://en.t-press.cz/tiskove_zpravy/2009/969/

[20] Fujitsu. (2011, May 20). *Fujitsu announces winners of design award 2011*. Retrieved on December 15, 2011 from: http://www.fujitsu.com/global/news/pr/archives/month/2011/20110520-01.html

[21]Santerre RE, Neun SP. Health Economics: Theory, Insights, and Industry Studies, 5th ed. Florence, KY: South-Western, Cengage Learning, 2010:624pp.

[22] Davis, K., Schoen, M.S., Schoenbaum, M.D., Doty, M., Holmgren, A., Kriss, J., Shea, K. Mirror, Mirror on the Wall: An International Update on the Comparative Performance of American Health Care. URL: http://www.commonwealthfund.org/Publications/Fund-Reports/2007/May/Mirror--Mirror-on-the-Wall--An-International-Update-on-the-Comparative-Performance-of-American-Healt.aspx. Published May 15, 2007. [last accessed December 2012].

[23] U.S. Census Bureau. Profile America: Facts for Features. URL: http://www.census.gov/newsroom/releases/archives/facts_for_features_special_editions/cb11-ff08.html. Published May 2011. [last accessed December 20, 2012].

[24] Sarasohn-Khan, J. (2010, June 7). Telehealth beginning to go mainstream, but long road lies ahead. URL: http://www.ihealthbeat.org/perspectives/2010/telehealth-beginning-to-go-mainstream-but-long-road-lies-ahead.aspx. Published June 7, 2010. [last accessed December 2012].

[25] Lehmann, C., Giacini, J. Point-of-Care Testing in the Home and Community Environment: Key Ingredients for Tomorrow's Community Health. In: Christopher Price, Andrew S. John., Larry L. Kricka, eds *Point of Care Testing.* Washington, DC: AACC Press; 2010: 311-321.

[26]Age of Digital Opportunity: Connecting the Generations Part II. (2007) and International Student Design Competitions Retrospective. URL:. http://www.international-iccc.org/ICT_Publication_compressed.pdf Published 2007 and 1994-2005, respectively. [last accessed November 2012].