

International Pediatric Telemedicine and eHealth: Transforming Systems of Care for Children in the Global Community

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I. Introduction

Telehealth and e-health are providing a means to transform systems of care for children throughout the world by providing greater access to clinical service and consultation, as well as sharing knowledge, education and training. Leap-frogging over prior barriers, these information and communication technologies (ICT) also have the potential to offer greater access to these services in developing countries¹. The use of telehealth must be put in the context of the critical health needs in each country, cultural perspectives, current and future communication infrastructure, other supportive resources, and likelihood for sustainability. Furthermore, these telehealth efforts should be aimed at improving the local capacity in providing ongoing health services in each country and blending into that country's current and future health care system. Fundamental steps in addressing global health issues include reducing poverty; improving education and health promotion strategies; ensuring access to clean water; and investment in sustainable waste removal and renewable energy programs.

Rapid advances in ICT provide computing and wireless networks capable of improving access to healthcare information, health services, research and education - independent of distance and on an international level. In combination, these communication technologies and health-related applications constitute the concept of Telehealth. As stated by the World Health Organization (WHO), Telehealth provides a broad spectrum of health services over distance and the integration of telecommunications systems into the practice of protecting and promoting health^{2,3}. Telehealth covers clinical services, health education, public and community health, health systems development, epidemiology and research. In turn, telehealth allows an enhanced means of sharing knowledge and expertise, eliminating many of the usual barriers associated with distance and time.

research. In turn, telehealth allows an enhanced means of sharing knowledge and expertise, eliminating many of the usual barriers associated with distance and time. Global development and integration of communication systems and networks, combined with better wireless and broad band services, are creating opportunities for international collaboration using Telehealth and provide a platform for exchange with the potential for formation of a true “network of networks” and “virtual collaboratory” that can be used world-wide⁴. A network of this magnitude represents far more than a communication infrastructure because it facilitates partnerships and collaboration between healthcare providers and educators, public health workers, investigators, and other international organizations and stakeholders. The United Nations has set the improvement of maternal and child health as one of its highest priorities⁵.

As the world continues to “shrink”, developing this international telehealth “network of networks” offers an opportunity for cooperation, collaboration, knowledge sharing and improving the health of every individual in the world, applying information technologies for peace and the betterment of mankind. The time is now for open and constructive dialogue designed to facilitate that coordination between key stakeholders and other international organizations. These types of international exchange experiences offer significant opportunities for understanding the common denominators, as well as unique differences, related to global health among countries and cultures around the world. For example, the mounting concerns related to the HIV/AIDS epidemic, the re-emergence of tuberculosis, increasing issues related to hepatitis C, malaria and the threat of pandemic influenza, all highlight the importance and value of telehealth and international collaboration. These programs can promote international understanding and mutual respect in a manner that can improve the entire global community. The primary goal of any international pediatric medical outreach program is to improve patient care by increasing the number of children treated, providing medical education to all members of the health care team, and, most importantly, by building sustainable in-country medical systems. Transport of patients out of country, education of medical personnel abroad, and visiting medical missions are a mainstay of many international health programs. However, long term sustainability requires daily education and ongoing medical care. Telemedicine and distance learning can achieve this goal in an ideal way. Telemedicine can most simply be defined as “practicing medicine at a distance⁶”, but this simple definition does not capture the complexity of the discipline. Telemedicine can also be defined as the use of technology to improve access to high quality health care, provide distance education, and compile and maintain health information across the continuum of health care⁷. Telemedicine spans the spectrum of health care; from the patient’s home to rural health care providers, primary care physicians, community physicians and hospitals, and tertiary care centers. Today, international pediatric telehealth encompasses the full spectrum of telemedicine. This article describes factors which are important for the success of telehealth programs which support developing countries, the challenges, and opportunities which exist while establishing and managing such services. We provide several examples of international telehealth programs and consider the future opportunities which may arise as a result of united effort to provide telehealth on a global scale.

II. Examples of Current International Pediatric Telehealth Activities

There are many examples of telehealth programs which are supporting children and families in developing countries. We have identified a few to demonstrate the potential of telehealth in these regions. Clinical pediatric telemedicine applications can be found in almost every subspecialty including cardiology⁸, radiology, neurology^{9,10}, neonatal care, genetics, emergency medicine, pathology¹¹, mental health¹², hematology, oncology¹³, dermatology, otolaryngology, ophthalmology, orthopedic surgery, urology and general surgery. Telemedicine applications have also been developed for distance learning, home care, correctional care, international collaboration, humanitarian assistance, rural health¹⁴, military health, pharmacy, and consumer health. Medical education support is helpful in increasing adoption. The inclusion of facilitated continuing medical education credits will improve the attractiveness of telemedicine programs that include distance education. Additional added-value tools will allow users to acquire and to create content, to incorporate multimedia and to gain access to evidence easily. The ideal telemedicine

improve the attractiveness of telemedicine programs that include distance education. Additional added-value tools will allow users to acquire and to create content, to incorporate multimedia and to gain access to evidence easily. The ideal telemedicine program should be tailored to the end user goals and available technology with consideration of whether synchronous (live) or asynchronous (store and forward) is more appropriate. Healthcare provider champions, technical support staff, and administrative leaders are necessary to promote use of this technology, especially with physicians who may be resistant to change. Advocacy for any telemedicine initiative must be active on both sides of the connection. International telemedicine often involves interaction with foreign government officials. It is important to have a strong understanding of the local political landscape, both in government and medicine. Clearly the type of telemedicine program will be dictated in part by a given country's political, economic, and social climate.

As one example, Children's National Medical Center (CNMC) in Washington DC has several international telemedicine programs with pediatric cardiology being the most widely used application. Live transmission of echocardiograms has been shown to be accurate. Patient management improve include: facilitating timely transport of critically ill children with heart disease, preventing unnecessary transport (patients diagnosed with normal hearts), improving cost-effectiveness without increased echocardiography usage and reducing length of stay¹⁵. Telemedicine has streamlined the approach to patients with suspected heart disease. Transmission of echocardiograms to a pediatric cardiologist provides an immediate interpretation and recommendations. Cardiologists using this tool can also help local sonographic technicians perform better quality echocardiograms. This pediatric tele-cardiology program uses both asynchronous digital echocardiogram transfer and live videoconferencing over three bonded ISDN lines (384 Kbps) or through an IT connection at equivalent of greater bandwidth. Reports can be transmitted or faxed immediately to the referring physician and form a digital medical record and database. Since the program began in 1998, over 6000 studies have been performed from ten regional hospitals and several international partners including Qatar, Morocco, Iraq, Uganda, and Germany. CNMC has international partner hospitals in three categories: charity programs (Morocco, Uganda, Iraq, Serbia/Kosovo), military programs (Germany, Italy), and business development programs (United Arab Emirates, Qatar, Kuwait, Saudi Arabia). In most cases, telemedicine is used to assist with patient management at the referring center. A future application of this program will be to allow tertiary care hospitals to provide support for more rural health care workers in remote villages through telemedicine technology to address such medical problems as maternal and newborn care, malnutrition, and infectious disease prevention. CNMC also offers synchronous and asynchronous distance education programs in several topics and formats, with physician-led live videoconferences, including presentations to local, national, and international audiences, and weekly hospital grand rounds to regional hospitals in Iraq and Morocco. CNMC also has a program for creating asynchronous distance education content from digitally recorded pediatric lectures, accessible to medical students from a secure Web site with required translation of the content when needed. New content is made available via Internet as it becomes available.

In South Africa, with improving infrastructure, the University of KwaZulu-Natal has developed videoconference based postgraduate education in a range of specialties including pediatrics and pediatric surgery. In 2008, 41 pediatric postgraduate seminars were broadcast with a cumulative attendance of 1,060 people and 50 Pediatric Surgery seminars were broadcast to three other sites, including another medical school, with a cumulative attendance of 3,373 people. On average 14 people were present at the send site and 63 at the receive sites for the pediatric surgery seminars. In order to overcome lack of bandwidth and videoconferencing equipment at some sites, video-conference teaching sessions are recorded to DVD and then mailed to four medical schools in central Africa for their use. More rapid uptake of tele-education, in preference to service telemedicine, is similar to early telemedicine experiences in the developed world¹⁶. Hearing deficit in childhood in the developing world is a largely unaddressed but significant problem. This is due largely to the shortage of otorhinolaryngologists and

Hearing deficit in childhood in the developing world is a largely unaddressed but significant problem. This is due largely to the shortage of otorhinolaryngologists and audiologists and lack of screening. These children face developmental problems and are frequently trapped in a vicious cycle, where poverty predisposes to hearing loss and hearing loss predisposes to poverty¹⁷. An international non-governmental, non-profit organization, the Tele-Audiology Network (TAN) has recently been formed. One of its objectives is to use tele-audiology for screening and diagnosis of hearing loss in children in Africa. A new tele-audiology device has been developed, that does not require a soundproof booth, and which allows for both synchronous and store and forward tele-audiology using mobile phone communication. With the rapid expansion of mobile phone coverage in Africa, this device has the potential to take screening and diagnostic services to children in rural areas. Studies using the device in rural settings in South Africa are being conducted. International co-operation and service is needed to meet the clinical load that screening will generate.

As another example, the concept of boats traveling along rivers in South America to provide medical services to local communities is becoming a reality. Boats in the Amazonian region are currently being configured as mobile floating clinics on the Rio Aquarico, Rio Napo and Rio Morona; major tributaries in Ecuador connecting to the Amazon. Plans are underway to provide these boats with Telehealth connectivity to medical experts in Ecuador and anywhere in the world through wireless telecommunication connections. Formal agreements for these projects have been established between Universidad Tecnológica Equinoccial (UTE) in Quito, Ministry of Public Health in Ecuador, and University of New Mexico School of Medicine. The Ecuadorian Air Force has donated broad-band satellite connectivity throughout the country, as well as links to international networks. This is providing opportunities for cultural exchange and knowledge sharing, as well as opportunities for international faculty and student interaction in many disciplines. Medical students from UNM have been traveling to Ecuador to conduct preliminary surveys regarding the health knowledge, attitudes, beliefs and behaviors of the local people and providers. Not surprisingly, as in other developing countries, the students have discovered that major health problems in Latin America relate to poverty, malnutrition, unclean water and a variety of potentially preventable infections. The remote telemedicine sites can serve as “base camps” for ongoing field research, such as further investigation related to tropical diseases such as Chagas, malaria, dengue fever, and leishmaniasis. This Ecuadorian telehealth network has initially established connections between a telemedicine center at UTE and two remote communities, one in the jungle and other in the Galapagos, with plans to expand to sites throughout Ecuador. Overall, 29% of the telemedicine consults have included of patients < 18 years of age. Several other Latin American countries have established active telehealth programs and these efforts are being coordinated in part through collaboration with the American Telemedicine Association Latin American, Caribbean Chapter (ATALACC).

There are several examples of lower band-width telehealth solutions. The Swinfen Charitable Trust (SCT), established in 1998 by Lord and Lady Swinfen in the United Kingdom, aims to assist poor, sick, and disabled people in the developing world by providing an inexpensive store and forward telemedicine service to hospitals, clinics, lone doctors, and nurses in the developing world. Referring sites agree to treat patients free of charge if they cannot afford to pay. SCT provides digital cameras, tripods and occasionally computers to referrers if required. All staff and specialists work on a voluntary basis with the exception of one part-time administrator. Specialists participate from all over the industrialized world. As of June 2009, 153 participating hospitals and clinics in 50 countries use the SCT program. A web based message handling system coordinates and tracks referrals and responses and also archives all messages. Pediatrics and its subspecialties account for about 28% of all telemedicine consults. A similar Web-based international consultation program has been recently launched in the United States called iCons in Medicine that is based at the Center for International Rehabilitation in Chicago; <http://www.iconsinmed.org/>. Similar to SCT, The mission of iCons in Medicine is to improve healthcare in remote and medically underserved areas and to reduce global

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Medical Missions for Children (MMC), <http://www.mmissions.org/>, incorporates telehealth to share knowledge across the global community. At MMC, their mission is stated to “transfer medical knowledge from those who have it to those who need it using the latest in communications technology.” As part of their efforts, they have a “Telemedicine Outreach Program (TOP)”. MMC maintains a network of mentoring hospitals in the United States and Europe that participate in TOP. Through a recent partnership with the World Bank, they now have a direct presence in more than 100 countries, electronically linking a physician with a patient in a remote location, providing a diagnostic consultation for providers in these countries directly benefiting the patient, as well as providing a valuable learning experience for all the medical professionals involved.

Founded in 1991, the Global Health Education Consortium (GHEC), <http://globalhealthedu.org/pages/default.aspx> is a consortium of health professionals, educators, students and institutions developing systems to provide health education and training materials to the global community. GHEC is a non-profit organization committed to improving the health and human rights of underserved populations worldwide and the ability of the global workforce to meet their needs through improved education and training. GHEC, has also been committed to improving the ability of the global workforce to meet the needs of underserved populations. GHEC members are active in more than 70 health profession schools and training programs in the United States, Canada, Central America and the Caribbean and a significant part of their educational and training efforts includes addressing the health care needs of children throughout the world.

The American Telemedicine Association (ATA), <http://www.americantelemed.org> , has also developed a Web-based International Telemedicine Resource Center designed to facilitate links to several international programs, such as those previously mentioned, addressing telehealth initiatives in a host of countries. The ATA international resource center offers an expanding inventory of international telehealth programs, as well as provides a point of contact for promoting coordination and awareness of these projects , as well as a platform for improved relations between developed and developing countries, that is a forum for health diplomacy.

III. Challenges

The challenges facing expansion of international pediatric telehealth can be summarized in several ways; lack of affordable ICT infrastructure, need for training local community individuals in the use of ICT for telehealth, lack of adequate specialty and primary care providers, political conflicts, corruption, varied cultural perspectives related to health and wellness, language differences, illiteracy, lack of funding, lack of coordination among developed countries, non-governmental organizations (NGOs), telehealth organizations, and industry.

More routine obstacles include resistance from primary care providers and specialists, lack of standardized telemedicine practice protocols, and concern that telemedicine may decrease the bedside presence of consulting physicians in local hospitals. Technical challenges include the complexity of many different software, hardware, and telephone line options in different locations (all of which may function normally in isolation but not in concert) and which may pose difficulties when locating system malfunctions. Essential to any effort is planning for “down time” and for disaster recovery. Strong leadership must exist to overcoming barriers to acceptance including removal of technical, organizational and legal issues surrounding telemedicine.

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The time difference can be crucial when trying to do live videoconferencing between North America and European, Middle Eastern, African, or Asian countries. Many Middle Eastern countries observe different weekend days which further limits the amount of common work time for live patient care discussions and educational conferences. Language barriers must be considered and a plan for translation on both ends, both spoken and written should exist. Time zone and language issues are compounded when multisite teleconferencing is carried out. Constant IT staff communication must take place to overcome any issues with computer hardware and software incompatibility. Wireless cellular technology is ubiquitous and provides additional opportunities for connectivity. Availability of correct cell phone contacts for key medical and IT staff is often the difference between success and failure.

A thorough understanding of local bandwidth availability and telecommunications networks are crucial. Many underdeveloped countries still have limited bandwidth that does not allow for practical viewing of video streaming and downloading of large files. Sensitivity to local medical practices goes a long way toward building a long term relationship critical to success. Attempts at forcing medical practices that are not practical in the countries on the other end of the telemedicine links will not succeed. Ultimate sustainability depends on ongoing funding through a viable business plan and/or long term vision for grant support. Clear goals should be outlined and measures of success and failure should be tracked. Above all else, telemedicine partnerships are about the relationships between the end users. This includes visits by the telemedicine team to the countries involved, especially in the early stages of a program.

The term “developing world” is unfortunate because it aggregates a wide range of economies into one group. Approximately 5 billion people make up the developing world, but it is the “bottom billion” people, the poorest, who live in the least developed countries who have the greatest need for telemedicine support. Sub-Saharan Africa is home to many of the least developed countries. From the sub-Saharan African perspective, telemedicine holds great promise, but expectation must be tempered by reality. The WHO World Health Report of 2006 summarized the problem concisely, “... Africa has 24% of the burden (of disease), but only 3% of the health workers commanding less than 1% of world health expenditure.¹⁸” The United Nations Population Division, in its medium variant, forecasts the population of Africa doubling over the next 40 years¹⁹. In three African countries the median age is 16 years or less. Achievement of the Millennium Development Goals (MDG) aims at reducing maternal mortality, infant mortality and infectious diseases, tuberculosis, malaria and HIV/Aids all of which affect child health⁵. In July of 2008, the MDG Africa Steering Group noted that, “Africa as a whole is off track to meeting the MDGs on reducing child mortality, improving maternal health and combating infectious disease.²⁰” For the foreseeable future there will be a large number of children being born and dying in Africa because of resources shortages.

Telemedicine requires infrastructure which is lacking in many countries such as in sub-Saharan Africa. Poor nations have low GDPs, small national budgets, and as a consequence, Governments of over 30 African countries budget less than US\$ 0.06 per capita, per day, for healthcare²¹. Telecommunication is expensive and Internet penetration in sub-Saharan Africa is less than 4%²². Only 40 of over 2000 languages spoken in Africa are available on the Web²³. Mobile phone penetration in sub-Saharan Africa is currently at about 30% and in several countries the cell phone is now the predominant means of Internet access. Facing these constraints, it is hardly surprising that telemedicine use is very limited in sub-Saharan Africa.

Enthusiastic proponents of telemedicine for the developing world also often overlook several additional fundamental issues. Telemedicine increases workload; it adds extra steps into the routine workflow for both the sender and the recipient. When there is already an extreme shortage of health workers who are already overburdened these extra steps make telemedicine, as a solution, unattractive. The solution may not be in solving the problem within a country but through international, cross border telemedicine. Apart from the technical issues, there are financial, political, and cultural barriers to telemedicine.

steps make telemedicine, as a solution, unattractive. The solution may not be in solving the problem within a country but through international, cross border telemedicine. Apart from the commonly cited potential legal and ethical problems of international service, there is need for an understanding of commonly seen local pathology, diagnostic algorithms, availability of diagnostic tests, therapeutic options, and the local pharmacopoeia.

Another overlooked issue is that when there is a shortage of doctors in a country, there is usually a shortage of doctors to teach doctors. Where there is available infrastructure, tele-education is well received. There are examples of successful international tele-education programs in Africa which include some pediatric education. In the Francophone African countries, the RAFT (Resau en Afrique Francophone pour la Telemedicine) project, based at the Hopitaux Universitaires de Geneva, runs a weekly medical education session involving up to 15 sites in West Africa. The African Medical and Research Foundation (AMREF) based in East Africa has begun a CD based nursing training program to improve the training and qualifications of nurses in Kenya and Rwanda and is soon to implement distance based nurse education.

The major challenge facing international pediatric telemedicine initiatives designed to assist the developing world is the need for a paradigm shift along with the development of a new telemedicine model appropriate to the realities of the developing world²⁴. Consideration has to be given to finding ways of extending existing humanitarian services such as those offered by the SCT and other similar organizations. Another possibility is to have hospitals in the developed world “on call” for partner hospitals in the developing world. Unpublished data from a recent pilot study in South Africa suggests that the number of pediatric cases that would be referred from a typical rural hospital for second opinion advice would average about one per day. Humanitarian assistance is not without potential problems. Turn around time for store and forward telemedicine advice needs to be monitored and controlled. There is the issue of dependency on an external service, beyond government control, which could be withdrawn at any time for a variety of reasons.

IV. Opportunities

Moore's law states that technological capability will double approximately every two years²⁵. The implications of this concept for the exponential growth and widespread acceptance of telemedicine are tremendous. The line between traditional health care and telemedicine will continue to blur as computing speed becomes greater, storage space becomes less expensive, and options for high speed bandwidth become more universal. The vision of being able to open up a computer (or hand held device) at anytime in anyplace and have full access to any type of medical test (including full motion video) and any education content with wireless technology at acceptable speed is not far off. Of course the ability to maintain confidentiality and security will need to expand at the same time. Virtual diagnostic and therapeutic health care centers could be established in community hospitals without access to subspecialists, rural areas, and third world countries. These centers could also serve as education hubs for nurses, physicians, and the public. A parent could take their child to one of these centers and receive almost any type of medical test through on site personnel who are guided by physicians at tertiary care sites. As long as high quality care is maintained, the conveniences of this type of program will likely lead to equivalent or greater satisfaction than traditional office visits.

Telemedicine is an obvious answer to many global health care and medical education needs²⁶. Yet, many obstacles remain and telemedicine is no where near its potential. As health care costs continue to spiral out of control and the variability in health care among socioeconomic groups widens, it is critical for physicians, hospital administrators, lawmakers, and the public to be forward thinking and take advantage of the great potential telemedicine affords.

V. Moving Things Forward and Next Steps

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Next steps should include developing an expanded virtual international telehealth resource center using Web-based technologies to improve awareness of telehealth initiatives within each country and across borders, promoting international collaborations and coordination among programs offering pediatric telehealth services. In addition, another step should include exploring and developing potential new pediatric telehealth services that meet needs as defined in each country that utilizes an expanding international network of networks. Emerging new information technologies, wireless systems and handheld devices can provide complimentary systems for global connected health and cultural exchange. These approaches will provide platforms for sharing knowledge and best practices that can be realistically customized to the needs of each country based upon existing resources and future potential improvements in their healthcare systems and ICT infrastructure. Additional efforts should focus upon provision of access to affordable educational and training materials, as well as electronic journals. As needed, multi-lingual materials and modes of communication should be provided. Lastly, recognition of traditional healing practices should be integrated that build upon unique cultural perspectives related to holistic health and wellness.

VI. Conclusion

ICT applications to healthcare called telehealth, eHealth, mHealth, or overall “connected health”, offer the opportunity to transform systems of care in profound ways that can improve the health and wellness of children and their families in the global community, at individual, community and population levels. These approaches can improve access to care, education, training, sharing knowledge, and health research throughout the world in culturally appropriate ways that address fundamental needs, as well as specific unique health needs of each country. Ultimately telehealth can improve capacity to manage health and wellness locally, improving the quality of life of all people including children and their families, by “thinking globally but acting locally.”

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