CHAPTER 127
Telemedicine and E-Health

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Introduction

The challenges facing Africa in delivering high-quality paediatric surgical care during the next century are great. Overcoming poverty, difficult access to medical care, governmental instability, lack of trained physicians, and a large burden of existing and emerging diseases all appear at times insurmountable. In September 2000, the largest gathering of heads of state ever held, including leaders from 189 countries, adopted the Millennium Declaration with eight Millennium Development Goals (MDGs) as a blueprint to accomplish by the year 2015.[1] These include progress in ending poverty and hunger; addressing universal education, gender equality, child health, and maternal health; combatting HIV/AIDS; and working toward environmental sustainability and global partnership. The MDG update report for 2008 shows that Africa continues to have the largest need of any continent in the world, and is making only minimal progress in meeting its goals.[2]

Medical diagnostics and therapeutics are becoming more advanced daily, creating a larger gap between services possible in the industrialised world and those available to most Africans. The physician in Africa is forced to work between two worlds: one of technologic advancement and voluminous medical information and one of limited resources and profound medical need. How can the modern African surgeon bridge this gap? Appropriately applied technology can provide part of the solution. Information and communication technologies continue to undergo a revolution, making instant access to remote locations easier and less expensive. Telemedicine utilises these technologies to bring medical information and services to geographically or physically isolated people who would not otherwise be able to reach a physician. Perhaps the greatest utility of these technologies is in the developing world, where the disparity between access and need is the largest. The World Health Organization (WHO) has recognised the capacity of telemedicine to increase health care information and delivery. WHO recommends that all their member states should:

> integrate the appropriate use of health telematics in the overall policy and strategy for the attainment of health for all in the 21st century, thus fulfilling the vision of a world in which the benefits of science, technology and public health development are made equitably available to all people everywhere.[3]

The Africa Health Infoway is the current initiative of WHO to provide a technology platform that supports the collection of subnational health data and statistics for analysis, dissemination, and use to facilitate decision making in health and to strengthen the capacity of African countries to use information in decision making.[4] WHO is working in collaboration with the International Telecommunication Union (ITU), Digital Solidarity Fund, Telemedicine Task Force, and others to establish telemedicine infrastructure, district health information systems, and e-health applications to improve health care delivery in Africa. Specific emphasis is being directed to remote areas. Having an understanding of the terminology, functioning, and applications of telemedicine is of great importance for the African surgeon. This chapter is written as an introduction to that knowledge.

Definition of Telemedicine

Telemedicine is the delivery of health care and the exchange of health care information across distances.[5] Information, rather than the individuals, is moved from one place to another. Analog voice and video are fading from use, although we may continue to rely upon handwritten messages—the modern information mode is digital. The capture and exchange of digital information is enabled by the targeted use of medical recording devices and communication technologies. Telemedicine is not a new form of medicine or a separate specialty; rather, it is technology applied to the entire scope of current medical activities to link one location to another. Telemedicine finds application in clinical evaluation of patients, physician consultation, continuing education for health care providers and the public, administrative tasks, and research. The term “telecare” refers to telemedical applications to deliver services to chronic or debilitated patients at home or in specialised care centres. An argument has been made for utilisation of the term “telehealth” to include public health ventures and other health professionals such as community health workers and psychologists.[6,7] The term “e-health” has also gained some favor to include medical applications utilising the Internet.[8]

History

Over the years, telemedicine has mirrored the development of communications technology. In the mid-19th century, the telegraph was utilised to convey casualty information and order medical supplies during the American Civil War.[5] The telephone was introduced in the late 19th century, and it immediately found widespread telemedical application. Radio medical consultation occurred as early as 1920 through the Seaman’s Church Institute of New York to provide medical advice to seafarers. The International Radio Medical Centre (CIRM), which was set up in 1935, became the largest organisation to provide maritime radio telemedicine. In its first 60 years, CIRM gave medical assistance to more than 42,000 patients at sea.[9]

The introduction of the television became a new source of inspiration for distance medicine. In the United States in 1964, the Nebraska Psychiatric Institute in Omaha set up a two-way closed-circuit television link to Norfolk State Hospital, 180 km away.[10] This was utilised for education and consultations between specialists and general practitioners. Another example was the Massachusetts General Hospital/Logan International Airport Medical Station established in 1967, which accomplished a two-way microwave link for medical care of passengers and airport employees 24 hours a day.[11] Satellite communications were first utilised in 1971 by the Alaska ATS-6 Biomedical Demonstration, which worked to improve village health in Alaska by using satellite-mediated video consultation.[12]

Initially, telemedical applications were expensive and required the funding of large high-tech ventures such as the space explorations of the National Aeronautics and Space Administration (NASA) in the United States. These applications were targeted for the monitoring and care of their own astronauts, but were also expanded very early to meet the medical needs of rural populations, such as the Papago Indian Reservation in Arizona in 1972.[13] NASA was also involved in the first international telemedicine programme in 1989 through the Space Bridge to Armenia and Ufa.[7] This project was initiated following a massive earthquake that hit the Soviet Republic of Armenia. It demonstrated the utility of telemedicine to cross geographic, cultural, political, and economic distances. Four medical centres in the United States utilised video, voice, and facsimile to deliver telemedicine consultations over a satellite network.

The contributions of many other individuals and organisations, combined with the rapid development of communications technologies, have led to the international explosion of interest and experience with telemedicine over the past 30 years. African telemedicine has seen several successful initiatives, but is still in its infancy. Perhaps the most established telemedicine system in Africa is the Réseau en Afrique Francophone pour la Télémédecine (RAFT).[14] Formed in 2000, RAFT now broadcasts weekly continuing educational sessions, coordinates videoconferences, and facilitates teleconsultations to 10 French-speaking African countries. The future of telemedicine and e-health in Africa is full of promise.

Classification

Telemedicine can be classified by the people involved in the connection, the types of interactions, and the information conveyed. Typical forms of people interactions include clinical evaluation between doctor and patient, clinical consultation between physician and expert, and education between professor and student. Many other forms of communication are possible, such as conferencing for strategic planning or administrative tasks.

Interactions can be either asynchronous (also called store-and-forward) or synchronous (real-time). These forms have their respective benefits and drawbacks.

Asynchronous Telemedicine

Asynchronous applications rely on storing prerecorded digital data, which can be accessed at any time by the recipient. One example is email, which is sent to and stored at a regional network server. Asynchronous telemedicine can be very convenient for both parties because it eliminates the need to coordinate complex schedules, sometimes across time zones, for a live consultation. The systems infrastructure to support it is relatively simple, generally requiring less bandwidth and fewer technical components than synchronous telemedicine. Asynchronous telemedicine also has much lower costs associated with its utility compared to live interactions. Teleradiology, teledermatology, and telepathology are fields of medicine that lend themselves well to this form, as they rely mainly on static images, which can be easily digitised and transferred. Electronic medical records (EMRs) and data reports are also conveyed well asynchronously. Asynchronous technologies have been shown to be feasible, clinically useful, sustainable, and scalable for the developing world.[15,16] Disadvantages of asynchronous telemedicine include delay in response to the question, the impersonal nature of the communication, and the inability for the consultant to affect or manipulate how the data are acquired. Asynchronous technology cannot be the primary modality for emergent situations.

Synchronous Telemedicine

Synchronous telemedicine involves a real-time connection with continuous streaming of data. One simple example of real-time audio telemedicine is through the use of the telephone. This has been widely used for patient evaluation, follow-up, and education. The current advances in mobile phone technologies are exciting, with many potential applications to telemedicine. Mobile phones have already been utilised effectively to convey digital images and electrocardiograms (ECGs). Another example, which many associate most readily with telemedicine, is videoconferencing. This form of telemedicine is effective in terms of patient consultation and has good patient satisfaction.[17,18] It allows immediate results, and consultants can request missing data with instant response. Real-time consultation also enables greater education to be conveyed from the expert to the recipient. Bergmo has estimated that a general practitioner in rural Norway was able to reduce his referral rate to an ear, nose, and throat (ENT) specialist by 50% in one year based on the improved knowledge acquired through weekly interactions.[19] Drawbacks to videoconferencing technologies include scheduling difficulties, high costs for system acquisition and upkeep, and the larger bandwidth required to support the application.

Types of Telemedicine Data

Data conveyed through telemedicine can be classified into text documents, audio, still images, and video images. All of these forms can be utilised by synchronous or asynchronous technologies. Text documents can be recorded in digital form on an EMR or digitised from paper forms with a document scanner. Audio applications include voice recording through radio, telephone, or video as well as digitised stethoscopes, which can be effective in evaluating heart tones. Still images can include radiographs, ECG tracings, digital photos, pathology slides, and other medical reports. Low-cost digital cameras can be invaluable in data recording. Diagnostic agreement between teledermatology consultations using digital still images and face-to-face consultations have been found to be between 51% and 95%, which is similar to levels of agreement between dermatologists in separate face-to-face examinations.[20] Prerecorded telepathology images have been shown to have a high degree of agreement (97%) versus examination at the microscope.[21] Radiology already has wide applications in telemedicine, and well-established DITEC standards of image quality.[22] Videos are useful for patient exam, and for medical study data such as ultrasound, teaching, and operative recording.

Distance Information Transfer

Transfer of digital data requires a recording device at one end that can encode the information for transfer, a transfer path or "backbone", and a receiving device that can decode the information and display it. Many different technologies have been developed and continue to emerge to facilitate these three phases of distance information transfer.

Data Technology

Digital data are transferred in quantities called bytes (B) and bits (b). A byte of information corresponds roughly to a single character of alphabetical text. Each byte is represented in the computer by 8 binary digits (either 0 or 1) called bits. Thus 5,000 bytes (5 kB) is equivalent to 40,000 bits (40 kb). Telecommunication networks are evaluated by how much data-carrying capacity they have, or their bandwidth, which is measured in bits per second (bps). Bandwidth can range from 1,200 bps for certain mobile phones to more than 1,000 Mbps (1,000 million bps) for fibre-optic cables.[5] The speed of data transmission is based on how much bandwidth is available. As more connections are made through the same server simultaneously, the amount of bandwidth available to any single user decreases. To speed data transfer or accommodate bandwidth, digital data can be compressed to smaller amounts by using algorithms such as those employed by commercial videoconferencing units. This, however, may lower the quality of the video image in order for it to be transmitted in real time. If higher quality is required, either more bandwidth is required for real-time functions or data can be sent asynchronously over a longer time. For many telemedical applications, however, data of adequate quality can be conveyed at very low bandwidth.[23] Compression devices must be compatible on both ends of the link. International standards have been adopted through the ITU to ensure that videoconferencing units from different manufacturers can operate with one another. The common intermediate format (CIF) provides compatibility between the National Television Standards Committee (NTSC) broadcast TV video standards utilised in Japan and

North America and the phase-alternating line (PAL) used in Europe, despite the different display characteristics in these systems.

For a telemedicine connection to be functional, it needs to have adequate bandwidth and be sufficiently reliable. Many possible solutions to the means of data transfer have been developed. The following discussion of the subtypes of data transfer is intended to show that a technical solution to the information problem can exist anywhere in the world. Some technologies lend themselves more strongly to the solution in certain areas.

Standard telephone

Standard older telephone lines operate on an analogue-based public-switched telephone network (PSTN). This technology sets up a one-to-one connection between the ends of the link but has low bandwidth (56 kbps) and is not reliable due to complex mechanisms required for electromechanical switching. In addition, analogue data are lost based on the distance the information has to travel.

Digital data transfer

The advance to digital data transfer used in Integrated Services Digital Networks (ISDN) in many areas of the industrialised world preserved the one-to-one connection of PSTN lines while solving some of its problems. Digital data are not lost or corrupted across distance, do not require electromechanical switching, and offer higher bandwidth. Basic-rate ISDN lines offer a bandwidth of 128 kbps in two separate 64 kbps channels, which are capable of operating basic commercial video-conferencing systems. Three ISDN lines can be aggregated together in a cable to provide bandwidth of 384 kbps, and primary-rate ISDN lines offer a bandwidth of 2 Mbps. ISDN lines are very useful for telemedicine because they are reliable, secure, and have sufficient bandwidth. However, they are not available in most areas of Africa, require significant cables to be run over large distances, and are expensive to operate. Telemedicine can employ such technology only when demand has been created by a wide range of commercial users. Due to these limitations, this is likely not the best solution for development of telemedicine infrastructure for Africa.

Satellite

Satellite connection offers bandwidth similar to that of ISDN and has global coverage with good utility in remote locations. Satellite has traditionally been very expensive to establish and operate, but as technology improves, costs decrease. The Telemedicine Task Force, composed of various African organisations, WHO, the European Commission (EC), and the European Space Agency (ESA) completed an evaluation in sub-Saharan Africa in 2007, finding it the most disenfranchised region in the world with regard to Internet access.[24] The Task Force concluded that complete telemedical coverage of the region could be accomplished by complementing the existing terrestrial infrastructure with satellite communications.

Broadband

With reference to standard telephony, the digital subscriber line (DSL) is often referred to as broadband and provides the user with an Internet protocol (IP) address. It utilises the same copper wires as a telephone to establish a higher bandwidth connection. One limitation is that the connection must be within 5 km of the telephone company switch, as speed drops off with distance. Also, the bandwidth to receive data is much higher than what is available to send data, so it has limited application for videoconferencing.

Wireless

Wireless technology is already finding widespread application in Africa through mobile phones. Currently, digital data transfer on this technology is limited by low bandwidth, similar to the situation with PSTN. Even at this bandwidth, some telemedicine applications are possible. Mobile phone technology has already been used to effectively transmit computed tomography (CT) scans[25] and ECGs,[26,27] evaluate soft tissue injury,[28] and monitor glucose levels and insulin therapy in diabetics.[29] As mobile third-generation (3G) networks that offer higher bandwidth become established, more applications will be forthcoming. The development of fourth-generation (4G) networks carry bandwidth potential of 100 Mbps or perhaps a Gbps (1,000 Mbps). This can provide comprehensive Internet, voice, text, and video transmission wirelessly, where available. One special aspect of wireless is that it relies on line-of-sight transmission, so there must be a regular tower to pass on the signals. Wireless cannot go through walls unless the transmission energy is appropriately strong. Wireless can bridge back to a satellite transponder or to a suitable fibre-optic cable in larger cities. In terms of cost and utility for rapid telemedicine systems development, wireless technology will likely be the most appropriate solution in developing nations, rather than expanding traditional terrestrial forms such as ISDN. In currently available WiMAX (worldwide interoperability for microwave access) configurations, transmission rates for wireless easily reach a megabit per second (a million bps). WiMAX technology, a telecommunications protocol that provides fixed and fully mobile Internet access, is already available in many parts of Africa, with deep penetration in South Africa and Uganda. We can anticipate significant gains toward at least WiMax, and eventually 4G, for coverage of the continent with dependable and affordable telecommunications.

Asynchronous Transfer Mode takes advantage of fibre-optic cables for very high bandwidth transmission (gigabits per second). Usually this is used for the backbone for major telecommunications carriers for data transfer over large distances. It is not available for user application.

Internet

The Internet is a collection of interconnected worldwide web (WWW) servers that store data for subsequent distribution to users. It is accessed via a modem at the bandwidth of the lines through which it operates. The Internet has limitless application for telemedicine. One of the difficulties with the Internet is limiting access to secured information. Virtual private networks (VPN) or private secure connections between two sites can be established. The limitation is the bandwidth available locally through the Internet service provider (ISP). In 2008, most of the world switched to the next protocol iteration standard, called IPv6. In this Internet agreement, delay at routers is much reduced, and privacy is greatly enhanced by encryption technology inherent to the format. The Internet can easily be made broadband by additional fibre links and can be accessed by satellite.

Voice-over-IP technology is the intersection of Internet and telephony and can convey voice and imaging with great fidelity. Simple Internet access can assure participation in the global knowledge pool of medicine, which doubles every several years. Internet means that medical innovation need not remain out of reach until someone actually travels to the site of the innovation and participates in expensive courses.

Internet email means that the community of medicine can be truly collegial. It allows physicians to contact peers in the region to accumulate information on disease burden or epidemics. Certainly, local experience is pertinent and may be paramount in seeking solutions for one patient or a population. Digitising data allows smaller areas to pool data into larger databases, which may have a higher impact on understanding regional disease patterns. Sometimes it is much more reasonable to contact the surgeon in the next district who shares the same issues and challenges rather than to look for advice from Europe or the United States. However, paediatric surgery is a specialty with certain diseases and congenital malformations that present infrequently. Many of these rarities can be easily treated with the right guidance. Internet email allows a doctor anywhere to contact the best medical centres with the most advanced technology to seek advice on difficult cases.

Implementing a Successful Telemedicine System

Many barriers and problems can exist when implementing a telemedicine system. Programmes have been started with excitement only to see expensive equipment sit idle. Careful planning, clearly defined objectives, and perseverance are necessary for success.[30] A list of helpful guidelines for anyone considering telemedicine applications follows:

1. Be sure technology supports a defined medical need. Purchasing expensive videoconferencing technology is wasteful if the objectives can be met through a simpler technology. American surgical teams visiting Africa have shown low-bandwidth store-and-forward patient descriptions and digital photos have high accuracy and utility for adult and paediatric surgical prescreening.[31] These simple and inexpensive technologies should be the starting point for teleconsultation and network building in the developing world.

2. Become familiar with technology and terminology and facile with such computer applications as Microsoft® Word, Excel, and PowerPoint. Be able to speak authoritatively with decision makers about plans and purchases. Telemedicine input is just as important as advice on the purchase of a new medical device or stocking a new drug. Be the champion and not the victim.

3. Utilise electronic means to record and track your own practice. Electronic charts and digital photos provide a great data resource for patient follow-up, can easily be transferred to email communication for consultation, and can be incorporated into data bases, papers, and presentations.

4. Identify committed individuals at both locations in the consultation link who will champion the effort. If the desire and work is unidirectional, unanswered communication can cause frustration and system failure.

5. Make technology infrastructure simple to use and reliable. All individuals directly involved need to have adequate training on the operating systems. Technical support should also be available. Apprehension about unknown and confusing technology can be a large barrier to some medical professionals becoming involved in telemedicine.

6. Develop good relationships with local government, surrounding hospitals, and remote sites. This is essential. The telecommunications backbone often requires upkeep and upgrading at the governmental level. Be open and honest about intentions and needs.

7. Involve an expert when planning a budget for the project. Expenses for equipment acquisition and setup, communications charges, education, personnel, and data-recording devices need to be included. Reimbursement for services should be established with the consultant. Make clear which expenses are the responsibility of the remote site. Many private and public grants and initiatives for telemedicine are currently targeting sub-Saharan Africa. With clearly defined goals and needs assessments, money can be available to initiate these programmes. This is especially helpful in the initial start-up phase, when the majority of the financial burden exists for equipment acquisition and setup.

8. Look for international efforts that seem to be helpful. If short-term volunteer groups are coming to the area, make the best use of their time by store-and-forward consultation ahead of time to set up an operative plan and list of equipment needs. These groups are an excellent resource for future collaboration and consultation on difficult cases. Make sure that you build relationships through progress reports and follow-up on patients these teams cared for.

9. Take advantage of the many opportunities for virtual networking. Get email addresses of colleagues in the region and communicate frequently, anecdotally and even quantitatively, as you share your experiences, problems, and joy of practice in a virtual community. Contact a professional society with a question. Try the Swinfen Trust for consultation. Send an email to the corresponding author on a paper. Join a telemedicine society.

Tele-education

The Internet provides a platform of instant access to up-to-date medical information, continuing education, video instruction, medical societies, and research. Online publishing is unregulated, so care must be taken to gather information from reputable, peer-reviewed sources of information. Online access to medical societies, full medical texts, and journal articles has in the past been limited in Africa due to the cost of subscriptions.

Health InterNetwork Access to Research Initiative

The Health InterNetwork Access to Research Initiative (HINARI) gives the developing world free or very low-cost online access to peer-reviewed journals in biomedical and related social sciences. HINARI was launched in 2002 by WHO in collaboration with major publishers as well as public and private partners to strengthen public health services by providing access to high-quality, relevant, and timely health information via the Internet to public health workers, researchers, and policy makers.[32] Local, not-for-profit institutions can register for access to journals through HINARI with cost based on the country's annual gross national income (GNI, World Bank figures). Those countries with GNI per capita below US$1,250, which includes many African nations, are eligible for free access. Those institutions in countries with a GNI of US$1,250–3,500 pay a fee of $1,000 per year per institution. The programme has more than 2,500 participating members in 113 countries. More than 100 publishers now give access to more than 5,500 full-text journal titles. The Internet also offers webinars and other websites for information. Because Internet data are not officially regulated, however, not all information is reliable. Professional societies are usually reliable and provide links on their websites to other good resources.

Instructional and continuing education sessions can be established through a real-time video or audio link. This access can provide expertise that would otherwise rarely be available in remote settings.

Information and Communication Technologies

Although widespread adoption of the use of information and communication technologies (ICT) has not occurred in sub-Saharan Africa, isolated examples of sustained use of ICT in health education do exist, which serve as models of what is achievable. The Internet, WWW, and videoconferencing offer seemingly simple solutions to the provision of, and access to, information and teaching for countries with a shortage of doctors. They also offer the potential of telemedicine and learning through case discussion.

Several reasons exist for the lack of technology on the African continent, including restrictive telecommunications' legislation, lack of basic infrastructure, and high telecommunication costs. Although every sub-Saharan African country has Internet access, this is presently mainly in the urban areas. Rural areas, where it is estimated that approximately two-thirds of sub-Saharan Africa's population lives,[33] have only limited access. Internet penetration for the continent is 11%, and for sub-Saharan Africa, it is 7%.[34] Broadband penetration is about 1%, with fixed line broadband access less than 0.1%.[35] Internet access costs are high. The ITU has developed an ICT Price Basket and ranks 161 countries on the basis of a set of standardized fixed phone line telephony, mobile cellular, and broadband services, and describes these in terms of relative cost expressed as a percentage of the average monthly GNI per capita. Nineteen of the 20 most expensive services are in sub-Saharan African countries.

Broadband costs vary greatly. In the Central African Republic, Ethiopia, and Malawi, the monthly cost of the ITU bundle for fixed broadband services is 39, 21, and 20 times the average per capita GNI per month, respectively. Broadband access exceeds the monthly GNI in 19 African countries.[36] Satellite connectivity costs in Africa also are higher than in the developed world. The average annual satellite Internet licence fee for African universities in 40 countries was US$13,553, compared to US$426 for European Union universities.[37] Even though prices have come down, they remain higher than terrestrial links.[38]

Significantly more bandwidth has become available to Africa with the completion of the TEAMS, Seacom, and EASSY undersea cables that have been laid around the East coast of Africa, with landfall sites in South Africa, Mozambique, Tanzania, Kenya, Somalia, Djibouti, Eritrea, Sudan, and Madagascar. West Africa, which has long been dependent on the SAT3 cable for terrestrial bandwidth, will have another four undersea cables operational in 2011. Several countries have commenced laying a fibre-optic backbone between cities and into larger towns. Expectations are that bandwidth costs may fall by as much as 90%, but this has yet to realised.[39] O3b, which stands for the "other three billion people" who do not have Internet access, is a company that announced an ambitious plan to position 16 satellites over the developing world to offer low-cost, high-speed access to the Internet. More cost-effective Internet-based communication may soon become a reality in Africa.

The Future

The anticipated gradual deregulation of the telecommunication industries in Africa, reduction in bandwidth cost, and an associated increase in bandwidth provision will allow expansion of existing projects and the implementation of new projects. Internet penetration will, however, probably still remain low due to hardware setup costs. Internet access using mobile phones may increase penetration, but this is presently an expensive option. Videoconferencing hardware will remain expensive, but the alternative of desktop videoconferencing offers great promise for the African setting, especially if it is accomplished by using free and open source software.

Africa has a rapidly developing cellular telephone industry, with cellular telephone penetration in the region of 37%, as opposed to 7% for Internet penetration. Cellular telephony is set to grow in Africa. In 2007, the GSM Users Association pledged US$50 billion to the development of cell phone infrastructure in Africa over the next four years, to which the World Bank added US$5 billion. Cell phone coverage will far exceed Internet coverage in rural areas. Rapid advances are being made in migrating e-Learning to m-Learning (mobile learning) on smart phones and personal digital assistants (PDAs). Surgeons have been leaders in the use of technology in medicine, and it is probable that Africa will leapfrog what the developed world has taken for granted in terms of PC-based access to the Internet and the WWW and join in the cellular phone environment.

Conclusion

The medical needs of Africa are great, and many entities are committed to its improvement. Telemedicine can be utilised to bring high-quality information and medical care to locations previously limited by lack of finance, inadequate training, and geographic distance. Adherence to the principles described in this chapter can aid the development of successful telemedicine programmes throughout the African continent. WHO and many developed countries aim to aid Africa in its efforts to develop a functional telemedicine infrastructure that will ultimately have a major impact on the health of its children.

Helpful Resources

- PubMed: The National Library of Medicine's MEDLINE access (http://www.ncbi.nlm.nih.gov/PubMed) is a search engine offering free access to abstracts and many full-text articles for all medical literature indexed by the National Library of Medicine since 1966.
- Telemedicine Information Exchange (TIE; http://tie.telemed.org) is the largest and most comprehensive online source of information on telemedicine. It offers a bibliographic database to more than 15,000 telemedicine publications, information on more than 150 major international telemedicine programmes, lists of telemedicine meetings and conferences internationally, information on vendors of telemedicine equipment, and an extensive list of links to other telemedicine resources.
- Google.com is one of the largest and best search engines on the Internet.
- The International Society for Telemedicine and ehealth (ISfTeH; http://isft.net) is an NGO in official relation with WHO that exists as an international umbrella for national telemedicine groups and functions to disseminate knowledge and experience in telemedicine and e-health worldwide.
- The American Telemedicine Association (ATA; http://www.americantelemed.org) sponsors an international special interest group.
- The Swinfen Charitable Trust (http://www.swinfencharitabletrust.org runs a system that can be used in Africa for simple e-mail consultation.

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