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Telemedicine and the Pediatric Tertiary Care Center

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Telemedicine is broadly defined as the use of electronic communication and information technologies to provide or support clinical care at a distance. As such, telemedicine is not new to the practice of medicine, especially from the perspective of a tertiary care referral center. One can readily appreciate that the use of the telephone and fax machine in the support of clinical care meets this definition with familiar tools the medical community has accepted and incorporated for some time.

NEW TECHNOLOGY

The explosion in the use of personal computers, the rise of the Internet, and the increase in bandwidth capabilities over the past several years have provided a new set of tools with which to provide or support clinical care at a distance. The underlying infrastructure that now allows clinical practices to migrate from familiar technologies like the phone and fax machine to live, interactive video systems has been the dramatic increase in bandwidth capacity over the past several years. Using a highway analogy as a measure of information flow capacity, we move from a three-foot wide garden path to a four-lane highway as we compare bandwidth of plain old telephone service lines to a fixed data transmission (T1) line. Even the digital subscriber lines (DSLs) or cable modems now available in most communities for home Internet access provide the equivalent of a two- or three-lane highway through which information can be pushed. To appreciate the difference in the speed of transmission with greater bandwidth, one need only compare accessing the Internet at home through a dial-up modem with the use of a DSL. This increase in connectivity and digital information transfer capacity allows the use of new tools like videophones, asynchronous store-and-forward technologies, and live video interactive systems that directly mimic the physician or nurse's interaction with patients or referring physicians.

Videophones provide a low-bandwidth new technology that can augment standard interactions over phone lines. Clinical examples of the use of videophones with significant potential cost savings include use in the treatment of tuberculosis by reducing the need for public health nurses to travel to patients' homes in Washington state (1), and direct observation of inhaler use and assistance with exacerbation management in Japanese patients with severe asthma to improve asthma control and reduce hospital admissions (2). Videophones have been used in the neonatal intensive care unit at the University of New Mexico to allow mothers to see their premature infants and communicate with medical personnel when the mother is unable to travel to the tertiary care center. A videophone system used in Tokyo, Japan has also been used to provide respiratory care specialists' resources to primary care physicians and their pediatric patients requiring home ventilator support, resulting in a large reduction in unscheduled visits by patients, home visits by physicians, and hospital admission days (3).

Store-and-forward technology allows users to save (store) clinical information such as pictures, radiographs, video clips, laboratory reports, or historical data, and then transmit (forward) the information to a subspecialty consultant for an opinion. It has the advantages of allowing an asynchronous interaction when live, video interaction is not necessary and of requiring less bandwidth than live interactive video applications. Many aspects of the practice of pediatric subspecialties in dermatology, cardiology, radiology, and pathology are a natural fit for the store-and-forward telemedicine technique. Sending a digital picture of a rash, an electrocardiogram (4) or echocardiogram (5,6), digital radiology image, or pictures of pathology microscopic sections to a specialist for a second opinion is easy. Generally, specialists in these areas can be helpful to the patient and referring physician in the absence of a live interaction with the patient. Primary care physicians may also be the recipient of store-and-forward information. For patients with chronic illness, data being sent from the patient's home medical devices such as peak flow meters,

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blood pressure monitors, scales, or blood glucose monitors to primary care physicians via telephone lines are other examples of the use of store-and-forward telemedicine services. Since the specialist does not need to be present during the transmission of clinical data or images, it is easier to fit into his or her schedule. Unfortunately, store-and-forward services are generally not reimbursable except in special demonstration projects.

Live, interactive, video telemedicine services replicate the face-to-face clinician-patient interaction we are most accustomed to in the practice of medicine. This technique can be used for office visits, consultations, hospital visits, home visits, and continuing medical education. The availability of medical peripherals such as otoscopes, ophthalmoscopes, cameras, and stethoscopes extends the reach of the physician allowing much clinical care to be provided at a distance. When one includes the ability to receive digital x-ray images of plain radiographs, CT and MRI scans, electrocardiogram strips, and echocardiogram videos, we begin to appreciate the breadth of clinical services that can be delivered by telemedicine. The hardware, software, bandwidth, and cost required to support live, interactive telemedicine services exceed the needs of videophones and store-and-forward techniques, but this is the only model that is reimbursable in most states supporting telemedicine services.

Currently, hard-wired telemedicine systems are more common than those transmitting clinical data over the Internet. Hard-wired systems, connected by T1 lines, now allow the subspecialty physician to provide consultations at a distance to conference rooms or designated examination rooms in a hospital or ambulatory facility but limit the number of access points for referring doctors and consultants. An example of such a system is the Kentucky Telehealth Network which connects some 60 sites of clinical care across the state to medical centers in Louisville and Lexington (7). Greater connectivity will soon be achieved by using telemedicine applications on the desktop of referring physicians and their consultants, making access far more available than the current hard-wired system in Kentucky. Desktop connectivity via the Internet will increase the use of telemedicine services just as the availability of wireless telephones dramatically increased the reach and usage of telephones.

MAJOR FUNCTIONS OF A PEDIATRIC TELEMEDICINE PROGRAM

A telemedicine program can complement the pediatric services provided in tertiary care centers in two broad areas that can enhance relationships between physicians in the referral network and physicians at the tertiary care center: subspecialty clinical support and continuing medical education.

Clinical Subspecialty Support

Telemedicine support of pediatric clinical subspecialties can take several forms. The assessment and stabilization of the critically ill infant or child prior to arrival at the tertiary care center could be enhanced using live video communication linking specialists in emergency medicine, neonatology, critical care, or cardiology at the tertiary care center with physicians at the referral hospital. The feasibility of real-time telemedicine in facilitating pediatric transport to a tertiary center has been reported (8). Pediatric cardiologists have been providing this kind of urgent subspecialty support for over a decade by receiving and interpreting echocardiograms of neonates with suspected congenital heart disease.

Nonurgent consultation with medical or surgical subspecialists could be provided using store-and-forward methodology or live interactive services to assist the referring physician with assessment and management of patients. Many pediatric subspecialists already provide this kind of support by telephone. The use of telemedicine services provides a richer environment within which to deliver this service and is being reimbursed in many states if it is a live interactive video telemedicine visit. Many routine subspecialty follow-up visits for children with chronic illness could be accomplished with telemedicine technologies. This has been utilized for children with asthma, diabetes, and those needing psychiatric/behavioral or genetic counseling and dermatology or neurology evaluations (9).

Examples of the use of telemedicine in nonurgent pediatric clinical care settings abound. Clinicians at community hospitals in Iowa benefit from having access to pediatric radiology specialists at the tertiary care center (10), and the Center for Disabilities and Development at the University of Iowa uses telemedicine to provide evaluation by an interdisciplinary team of specialists for the estimated 70,000 children with developmental disabilities in that rural state (11). Children with type 1 diabetes managed in a telemedical care program in Germany enjoyed a significant decrease in mean blood glucose levels and hemoglobin A1c levels and a reduced frequency of hypoglycemic episodes compared with their own data prior to participation in the telemedicine program (12). The Florida Child Protection Team Telemedicine Network, operational since 1999, has reduced the need for child abuse victims to travel long distances for evaluation, allowing for timely and efficient evaluations close to home in familiar surroundings (13). Scott and White Memorial Hospital and Clinic, a large multispecialty group practice with their own HMO, has used telemedicine to link the central hub in Temple, Texas with 15 rural satellite clinics and hospitals. Their telemedicine network is used for emergency department consultations, pre- and postoperative care, and follow-up visits for children with chronic conditions requiring ongoing neurology or endocrinology evaluations. This network reduces the need for patients to travel long distances for specialty care and better serves their HMO members.

Continuing Medical Education

Continuing medical education (CME) provided via a telemedicine network can include the transmission of prepared CME content like Grand Rounds and other formal lectureships to physicians at sites in a network. Both university medical centers in Kentucky now send Pediatric Grand Rounds throughout the state via the Kentucky Telehealth Network. At the University of Louisville, we will likely expand this CME opportunity by offering our other major weekly teaching conference through the network as well. Our cardiologists are using the Kentucky Telehealth Network to train echocardiography technicians at rural hospitals in the nuances of pediatric echocardiographic examination techniques and to continue to improve the quality of studies we receive for interpretation. Specialty topics prepared for the primary care physician could be delivered through a telemedicine network to extend the reach of the subspecialist and to minimize travel. If the tertiary care center also trains residents and medical students at satellite facilities, telemedicine can provide a vehicle to allow satellite facility access to lectures, conferences, and other presentations delivered at the central location.

BENEFITS OF TELEMEDICINE

Using telemedicine for clinical care and CME has potential benefits to all stakeholders in the pediatric health care system. The child and his family may have to travel less for specialty care, and they can have more timely access to specialists managing chronic diseases such as asthma and diabetes. The remote clinician enjoys ready access to specialists and CME opportunities and can benefit from a reduced sense of isolation commonly felt by rural physicians. The rural hospital may benefit by capturing ancillary patient revenues that would have traveled with the patient to the tertiary care center and allows them to provide a broader range of clinical services to their community. It may also improve their ability to recruit and retain physicians in rural communities by reducing professional isolation. The tertiary care center benefits by strengthening its existing relationships with referring physicians. If the tertiary care center also provides insurance coverage for patients in the area, the use of telemedicine may have financial implications by reducing unnecessary transfers and providing better surveillance of patients with chronic conditions to avoid unnecessary hospitalizations and emergency department visits.

THE "NET GENERATION'S" EXPECTATIONS

As providers of primary and subspecialty pediatric care, academic medical centers and large multispecialty group practices will need to pay greater attention to the expectations of the "Net Generation," children currently 8-20 years old. Don Tapscott, in his book *Growing Up Digital: The Rise of the Net Generation*, defined how coming of age during the rise of the Internet affects the expectations of this generation in every aspect of their lives (14).

Instant access to large amounts of information, email, downloadable free software and music, scheduling vacations online, and instant messaging are as much a fixture of their environment as television was to my generation. As such, their expectations about how they want to interact with the health care system will demand things of us that most of us do not currently provide to our patients. This generation will want email access to their physician's office and online second opinions without waiting. They will question why it is necessary to drive 150 miles to see the specialist for a 15-minute visit that could have readily been accomplished via telemedicine. They will want to know why they and their hospitalized child with cancer cannot communicate via email or video link with other children with cancer at other hospitals or their classmates in school. The Net Generation's expectations for their own health care and for the care of their children must be taken into account by all of us who anticipate providing medical services to children for the foreseeable future. They are our current and the patients of our future pediatric patients for the next 20 or so years. Telemedicine services will be demanded by this generation. Systems of pediatric tertiary care that do not provide telemedicine services as a complement to traditional face-to-face physician/patient interactions will lose market share to those that do.

WHY SHOULD TERTIARY CARE PEDIATRIC CENTERS EMBRACE THE USE OF TELEMEDICINE?

There are four reasons why tertiary pediatric care centers should embrace telemedicine.

1. Telemedicine can improve the care we provide to children with chronic diseases like asthma and diabetes and reduce their need for travel to see subspecialists.

2. Telemedicine can extend the reach of undermanned subspecialists such as endocrinologists, neurologists, and pediatricians trained in child abuse evaluation.

3. Telemedicine services will be demanded for the next 20 years or so by the Net Generation and their children for some health care services, second opinions, health education, and home health care monitoring.

4. Telemedicine programs provide a strategy by which a pediatric tertiary care medical center could differentiate itself from its local or regional competitors, allowing it to gain and sustain competitive advantage in the health care marketplace.

Telemedicine could be used to extend the reach of the pediatric tertiary center's subspecialists to patient populations they are not currently serving. One need only look at the use of telemedicine for any population for whom travel to receive care is difficult. The University of Texas Medical Branch at Galveston has a long-standing history in the use of telemedicine. What began in 1996 as a less expensive and less dangerous way to manage the health care needs of Texas' prison population using telemedicine, has been turned to strategic advantage by serving other populations difficult or expensive to transfer, such as passengers on cruise ships and oil rig workers in the Gulf of Mexico. Telemedicine allows pediatric tertiary care centers to better serve the children and referring physicians in their traditional geographic referral region, but it also removes geographic barriers facilitating the delivery of unique subspecialty services to children outside of their traditional referral network. What other pediatric populations are in need of subspecialty consultation and second opinion services? Some creative thinking here by leaders of pediatric tertiary care centers might lead to new revenue sources desperately needed in the world of academic medicine in the United States.

CONCLUSION

Failure to appreciate, fund, and implement new telemedicine technologies in the support or provision of the care of sick children would be the equivalent of refusing to equip our hospitals and offices with a telephone system in the 1930s and 1940s, or with a fax machine in the 1990s. Newly available telemedicine technologies are a natural extension of the use of more familiar tools like the telephone and fax machines that we now routinely use to support or provide care at a distance. We need to embrace the use of these new tools to meet the health care needs and expectations of the children we care for now and for the foreseeable future.

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