

# International Teleneurology

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## Teleneurology

Teleneurology refers to the transfer of medical information from one site to another, using information and communications technology (ICT) for the management of neurological disorders. In this chapter, we discuss the rationale behind using teleneurology in different parts of the world, review work done in this field, and describe the various barriers affecting its widespread use.

## Why Do We Need International Teleneurology?

In a survey performed in 2006, the World Health Organization/World Federation of Neurology Atlas of Country Resources for Neurological Disorders showed inadequate resources for neurological disorders around the world. The survey included 109 countries and more than 90% of the world population. The survey showed disparities in access to neurology care, especially affecting low-income and developing countries [15]. Neurological and mental health disorders also have broader economic consequences. The cumulative global impact in terms of lost economic output from these disorders will amount to US\$ 16.3 trillion between 2011 and 2030 according to the World Health Organization [39]. The shortage of neurological

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services, experts, and treatment delays increases morbidity and mortality in this field. It is generally accepted that increasing the number of neuroscience specialists and providing them with the required infrastructure are not possible throughout the world [11]. The use of telemedicine to overcome some of the problems encountered by this shortage has been promising. Telemedicine enables more inpatient neurology consultations, provides effective treatment of acute stroke patients, optimizes treatment of epilepsy patients in hospitals, and gives better access to neurologists in developing countries [28]. The European Commission perceives that eHealth (providing health-care services through the use of information technology) and the broader application, ICT, can be used as a valuable tool to promote high-level neurological services, improve outreach, and make them more cost effective [7]. Government officials in the developing world have acknowledged the importance of this system in bridging the gap between need and supply of medical care [9, 36].

## International Telestroke Networks

Health systems are not well equipped to treat stroke patients in underdeveloped and developing countries. In a survey conducted across 25 European countries, with 448 of the 886 hospitals studied admitting at least 1 stroke per day, only 11.4% met the criteria for primary stroke center certification, showing ineffectiveness of stroke care, even in developed countries [21]. Majority of the suburban hospitals lacked stroke specialists, diagnostic equipment, and stroke treatment protocols in another survey from Beijing [38]. Telestroke has been used to great advantage in different parts of the world to overcome these obstacles in stroke care. Our experience, as part of the Michigan Stroke Network, has confirmed that telemedicine is an effective method for acute stroke care, especially for patients living in rural areas of Michigan, where there is a shortage of neurologists. This has been demonstrated by multiple different networks across the USA. Telestroke networks have also operated successfully in the Canadian provinces of Alberta and Ontario. Ontario has a single network with five consulting centers dedicated for acute stroke management [27]. In a report of 210 patients managed by the University of Alberta telestroke network, 44 (21%) received thrombolysis at 7 distant spoke hospitals. Over 2 years, the number of acute stroke transfers decreased from 144 to 15 at one of the “spoke” sites, a 92.5% decline [17]. This study indicates the importance of the increasing use of teletechnology in decreasing unnecessary transfers.

Telemedic Pilot Project for Integrative Stroke Care (TEMPiS) was the first pilot teleneurology network, outside the USA dedicated for stroke management established in 2002, supported by a Bavarian state grant. TEMPiS has since transitioned to be supported by a regular health insurance and is built around two comprehensive stroke centers in Eastern Bavaria. The network provided 10,239 neurology consultations between February 2003 and December 2006 and about 5.8% of the ischemic stroke patients were given thrombolytic therapy during this period [37]. Stroke Eastern Saxony Network (SOS-NET) is another large German telestroke network

in rural Eastern Saxony with approximately 1,600,000 residents. Over 3000 teleconsultations during July 2007 to December 2012 helped a quarter of the strokes to be transferred for comprehensive care and 43 % received recommendations for intravenous (IV) tissue plasminogen activator (tPA) administration [3]. Similar networks have also been established in other European countries including the UK, where there are now more than 30 acute trusts using telemedicine to provide prompt treatment to acute stroke patients [13]. The Lancashire and Cambria stroke network is the largest network among these, and serves about 2.2 million people with annual stroke rates of 4500/year [19]. The Helsinki University Central Hospital (HUCH) ran a network in Finland, and 57.5 % of the ischemic stroke patients were given thrombolysis during the 2007–2009 period with an acceptable incidence of intracranial hemorrhage rate (6.7 %) [33].

A pilot videoconferencing telestroke system was setup in Australia in 2009. It was established between Royal Melbourne Hospital (hub) and Northeast Health Wangaratta Hospital (spoke). The Northeast Health Wangaratta Hospital is 235 km from Melbourne and has a catchment population of approximately 90,000. Thrombolysis was not offered at this hospital as there are no on-site neurologists. The establishment of the telestroke system led to eight patients being offered thrombolysis in the first year without any complication of intracranial hemorrhage [26].

## International Teleneurology in Other Subspecialties

The use of teleneurology in other subspecialties is uncommon outside the USA. A systemic review in 2008, that included 15 papers, evaluated 5 ICT (information and communication technology) applications in dementia care around the world. The projects included ComputerLink, AlzOnline, Caring for Others, and two studies from the REACH project (TLC and CTIS). The results suggest that ICT interventions have moderate effects on improving caretaker stress and depression. All of these projects were based in the USA highlighting the rarity of ICT use for dementia care outside the USA [30].

Epilepsy remains an undertreated condition around the world though efforts to improve epilepsy care have been promising in the Western countries. There are over 50 million epilepsy patients in the world with 85 % living in developing countries according to WHO [6]. In developing countries, 75 % may not be receiving adequate treatment, while nine out of ten patients in Africa go untreated altogether [40]. Median number of neurologists in sub-Saharan Africa is estimated at 0.3 per 1 million populations with 11 countries having no neurologists. A collaboration with developed countries for neurological consultations [4] and teleneurology can be helpful in bridging the gap between the primary doctors in developing countries and neurologists in the developed world.

Epilepsy care presents with its own inherent problems, as these patients are restricted or unable to drive in most parts of the world. In nations with large rural populations, access to an epilepsy specialist can be difficult. The application of

store-and-forward technology for electroencephalography (EEG) interpretation is a reasonable alternative in some countries where neurophysiologists are not readily available. The feasibility of an EEG service between a community hospital and a tertiary hospital was tested in Spain. Most of the patients (98%) were satisfied with tele-EEG system in a 116-patient study. Seventy-five percent preferred it over the conventional consult, due to reduced traveling expenses and the total invested time in the EEG test [20]. Similarly, tele-EEG has been a timely and effective method of providing EEG services in the UK, especially for hospitals who are not able to recruit neurophysiologists [5].

In North America, the feasibility of epilepsy care follow-up through teleneurology was tested in a study conducted by the University of Alberta hospital epilepsy clinic [1]. Follow-up care through teleneurology videoconferencing was compared to traditional clinic follow-ups in out-of-town patients. Teleneurology production costs were similar to the patients' savings in traveling and lost productivity. About 90% of patients in both groups were satisfied with the quality of the service. A Canadian survey reported that a large number of neurologists (79.5%) had access to videoconferencing equipment. In this 2008 report, majority (64.1%) of the neurologists did not use teleneurology for epilepsy care, though 61.5% acknowledged the need for teleneurology for epilepsy care. The most common obstacles for broader use of teleneurology were reported to be the lack of infrastructure support and remuneration problems [2].

## **Intercontinental Teleneurology**

Intercontinental teleneurology or cross-border teleneurology refers to collaboration between providers in a country with the lack of access to a neurologist and the neurologist in a different country. Neurologists in the developed countries can help primary doctors, trainees, and mid-level providers through video links and store-and-forward technology. These systems can support education and training as well. The Swinfen Charitable Trust, UK, was established in 1998 with the policy to provide telemedicine links between medical practitioners in developing world and experts abroad who would give free advice via the Internet. Most of the consultations are done through secure e-mail links. An e-mail link communication with the facility to send high-resolution digital images is an inexpensive and simple form of telemedicine. A link established in Bangladesh was one of the original projects where still images captured at the Center for the Rehabilitation of the Paralyzed, Dhaka, were transmitted by e-mail to medical consultants abroad. Most of the 27 referrals done were for neurology and orthopedics. These consultations were judged to be beneficial for the establishment of the diagnosis, the provision of reassurance to the patient and referring doctor, and appropriate change of management. The Swinfen Charitable Trust also helped establish similar e-mail links in Patan Hospital, Kathmandu, Nepal, in March 2000. Over a period of 12 months, 42 telemedicine referrals were sent to specialists throughout the world; 21% of which were neurology referrals.

All replies from specialists were judged to be helpful for diagnosis, management, and education [12]. The studies published about the trust work have shown that a low-cost telemedicine link is technically feasible and can be of significant benefit for diagnosis, management, and education in a developing world setting. Over the years, the trust has expanded its work to many developing and poor countries. Patterson et al. reviewed the expanded work of Swinfen Charitable Trust in four Middle Eastern countries with 283 referrals and 22 other countries with 500 cases. One of the consultant neurologists received 26 referrals including 9 inpatients from Iraq, Afghanistan, Kuwait, and Pakistan. Radiological images were attached to the referring e-mail for ten patients and clinical images for eight patients. The neurologist requested video clips for a further three patients. Most of the cases (77%) were completed through e-mail communications between doctors of these countries and the neurologist. These consultations were helpful in the diagnosis of brain tumors, demyelinating disease, conversion disorders, etc. Some cases were referred to for neuroradiologist and neurosurgery opinions too [29].

Similar charitable works have also been established through in USA. Children's National Medical Center, Washington, DC in collaboration with Mosaic Foundation has developed projects in Africa, the Middle East, and Germany covering a number of specialties, including cardiac surgery, neurology, and genetics. The medical center performs mission-driven work in African countries such as Uganda and Morocco. It has also made business arrangements in Qatar, Kuwait, and the United Arab Emirates, where it focuses primarily on treating neurodevelopmental disorders [18].

Teleneurology consultations for overseas combat forces have been successfully used for better triage and remote management of traumatic brain injury (TBI) patients in remote areas. High rates of neurologic injuries combined with a limited number of practicing neurologists' overseas mandate other alternatives. Teleneurology can potentially cover this gap effectively. The US Army Medical Department approved the use of the army knowledge online (AKO) electronic e-mail system as a teleconsultation service in 2004. It was originally used to provide teledermatology consultation to health-care providers in Iraq, Kuwait, and Afghanistan. Later on, it was expanded to other subspecialties including teleneurology [22]. Teleneurology group of AKO can be perceived as a form of intercontinental teleneurology. Deployed providers generate teleconsultation requests into the AKO system by entering a patient's history and physical examination, clinical photographs, radiographs, and laboratory results into the Internet link. It is mandatory by the Office of the Surgeon General of the Army that all consultations are responded within 24 h. A retrospective analysis of AKO teleneurology from October 2006 to December 2010 is reported. The analysis included TBI consults from March 2008 to December 2010. It is difficult to judge the effectiveness of this program with limited outcome data and comparisons to other health-care models. But this chapter supports the aim for the creation of a more robust program and continued research in this aspect of teleneurology [42].

Another example of intercontinental teleneurology is the collaboration between neurology teams of the developing and developed countries. King Hussein Cancer Center, Jordan, and the Hospital for Sick Children, Canada, collaborated between

December 2004 and May 2006 to discuss 72 cases of pediatric neuro-oncology. Experts from two sides had 20 sessions through videoconference. In 23 patients (36%), major changes from original management plan were recommended on different aspects of the care. In 21 patients (91%), those recommendations were followed, with potentially significant positive impact on patients' care [31]. These twinning programs can serve as an important educational tool in addition to better patient management. Similar programs have been used in India at a national level. Sanjay Gandhi Post-Graduate Institute of Medical Sciences used videoconferences between 2001 and 2004 to discuss neurological cases. Patient management issues, radiology images, and neurophysiology examinations were discussed in 30 sessions during this period; two to three cases were discussed in each session. These conferences improved the knowledge of participants, provided an opportunity for a second opinion as well as modified the treatment decisions in some cases [25].

## **Internet Referral System**

An Internet referral system has been used in Ireland, as an alternative method of teleneurology to overcome the shortage in neurological expertise. National health project, Ireland and St. Vincent's University Hospital launched a pilot project Neurolink in 2006. It was a form of Internet referral system, and 710 consultations were performed until January 2011. General physicians filled out an electronic template using a series of drop-down menus for each patient they wanted a neurologist's opinion for. The referring general physician entered patient's information including clinical presentation and suspected diagnosis. The neurologist then logged on and viewed the referral after he or she was notified through e-mail. Consultant neurologists send a reply via the web-based application. The general physician was advised about further investigations to be ordered, and the need for neurology outpatient consultations. About 19% of the patients did not require further care with the neurologist. Ireland has the lowest number of consultant neurologists per capita in Europe and this method could help reduce the number of unnecessary outpatient neurology consultations, and allow for the better use of the neurologists' time for much needed patient care [41].

## **Challenges**

Telemedicine faces significant challenges worldwide due to several reasons. These include a lack of reimbursement, physician licensure or credentialing, language commonality, technological availability, trained support staff, and patient privacy and security assurances [16]. The nature of these challenges is different in various parts of the world.

The lack of reimbursement for teleneurology has been a universal problem [8, 14]. The primary method of financing neurological care is “out-of-pocket payments” in 83 % of countries from Africa, “tax based” in Eastern Mediterranean (58 % countries), Western Pacific (50 % countries), and Southeast Asia (40 %), while in 29 % of the countries in the American continent, private health insurance plans are the primary source for reimbursement. This represents a challenge for teleneurology, where the initial setup and cost for consult services could be deemed high. Telestroke programs in the Western world often look to the government or foundations to help with these significant upfront capital expenses [27]. Telemedicine research grants, spoke, hub or hub-and-spoke subsidization, spoke subscription-based revenue stream, health insurance reimbursement (government and nongovernment insurers), or a combination of the above are start-up options for telestroke networks [10]. These options are successful for telestroke networks and can be applied to other teleneurology subspecialties worldwide as business models. The new teleneurology models should provide cheaper alternatives to traditional models and be regarded more acceptable. A new telehealth system to be implemented by the Wayne State University Physician Group is both simple and unique. The system is based on an interactive, encrypted patient data exchange on a cloud server using tablet-based format. The specially formatted tablet computers are designed to accept input from a range of medical devices—stethoscope, blood pressure, ECG, respiration, weight, and height. In the proposed Michigan Specialty Network, the service will enable rural providers to connect regarding neurological diseases with medical specialists miles away. Picture archiving and communication system (PACS) technology hosted in addition to the ICT will provide economical storage and convenient access to images from X-rays, magnetic resonance imagings (MRIs), computed tomography (CT) scan images for the end-user rural clinics and the specialist at the hub. The digital imaging and communications in medicine (DICOM) can also integrate images from scanners, workstations, printers, and servers and will provide access for consultations to be done through mobile devices.

Credentialing within a state, interstate, between countries is challenging and has been a barrier in the spread of teleneurology. Licensing requirements and consultant privileges vary in different countries. For example, physicians are allowed to practice video telemedicine in Australia if they have a Medicare provider number and the patient is located in an underserved designated telemedicine area irrespective of the state [35]. Similarly, a physician should be able to practice teleneurology in any European country for which they hold licensure. On the other hand, health and the licensing of doctors is a matter that is assigned to the jurisdiction of the provinces in Canada. If a physician in one province decides to provide teleneurology services to a patient in another province, the predominant view is that the physician should be licensed to practice for the province of patient’s location [2]. In most of the countries around the world, there is no separate set of rules for the practice of telemedicine including teleneurology as compared to medical practice in general. Most societies and legal experts recommend same best practice patient management rules and ethics for the practice of telemedicine.



Language barriers may become an important issue to consider especially with teleneurology practice across the borders. It can be overcome by having an interpreter in the vicinity where the patient is being evaluated. This interpreter should preferably be a trained nurse or physician assistant with the neurologist evaluating the patient at distant site through video interface. The other potentially successful way to overcome this difficulty would be the use of online interpretation. For example, the University of Missouri, with the help of funds from Missouri Foundation for Health, is trying to set up telehealth network with online concurrent interpretation of 25 different languages [23]. Swinfen Charitable Trust would also like to respond to increasing requests for services in multiple languages, and has done trials with system operations in English and French languages [34].

While information and communication technology is being used ever increasingly in the Western world, the lack of adequate infrastructure in poor countries creates suboptimal application of telemedicine in these countries. Robertson Global Health Solutions Corporation and Montana Healthcare Solutions Pty Ltd signed a commercial agreement with Telemedicine Africa in 2011 to provide a high-quality telemedicine care to African countries by providing affordable cost-effective technology [32]. Similar cost-effective models can enable better and timely health-care delivery to the poor countries, especially through partnership with respective peers in these countries.

The other factors such as policy, culture, and lack of political Interference are also crucial especially in the case of developing and poor countries. The providers need to work closely with lawmakers for developing policies and promoting a culture of teleneurology for it to be more successful. The Department of Information Technology in India has defined standards for telemedicine systems and the Ministry of Health and Family Welfare in India has constituted a national task force for telemedicine [24]. Similar work at government and providers level around will be helpful in setting up standards and policies, and promoting cultures.

## Conclusion

Neurologists should promote and refine teleneurology as a critical branch of health-care delivery in the years to come as this technology promises to bring quality neurological services to underserved patients both locally and abroad. Services provided should include expert consultation, continuing education, and improving the quality and efficiency of decisions that can impact neurological outcomes. These can be accomplished by more timely provision of service with 24-h remote hospital coverage. In order for teleneurology to gain broader acceptance, it has to resolve a few hurdles such as that of credentialing and reimbursement across all states, reducing language barriers, availability of resources in remote areas, and ensuring protection of patient's privacy. With advances in the development of mobile communications in the future, we can assume that teleneurology will have a greater impact in the delivery of health care around the world.



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