Telemedicine in Neurorehabilitation

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Telemedicine is the assessment, diagnosis, direct treatment, education, monitoring and support of patients at remote sites via telecommunications, ranging from the plain old telephone service (POTS) to real-time videoconferencing through the Internet (Table 1). Telerehabilitation, one of the numerous applications of telemedicine, was initially utilised to provide home-based physical therapy to disabled stroke patients, who, due to their physical limitations, had particular difficulty in travelling to urban rehabilitation facilities.[1] With computers and the Internet becoming an integral part of our daily lives, telerehabilitation may be extended beyond the hospital and into the community or the patient's home, whereby health care providers can continue to monitor patients' progress, identify areas in need of improvement before complications set in, and ultimately improve function and minimise disability and costs.

Telemedicine has been applied with success in the field of neurology, from acute stroke management[2] to consultations with specialist neurology centres.[3] Moreover, the role of telemedicine in rehabilitation and management of chronic neurological diseases such as stroke, multiple sclerosis, brain or spinal injury, Parkinson's disease and dementia has been studied.[4]

Clinical applications of telerehabilitation

Stroke

The role of intensive multidisciplinary rehabilitation following stroke is well established. Conventional physiotherapy targeting major motor deficits following stroke could be delivered via teleconferencing.[1] The author conducted a study in which stroke rehabilitation in a group format was provided via teleconferencing at a community social centre for seniors. Significant improvement was seen in physical (Berg Balance Scale) and psychosocial (Medical Outcomes Study Short Form (SF-36), State Self-Esteem Scale) outcomes as well as the Stroke Knowledge Test.[5]

Task-specific approaches that deal with lost abilities, for example, hand function, are also important in stroke rehabilitation. Robotic devices and virtual reality software can facilitate training of motor function and coordination in the limbs. A web-based monitoring and feedback system allows patients to continue training at home, while their therapist can monitor their progress and make gradual modifications to their exercise prescription (Figures 1 and 2).[6]

Parkinson's disease

In the United States, the Parkinson's Disease Research, Education, Education and Clinical Centers (PADRECC) operated by the Veteran's Health Administration (VHA) have established telemedicine clinics to provide expert medical care and education to patients, carers as well as health care providers located some distance from a PADRECC.[7]

Step counting is an important index in motion monitoring and rehabilitation in Parkinson's disease. However, commercial pedometers are confounded by the abnormal movement style in this condition and rendered inaccurate. Giansanti's group from Italy has developed a new wearable step counter based on calf muscle expansion during walking. The step counter device collects and transmits data from the patient at home back to the therapist. Remote telemonitoring and telerehabilitation could thus be offered to patients with Parkinson's disease as well as a number of conditions requiring motion rehabilitation (for example, stroke or weight-reduction programmes).[8]

Table 1: What is Telemedicine?

Means of communication	Information exchanged
Telephone / Fax	Traditional consultation
Email	Photographs, digitalised radiographs, videos
Internet	Health web sites, on-line assessment +/- feedback or education, computer assisted rehabilitation programmes
Videoconference	Real-time, audio-video link
Suitable patient	Isolated, disabled, elderly
Health care provider	Limited resources or expertise, long travelling time
Setting	Patient's home, primary care clinic, rural health facility, community elderly centres
Hardware and Infrastructure	I.T. hardware (personal computers, designated devices for transmitting clinical data, videoconferencing equipment); data transmission (integrated services digital network (ISDN) line, broadband [fixed or wireless])

Figure 1: Haptic glove.

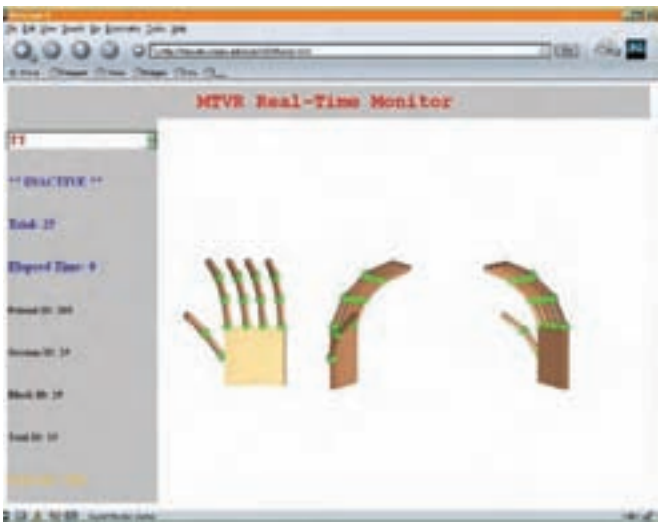

Figure 2. Physiotherapist's screen with real-time patient performance.

Multiple Sclerosis

The progressive and disabling nature of multiple sclerosis means most patients have difficulty accessing health care facilities. Telemedicine can extend traditional outpatient services to patients from rural areas. A telemedicine network can link a regional centre specialising in multiple sclerosis with the primary health care provider of the patient, allowing discussion of the diagnosis, prognosis and goal setting. Web sites targeted at the disease allow patients and caregivers to access information and participate in therapy, training and support. Moreover, telemedicine has been used to manage complications of multiple sclerosis, including pressure ulcers, depression and gait disorders.[9]

In a study where frequent assessments by a wound specialist via teleconferencing enhanced usual care provided by a community nurse, improved healing rate and cost savings was achieved for home-dwelling patients with pressure ulcers.[10]

Multiple sclerosis patients have a 50% life-time risk of depression.[11] Telepsychiatry is effective in managing depression and other mental health problems, with positive outcomes in terms of quality, access and cost.[12]

Mobility problems affect 60% of multiple sclerosis cases,[13] and frequent monitoring of their physical status and adjustment of exercises and assistive devices in the home is important to prevent deterioration. Telemedicine was shown to be reliable in neurological evaluation[14] and the assessment and management of falls.[15]

Dementia

It has been demonstrated that a videoconference link is as effective as face-to-face interviews in the assessment and diagnosis of dementia.[16] Web-based information and support systems (e.g., AlzOnline, http://alzonline.phhp.ufl.edu/) as well as telephone and email access to specialist nurses can provide practical advice and emotional support to demented patients and their caregivers.[17]

A randomised controlled trial was conducted by the author's group at the Chinese University of Hong Kong, in which 12 sessions of cognitive training were provided via videoconferencing or by face-to-face method. Significant cognitive improvement as measured by the Mini-Mental State Examination, Rivermead Behavioural Memory Test and Hierarchic Dementia Scale was observed in both treatment arms. The telemedicine group was as effective as the conventional treatment group, and well accepted by the clients.[18]

Other issues

Much of the experience in telemedicine came from the VHA, one of the largest health care organisations in the United States. Taking advantage of economies of scale, the VHA is able to service entire regions, sometimes comprising of several states. VHA facilities are connected by a highly developed information infrastructure which includes an electronic medical record system, medical imaging, videoconferencing and a large PC-based network.[9]

Costs and reimbursement

Despite considerable reductions in the price of commercial available videoconferencing units (e.g., Polycom®, Tandberg), start-up and maintenance costs are still relatively high. A British study calculated the average cost of a neurology outpatient to be $72 via teleconference whereas the conventional clinic visit cost $49.19 In 2001. The author reported costs per teleconsultation to nursing home residents ranging from USD3 for a nurse to USD15 for a dermatologist.[20] To maximise cost-effectiveness, the telemedicine infrastructure should be a high-volume service, shared by multiple health care providers and serving as many remote sites or users as possible.

When transport & travel costs exceed treatment costs, tele-rehab may be the answer

In the United States, reimbursement mechanisms for telemedicine can be complex, as Medicare insurance only provides partial payment for teleconsultations compared with conventional face-to-face care episodes. Not surprisingly, telemedicine practice and research have predominantly been federal-funded demonstration projects, conducted by large health care organisations such as the VHA or Kaiser Permanente.[9] In fact, the United Kingdom's socialist health care model may be more conducive to the development of telemedicine.

Legal

Health care professionals' licensure requirements may restrict the practice of telemedicine across state or country borders. As of 2002, twenty-six states in the United States have introduced licensure laws which actually make the practice of telemedicine more difficult across state lines. The VHA, however, allows all its practitioners to practice in any VHA facility within the country, hence allowing telemedicine to develop and expand within the organisation.[9]

Privacy

It is important to protect the privacy or security of patient-identifiable information in all health provision settings, and telemedicine is no exception. Specific issues relating to telemedicine include the presence of non-clinical personnel (e.g., camera technicians) during consultations, and the handling or storage of patient information (e.g., clinical photographs, videos) separate from the conventional or electronic medical notes. Commercially available videoconferencing equipment has built-in encryption which ensures secured communication between the provider and patient during teleconsultations.

Acceptability

Telemedicine challenges the basic belief that all health care is best delivered face-to-face. It requires a shift in culture in both patients and health care professionals. Patient satisfaction towards various forms of telehealth has been consistently high, with common cited reasons such as improved access to specialists, reduced travel and associated costs, shorter waiting times for appointments and the opportunity to participate in health education or group therapy.[21]

From the health provider's perspective, satisfaction surveys are generally positive for the same reasons mentioned above. General practitioners and doctors in rural or deprived areas appreciated the educational aspect of telemedicine, where the support of specialists allows them to diagnose and management patients with greater confidence. Nevertheless, the need to learn and adjust to a new technology and make changes in their daily work routine may explain the cynicism held by a minority of health providers.[21]

Technical

In the infancy of telemedicine, the slow POTS connections meant that video quality was choppy with low resolution. This improved with integrated service digital network (ISDN) technology, which allowed the transmission of simultaneous voice and video data at a fixed rate of 128kB/s within a network. More recently, as moderate to high bandwidth broadband networks became more widely available, teleconferencing applications can support real-time audio-video link at 764kB/s or above. However, the bandwidth has to be monitored so that the image quality does not degrade with heavy network traffic. Store-and forward clinical information such as photographs, CT scans and echocardiograms can be transmitted as e-mail attachments via lower bandwidth systems.[9,22] Wireless telemedicine using satellite, 3G and other emerging wireless networking technology is an attractive means for linking ambulances with hospital Emergency Rooms and in the provision of emergency medical care to soldiers in the battlefield.[23] In chronic disease management, mobile phones are becoming an important method of enhancing health provider-patient communication, monitoring health outcomes and delivery of health interventions.[24]

Conclusions

Telerehabilitation is an attractive method of delivering services to disabled patients without a need for both the patient and health care professional to be in the same location at the same time. It has a major role in providing remote rehabilitation to patients with chronic neurological conditions, and fills a service gap among those who have limited access to expert care. New telecommunication technologies will enhance the quality and intensity of therapy delivered to the patient at home, and provides important clinical information to the health provider. To maximise cost-effectiveness, health care professionals and patients in various medical specialties should utilise a telemedicine service, rather than limiting its use to an exclusive few. ◆

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