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The progress of telestroke in China

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ABSTRACT

Stroke remains the leading cause of death in China. The disparity of distribution in specialists and hospitals affects access to timely stroke care. Telestroke, the use of telemedicine for stroke, may be the solution to access to stroke care. Telestroke can improve the rate of successful intravenous thrombolysis and shorten the time to treatment. Here we review the progress of telestroke in China.

INTRODUCTION

Stroke is the leading cause of death in China and the second leading cause of death around the world.[1] Acute ischaemic stroke (AIS) accounts for approximately 80% of all strokes.[2] Currently intravenous thrombolysis with or without intra-arterial thrombectomy is proven effective if patients with stroke presented to the hospital within the time window.[3–5] However, the rate of intravenous thrombolysis is generally low in China, around 1.6% between 2007 and 2008 according to the data from the China National Stroke Registration (CNSR).[6] It was lower than the reported 3%–5% in the US A during the same period.[7] CNSR has also reported that approximately 52.4% hospitals had a stroke unit, 63.8% had neurology coverage in the emergency departments, 99.2% had CT 24/7. In China, about 21.5% of patients with acute strokes presented to the emergency department within 3 hours and 12.6% were eligible for thrombolytic treatment.[6] The delay in treatment was due to: (1) lack of public awareness of the signs and symptoms of stroke; (2) lack of stroke neurology coverage in community hospitals; (3) lack of neurological expertise in rural areas;[6] and (4) delayed time in transporting and triaging patients with stroke.[8]

Telestroke, a solution to address the lack of stroke coverage in the USA has been implemented since 1999.[9] Since then, research has showed that telestroke could effectively provide neurological expertise to underserved areas, shorten the time to thrombolysis and improve the rate of using intravenous thrombolysis.[10–17] In China, telestroke is relatively new. Here we provide a comprehensive review of the status of telestroke and its application in China.

Telestroke system

In 2012,[18] the Queen Elizabeth Hospital (QEH) of Hong Kong used phone calls and emails to provide consultations at home during non-office hours. Unfortunately, the article lacked detailed description about its operational approaches and effectiveness. However, telephone calls had been proven less effective and led to more incorrect diagnosis comparing to a real-time video conferencing telemedical system. The decision on the use of tissue-type plasminogen activator (tPA) was made more correctly with video telestroke (98%) than telephone (82%) consultations.[19] Therefore, in Hong Kong, a 'drip and ship'[20] model that will transport patients with AIS from smaller hospitals (spokes) into QEH (a designated hub) after giving intravenous recombinant tissue-type plasminogen activator (rt-PA) was more appropriate.

On 18 May 2014, the National Telestroke Center[21] was established in Xuanwu Hospital, which marked the official launch of the telestroke project in China. The National Telestroke Center was designed to provide neurological coverage to 300 rural hospitals throughout the country through the telestroke network platform. It was a 'hub and spoke' model, integrating medical resources and establishing branches as the regional centres in underserved areas in China.[22] This telestroke centre would guide rural hospitals on the use of intravenous thrombolysis, neurosurgery, even the treatment of critically ill patients in intensive care units and rehabilitation. It will also provide public education on recognising signs and symptoms of stroke and stroke prevention.[22]

A year later after the establishment of the National Telestroke Center, Luhe Hospital, a community hospital located in Tongzhou district, Beijing, improved its successful rate of intravenous thrombolysis and thrombectomy, comparable to those leading hospitals in stroke care such as Xuanwu and Tiantan hospitals. It became the third leading user of intravenous thrombolysis in more than 70 tertiary care hospitals in Beijing.[22] In addition, the First People's Hospital of Shenyang reported

its success in stroke diagnosis and treatment through the National Telestroke Center platform.[23] Despite the initial success of the National Telestroke Center, data are scarce on its usage and efficacy. No large-scale telestroke application was available. Therefore, telestroke is still in its early stage of use in China.

The application of Google Glass in China

The world's first experience of administering intravenous thrombolysis was for a patient with acute ischaemic stroke guided by a teleconsultation system with Google Glass. In addition, the first application of Google Glass for remote medical treatment was completed by Xianyang Hospital and Xijing Hospital. Google Glass allowed the entire management to be performed as if it were conducted by the expert himself because of its hands-free operation for the local physician. However, the time required by this teleconsultation was quite long (37 min), although rt-PA was injected within 3 hours after onset. This delay was because of unfamiliarity of Google Glass by the consulting physicians, and unreliable internet connection at the local hospital. This telestroke model could potentially improve the rate of intravenous thrombolysis and provide stroke care coverage in the underserved areas. Google Glass was convenient and reliable if the users are good at it and internet is reliable. It may bring revolutionary changes to the way that we perform telemedicine in the future.[24]

Intravenous thrombolysis with telestroke service

The American Heart Association (AHA) has given a level I grade A evidence to telestroke and level I grade B evidence that intravenous rt-PA could be given at a remote site through telestroke.[20 25] However, such evidence still needs to be studied in China.

The Acute Stroke Advancing Program using Telemedicine (ASAP-Tel) is the first study to evaluate the effectiveness and safety of the decision-making process on the use of intravenous thrombolysis via a telemedicine consultation in China. The study tested the effectiveness of telestroke to improve the rate of patients eligible for intravenous thrombolysis as well as improved clinical outcomes in underserved areas of China. ASAP-Tel was a multicentre, superiority-designed study with historical control, with a planned enrolment of 300 participants in each of the two groups. The trial is ongoing.[26] Hopefully it will provide the needed data on telestroke in China.

Outcome measures in telestroke

In several studies, the National Institutes of Health Stroke Scale (NIHSS) Scores obtained by bedside or remote evaluation by a neurologist strongly correlated (r=0.97, p<0.001), but were slower than the bedside assessment (9.70 min vs 6.55 min, respectively).[19 27 28] There are no published data on the reliability of remote NIHSS evaluation in China. A Hong Kong study found that it was reliable and feasible to administer the Montreal Cognitive Assessment 5-minute protocol (MoCA 5 min protocol) over the telephone. Four items examining attention, verbal learning and memory, executive functions/language, and orientation consisted of the MoCA 5 min protocol. The total scores of the MoCA and MoCA 5 min protocol highly correlated (r=0.87, p<0.001). The MoCA 5 min protocol was a reliable cognitive screen for patients with stroke or transient ischaemic attack , and was easily done via telephone.[29]

Telestroke technology

Initial experiences with video teleconferencing were limited by the slow transmission rates via integrated services digital network (ISDN) or dedicated local area network connections.[27 30] The proliferation of broadband, Wi-Fi and cellular access, combined with high resolution video, can provide high resolution, low latency audiovisual connections.[31] Early videoconferencing technology required the hub consulting neurologist to be located at a fixed workstation.[27 30] Now laptop computers[31 32] and smartphones can provide videoconference.[33–35] Fourth generation wireless connectivity will enable the consulting neurologist to be mobile and shorten the delay of evaluation.[34 36]

Information confidentiality in China

New technology may improve the protection of the patient's information in China. The security-enhanced mobile imaging distribution system (SEMIDS)[37] by PolyU would let the treating neurologist view CT images in all iOS platforms (ie, iPhone, iPad, MacBook Air, etc) with great confidentiality. In this system, only one patient's image is processed each time by their last name and a four digit ID number. No image can be saved on this remote device.

In addition, a high level of information security could be provided by the technology of chaotic mapping, which uses the no-period and no-convergence properties of a chaotic sequence to create image chaos and pixel averaging. This chaotic sequence is used to encrypt images.[38]

Mobile stroke care facilities in China

China is developing its own mobile stroke ambulance that is similar to the mobile stroke unit (MSU) in Europe and USA.[39] The stroke ambulance is capable of providing prehospital thrombolysis, thrombolysis, monitoring post-thrombolysis, cardiopulmonary resuscitation, telemedical communication, data management, power system and portable CT and X-ray. The MSU has been proven to provide quicker stroke assessment and thrombolysis[40 41]

Cost-effectiveness of telestroke

In 2002–2013, a government-sponsored telemedicine programme was established at the West China Hospital of Sichuan University (hub).[42] The network covered 249 spoke hospitals in 112 cities throughout western China and the hub could provide types of 40 specialty care to remote areas. The study of 11 987 consultations by

telemedicine over a 12-year period has showed an estimated net saving of $2,364,525 (if the patients travelled to the hub) or $3,759,014 (if the specialists travelled to the spoke hospitals). For the first time, telemedicine has been proven cost- effective in China.[42]

Telerehabilitation

China has 2.5 million new strokes each year and 7.5 million stroke survivors.[43]The rehabilitation services have neither been well established nor standardised. There are only a few community rehabilitation institutions in China, which could not meet the needs of patients with stroke .[44–46] Telerehabilitation may be a good alternative in China.[44 47] One Chinese study reported that remote guidance in rehabilitation showed better results in the functional outcome in patients with stroke measured by the Modified Barthel Index, Fugl-Meyer Assessment Scale, Berg Balance Scale, Hamilton Anxiety Scale and Hamilton Depression Scale results ($p<0.05$). However, patients receiving remote guidance showed dissatisfaction of care at night, feeling more insecure ($p<0.05$). In general, home services under remote guidance showed a positive effect on the physical and mental rehabilitation of the patients with stroke.[47] The *home-based tele-supervising rehabilitation for brain infarction patients* (HTRBIP)[48] trial (registration number: ChiCTR-TRC-14005233) in China will evaluate the efficacy and safety of HTRBIP in patients with stroke. It is expected to provide new evidence for the telerehabilitation application.

SUMMARY

According to the published data from CNSR in 2011, the median onset-to-needle time was 180 (IQR, 150 to 228) min; the median door-to-needle time was 116 (IQR, 70 to 150) min; the median imaging-to-needle time was 90 (IQR, 60 to 129) min for patients with AIS in China. These quality measures were significantly underperformed compared with those in the developed countries.[6] Telestroke may help to shorten these treatment parameters. However, the long-term sustainability and growth of telestroke still faces several challenges: unresolved issues on licensing and hospital credentialling,[49] financial barriers, and lack of a standard reimbursement structure.[50 51] Nevertheless, telestroke will greatly improve the level of accuracy in the diagnosis and treatment of stroke, and reduce the healthcare and socioeconomic burden of stroke in China in the near future.

Contributors All the authors meet the all four ICMJE criteria for authorship.

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