Mobile Stroke: An Experience of Intravenous Thrombolysis Guided by Teleconsultation Based on Google Glass

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Introduction

Telestroke is a success story of the telemedicine service after the introduction of teleradiology [1]. Evidence suggests that telestroke may help to resolve the shortage of neurological expertise in underserved areas, shorten the time to treatment and improve the use of intravenous (IV) recombinant tissue-type plasminogen activator (rt-PA), thus preventing permanent neurological impairment [2,3]. China is currently facing the problem of geographical disparity in the neurological expertise between urban and rural areas, and the rate of IV rt-PA treatment is extremely low [4]. Due to this situation, the Chinese government and agencies are making efforts to develop telemedicine. Here, we report the experience of IV thrombolysis guided by a teleconsultation system based on Google Glass for an acute ischemic stroke patient.

Case Report

The teleconsultation system used in this case is a real-time two-way audio/one-way video interactive system consisting of two clients: a Google Glass (generation 2.0) device worn by a local physician and a smartphone (Android) held by a neurologist in the hub hospital (teleneurohospitalist). A software company was delegated to develop the applications (apps) installed on the devices. The expert's smartphone rings when the local physician initiates a consultation with a specified expert on his or her Google Glass contact list. The local physician can perform examinations that are guided by the expert, and the teleneurohospitalist can observe the local patient on his or her smartphone with a first-person perspective. Under the current system, the patient is not charged for the teleconsultation.

A 58-year-old woman suffered right-sided dysphagia and asthenia while resting at home at 21:35 on December 10, 2014 and presented to the emergency department with a suspected stroke at 22:38. After swift assessment by a local physician, cerebral infarction was suspected, and the National Institutes of Health Stroke Scale (NIHSS) score was 5. At 22:58, noncontrast brain computed tomography (CT) images indicated no signs of edema, infarction, intracerebral hemorrhage, or tumor (Figure 1A). However, the local physicians were uncertain whether IV rt-PA should be injected.

After consent was received from the patient, a teleconsultation using Google Glass was established with a teleneurohospitalist at 23:36 (Figure 2). The teleneurohospitalist swiftly evaluated the patient's neurological impairment by guiding the local physician. At this time, the myodynamia of the patient's right upper and lower limbs weakened, and the NIHSS score increased to 7. After reviewing the CT images and other tests, the teleneurohospitalist reviewed the inclusion and exclusion characteristics of the patient and suggested that IV thrombolysis should be initiated as soon as possible.

At 00:15 the following day, IV rt-PA injection was initiated. Thirty minutes later, the dysphasia resolved. At 01:35, the myodynamia of the right upper and lower limbs recovered from grade III to grade IV. At 11:00, the neurological function had completely recovered, although an infarction spot was noted on brain CT scans on December 12 (Figure 1B).

Discussion

Solutions for interactive audiovisual telemedicine have evolved from traditional teleconference rooms to telemedicine robots to

Figure 1 The noncontrast brain computed tomography (CT) images of the patient. (A) CT images on admission; (B) CT images 2 days after symptom onset. The red arrow indicates the infarction.

Figure 2 The teleconsultation scenes in the spoke and hub hospitals. (A) The physician in the spoke hospital examined the patient while wearing Google Glass. (B) The stroke expert in the hub hospital observed the patient on his smartphone at home.

wireless telecommunications networks and portable devices. Telemedicine apps on portable devices ensure that expertise can be provided 24/7 [5]. Remote evaluation of CT images and NIHSS scores, which are the two crucial elements in telestroke, can be made using smartphone apps, and are reliable relative to bedside assessments [6,7].

We have established a telestroke network based on smartphones in Shaanxi Province in China (*ClinicalTrials.gov*, NCT02088346). However, local physicians found that holding a smartphone was inconvenient during teleconsultation, especially when physical examinations were needed. Furthermore, teleneurohospitalists felt that this system did not possess the capability of evaluating patients in a manner similar to a face-to-face evaluation. More recently, wearable devices, such as Google Glass, introduced new ideas to solve these limitations. These devices facilitate interactive audiovisual telemedicine but also have the advantages of hands-free operation and first-person perspective. Therefore, we developed this teleconsultation system based on Google Glass.

The present report was our first experience administering IV thrombolysis for an ischemic stroke patient guided by teleconsultation based on a wearable device. In this case, due to the advantages of hands-free operation for the local physician and a first-person perspective for the expert, Google Glass allowed the entire management to be performed as if it were conducted by the expert himself, and the gap between the hub and spoke hospitals was overcome. However, the time required by this teleconsultation was too long (37 min), although rt-PA was injected within 3 hours after onset (Table 1). This delay occurred because physicians were not familiar with this teleconsultation system based on Google Glass, and the internet connection was not stable at the local hospital. However, this was a significant attempt to explore the feasibility of wearable devices in teleconsultation, and it will be helpful for future improvements. The greatest strength of this telestroke mode is that it may increase the rate of IV thrombolysis and promote stroke care in the underserved areas.

Due to rapidly expanding mobile technologies and devices and their portability and popularity among the population, telemedicine/

Table 1 Timeline of patient care

Action	Time	Time between adjacent actions
Stroke onset to door	63 min	63 min
Door to physician	4 min	4 min
Door to CT initiation	12 min	8 min
Door to CT interpretation	20 min	8 min
Door to consultation initiation	58 min	38 min
Door to response of stroke expert	60 min	2 min
Door to IV rt-PA	97 min	37 min

Door indicates the arrival at the emergency department of the spoke hospital; CT, computed tomography; IV, intravenous; rt-PA, recombinant tissue-type plasminogen activator.

telehealth are gradually migrating to a new concept of mobile medicine/health that describes services supported by medical apps installed on portable devices, such as smartphones and wearable devices [8]. Hence, we put forward the concept of “mobile stroke” to specifically describe the stroke management services supported by these mobile technologies.

Three aspects should be covered in mobile stroke consultations. First, teleneurohospitalists provide recommendations to physicians in the underserved hospitals by teleconsultation based on portable devices. Second, ambulance-based stroke management can provide earlier IV thrombolysis to eligible patients [9]. Third,

at symptom onset, the patient's family members or caretakers may ask for guidance from a physician using medical apps on their smartphones or Google Glass. In these three cases, the introduction of Google Glass is a more viable mobile stroke option with an enhanced quality of care. Mutual cooperation is essential for timely stroke management from onset to admission, especially for treatment with IV rt-PA. Only in this way can we maximize the effectiveness of stroke care.

In summary, this report demonstrates that a teleconsultation based on Google Glass was convenient and reliable. This method may greatly promote the emergency treatment of ischemic stroke in underserved areas and bring revolutionary changes to the way that we perform telemedicine in the future. The concept of mobile stroke conforms to the significant demand of stroke management delivery.

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Conflict of Interest

Sinofloat (Beijing) Co. Ltd had no involvement in the preparation, review, or approval of the manuscript or in the decision to submit the manuscript for publication.

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