A New Telestroke Network System in Northern Area of Okayama Prefecture

Ryo Sasaki[1], Toru Yamashita[1], Yoshio Omote[1], Mami Takemoto[1], Nozomi Hishikawa[1], Taijun Yunoki[2], Kazuki Kobayashi[3], Takashi Sawata[4], Yuki Sato[5], Junichi Kubota[6], Masayuki Mizobuchi[7], Takashi Hayashi[8], and Koji Abe[1]

1. Department of Neurology, Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama University, 2-5-1 Shikata-cho, Kita-ku, Okayama 700-8558, Japan.
2. Department of Neurology, Tsuyama Central Hospital, 1756 Kawasaki, Tsuyama, Okayama 708-0841, Japan.
3. Department of Neurosurgery, Tsuyama Central Hospital, 1756 Kawasaki, Tsuyama, Okayama 708-0841, Japan.
4. Department of Gastrointestinal surgery, Tsuyama 1st hospital, 438 nakashima, Tsuyama, Okayama 708-0871, Japan.
5. Department of Internal Medicine, Sato memorial hospital, 45 Kurotsuchi, Shouou-cho, Katsuta gun, Okayama 709-4312, Japan.
6. Department of Internal Medicine, Tajiri hospital, 550-1 akemi, Mimasaka, Okayama 707-0003, Japan.
7. Department of Neurosurgery, Kaneda hospital, 63 Nishihara, Maniwa, Okayama 719-3193, Japan.
8. Department of Orthopedics, Sayo central hospital, 3529-3 Sayo, Sayo-cho, Sayo-gun, Hyogo 679-5301, Japan.

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Address correspondence and reprint requests to: Prof. Koji Abe
Department of Neurology, Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama University, 2-5-1 Shikata-cho, Kita-ku, Okayama 700-8558, Japan.
Email: pwag680v@okayama-u.ac.jp

Abbreviations used: COVID-19, coronavirus disease 2019; CT, computed tomography; IVR, interventional radiology; MT, mechanical thrombectomy; tPA, tissue plasminogen activator.

Abstract

Background: Telestroke network can provide rapid access to specialized treatment and improves on-site management of acute stroke patients through the “hub and spoke” model. In the northern part of Okayama prefecture, there have been a regional gap of stroke care due to the shortage of stroke specialists and facilities. In addition, due to the novel coronavirus disease 2019 (COVID-19), it is required to reduce the unnecessary contact with stroke patients from other hospitals.

Aim: We organized a novel cost-free telestroke network with an image and video sharing for neurological diseases in the northern part of Okayama prefecture to improve the stroke management in the area.

Method: We prepared the tablet device on which Skype® application installed for each hospital and recruited the patients who visited or hospitalized in the spoke hospitals and were suspected to have some neurological diseases from April 2019 to May 2020. The patient’s clinical data were recorded and analyzed.

Results: During the study period, 5 patients were recruited including the cases with the initial diagnosis of stroke or brain tumor. Among them, 2 cases were transferred to the hub hospital, 2 cases to other hospitals, and 1 case was treated on site under specialist’s advice.

Conclusion: The new telestroke network system may be beneficial for acute stroke management and reducing the unnecessary patient’s transfer in the rural area especially under coexistence with COVID-19.

Key Word: telestroke, telemedicine, Okayama, COVID-19, Skype

Introduction

Telestroke is a specific type of telemedicine for acute stroke patients which provides rapid access to specialized treatment and improves on-site management of stroke (Kepplinger et al., 2016) and usually organized as the style called “hub and spoke” model (Agarwal et al., 2014). Telestroke network has been running in some regions of Japan with more rural, isolated, or distant area from 2000’s (Kageji et al., 2018).

In the northern part of Okayama prefecture mainly consisted of rural and mountain areas, there is a regional gap of stroke care caused by the shortage of stroke specialists and facilities relative to the vast area that potentially leads to poor outcome of the patients. In addition, the novel coronavirus disease 2019 (COVID-19) which widely spread from late 2019 drastically and forcibly changed the world’s medical management including stroke (Khosravani et al., 2020).

In the present network, we aimed to establish a new image and video sharing method for neurological diseases in the northern part of Okayama prefecture also to improve the stroke management in the area. Here, we report the short term outcome of the new teleconsultation network system for both up-dating stroke treatment and COVID-19.

Methods and Materials

Organization of the network

The present telemedicine network covered 6 hospitals in the northern area of Okayama prefecture which has a population of about 250,000 with many mountainous areas (Fig. 1A).

The “hub hospital” was Tsuyama central hospital, which is a general hospital having 515 beds and an interventional radiology (IVR) center. There were 1 neurologist and 4 neurosurgeons

who could perform both tissue plasminogen activator (tPA) administration and mechanical thrombectomy (MT) for the treatment of acute ischemic stroke in daytime.

The "spoke hospitals" were 5 smaller general hospitals in the area, namely, Tsuyama 1st hospital, Sato memorial hospital, Tajiri hospital, Kaneda hospital, and Sayo central hospital located 8.5 – 35.8 km distant from the hub hospital. Kaneda hospital had 1 or 2 neurosurgeons who could perform tPA therapy, while other hospitals were relatively unfamiliar to treat the acute stroke patients. Each hospital had immediate access to computed tomography (CT) or magnetic resonance imaging (MRI). The hub and spoke hospitals' data are detailed in Table 1.

Participants and subjects

This network was designed for patients having the acute neurological disease especially stroke in the northern area of Okayama prefecture, and ran from December 2018 to May 2020. We recruited the patients who visited or hospitalized in the spoke hospitals and were suspected to have some neurological diseases. Written consent including the risk of the patient's data sharing with Microsoft Corporation was obtained from the patient or patient's family, and the Okayama university ethics review board approved all procedures (No. 1811-017)

Devices and process

We prepared the tablet device Fire HD 8® (Amazon, USA) on which Skype® application (Microsoft, USA, version: 8.56.0.102 or 8.15.0.419) installed for each hospital. Other applications were deleted from the tablet in order to maintain the security of the device. The tablets were used on the virtual private network (VPN) in each hospital.

When the doctors in spoke hospitals had to consult to stroke specialists by using the telemedicine network, there were 2 ways according to the onset of the symptom. If the symptom onset was within 4.5 hours, a telephone consultation performed with clinical image data (the photo of the clinical image on the medical computer's display taken with the tablet's camera) and video sharing with the message chat on Skype® application in order to a detailed evaluation considering the "drip and ship". If the onset was more than 4.5 hours, a telephone consultation performed with only clinical image sharing (Fig. 1B). The shared images did not contain any of patient's personal information. The consulted stroke specialist at the hub hospital made some advice including transferring to other hospitals, or starting the treatment in the spoke hospital. If the doctors on the hub hospital were outside of the hospital at night or on weekend, they also shared clinical images with a dedicated tablet while they were on a voice call. Because the Skype® application uses Transport Layer Security (TLS) 1.2 encryption and the tablet did not contain any other application except for Skype®, the risk of information leakage was considered low. The patient's clinical data (age, sex, date and time of the network using, time from onset to network using, initial diagnosis, and outcome) were recorded in each spoke hospital by medical records, and analyzed.

Results

During the above study period, 5 patients were recruited from April 2019 to May 2020 (Fig. 1C) including the cases with the initial diagnosis of metastatic brain tumor (Fig. 1D), brain infarction/metastatic brain tumor (Fig. 1E), intracranial hemorrhage (Fig. 1F), left internal carotid artery plaque (Fig. 1G), and cardiogenic cerebral embolism (Fig. 1H). During the same period, 336 patients were treated for stroke in the hub hospital, and 1.5% of those used the present

network. Among them, 2 cases were transferred to the hub Tsuyama central hospital, 2 cases to other hospitals, and 1 case was treated on site under specialist's advice of Tsuyama central hospital (Table 2). For the all 5 cases, it took only 1 to 10 min for consultation between 5 hospitals and the hub hospital. Within the case of internal carotid artery plaque (Fig. 1G), a movie file of carotid artery ultrasonography was shared and all the image and movie sharing were performed without any transmission trouble. There were no case which matched the criteria of tPA use, nor showed acute progression after the consultations. The recruitment of the patients had to quit due to the pandemic of COVID-19 in Japan, which expanded on February with the peak on April.

Discussion

Expertise therapy for acute ischemic stroke with tPA and MT has become very important. Although an early treatment is essential for a good prognosis (Puig et al., 2020), previous studies reported the efficacies of a tPA administration 4.5 to 9.0 hours after the onset (Ma et al., 2019), an endovascular treatment 6 to 24 hours after the onset (Nogueira et al., 2018), and a direct MT without tPA administration (Yang et al., 2020).Thus, more ischemic stroke patients can be treated with tPA and MT, and thus an immediate consultation and a detailed information for the stroke facility is getting more important.

However, the rural areas such as the north part of Okayama prefecture is in shortage of stroke specialists to cover the vast area. In addition, since the COVID-19 pandemic spread in the world, it is required to reduce the unnecessary contact with patients from other hospitals even in the stroke care (Mayer et al., 2020). Okayama prefecture also had more than 20 cases of COVID-19 in the spring of 2020, and we have to get ready for the second wave with maintaining the quality

of the medicine (Nitkunan et al., 2020).

The present telestroke network enabled doctors of spoke hospitals to obtain useful advice from neurological specialists of hub hospital without the risk of COVID-19 infection through a cost-free image sharing system in the north part of Okayama prefecture. As a result, we might be able to save some medical resources which spent on unnecessary patient transport. Image sharing system products (e.g, “Join” by Allm inc., Tokyo, Japan) were partly available for acute stroke (Kageji et al., 2016, Munich et al., 2017) by sharing all of the image series directly from medical computer. However, the initial/running cost and highly require of internet connection quality may be limitations for equipping and maintaining it in many rural hospitals or clinic (Akiyama et al., 2016). In contrast, the present network system was used without expensive fees, which may be favorable for most hospitals. The present internet environment proved to be matured to perform the present styles of telemedicine even in a rural district. Because all spoke hospitals are already equipped with high-grade internet connection as a private network, the present network system was able to share more detailed images than using the mobile phone network previously reported in the same Okayama prefecture 10 years ago (Fujii et al., 2010).

However, the patient recruitment might have been difficult because most of spoke hospitals had many part-time physicians who were not familiar with the protocol of the network. In addition, we thought it would be useful to pre-determine the sequences of key images to be quickly sent and smoothly used in the network. The present network has adopted the hub-and-spoke model, which is the standard model described in the Guidelines for Telemedicine in Stroke Care (Project team for telestroke guidelines, 2020), and the hub hospital have been registered as primary stroke centers by the Japan Stroke Society. Also the network shared its philosophy and objectives,

management organization structure, privacy management and other awareness with the participating hospitals in writing as the guideline recommended. However, there are some differences between our devices and security and recommendation, which should be improved in the future to achieve the goal of the network “low-cost and safety”.

In terms of improving the expertise of stroke care and the necessity of reducing patients transfers to prevent COVID-19 dissemination, the present cost-free telestroke/teleconsultation network system may perform one solution for acute stroke management in the era of coexistence with COVID-19.

Conflict of Interest Statement

The authors disclose no potential conflict of interests.

Acknowledgments

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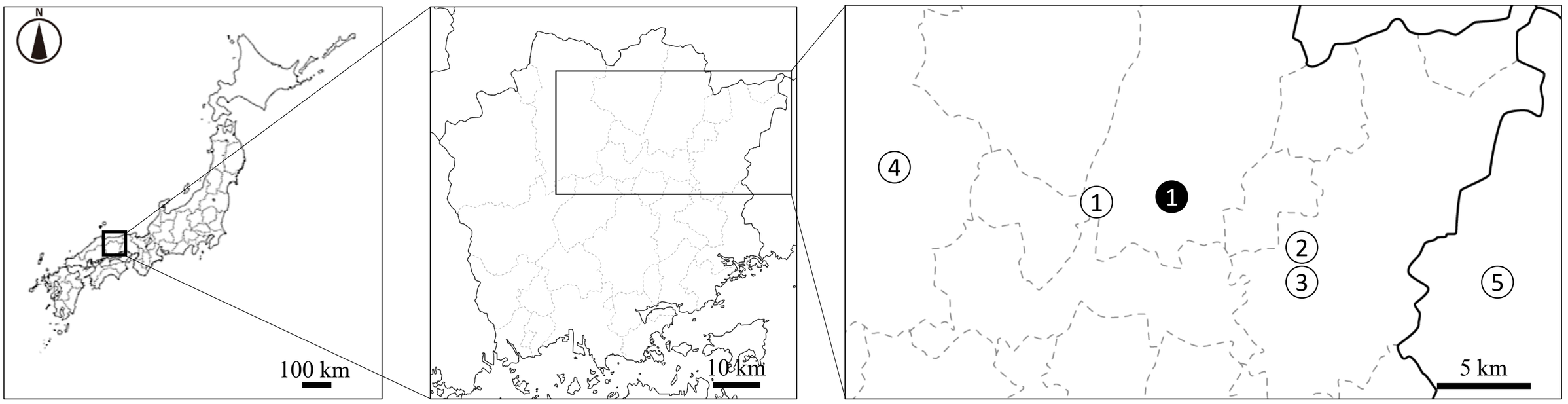
Figure Legends

Figure 1

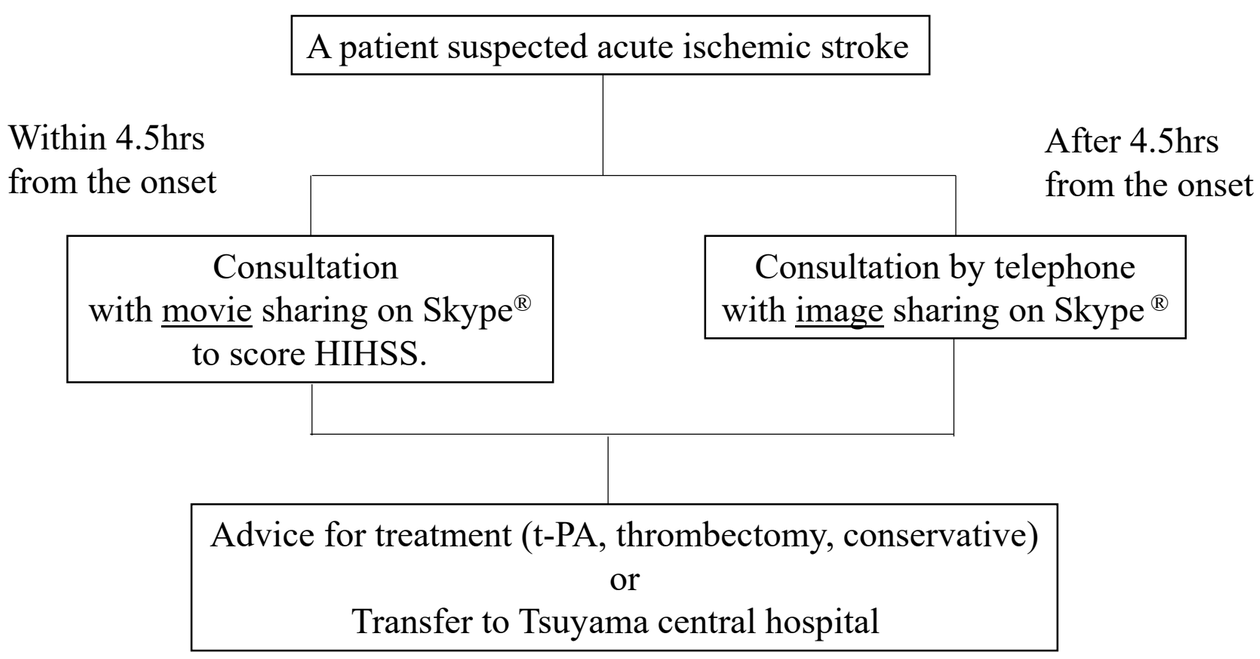
(A) The maps of Japan (left), Okayama prefecture (middle), and the magnified north area (right). In the right panel, the black and white circles represent the hub and spoke hospitals, respectively. (B) The procedure of the present network. Additional real-time video sharing was performed if the symptom onset was within 4.5 hours. (C) The time points of the 5 consultations with the new telemedicine network. The recruitment of the patients had to quit on 2020 March due to the pandemic of COVID-19 in Japan. (D-E) The brain image of 5 each case actually shared through the network. D, F; head CT. E, H; brain MRI diffusion weighted image. G; neck magnetic resonance angiography.

Figure 1

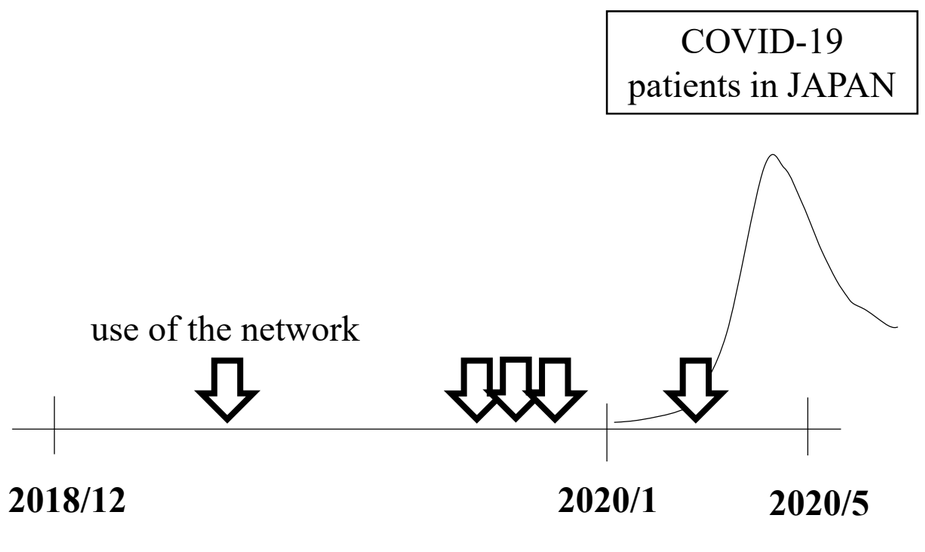
A


Japan
Okayama prefecture
Telestroke network in northern area of Okayama prefecture
N
100 km
10 km
5 km
1
2
3
4
5

B


A patient suspected acute ischemic stroke
Within 4.5hrs
from the onset
After 4.5hrs
from the onset
Consultation
with movie sharing on Skype®
to score HIHSS.
Consultation by telephone
with image sharing on Skype ®
Advice for treatment (t-PA, thrombectomy, conservative)
or
Transfer to Tsuyama central hospital

C


COVID-19
patients in JAPAN
use of the network
2018/12
2020/1
2020/5

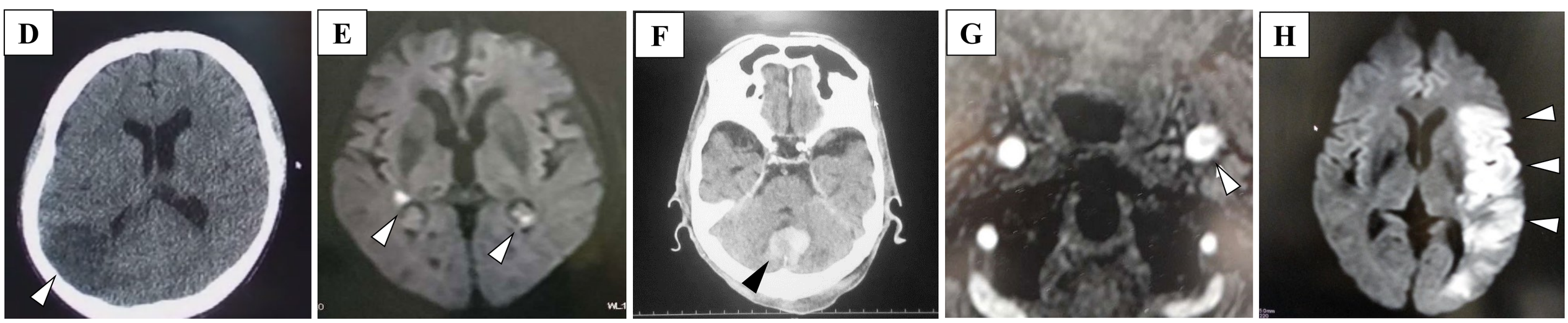

D
E
F
G
H

Table 1 Characteristics of the hospitals participated in the telemedicine network

Hub or Spoke	Hospital Name	Distance from Hub	Number of Neurologists
Hub	Tsuyama central hospital	0 km	5
Spoke 1	Tsuyama 1st hospital	8.5 km	0
Spoke 2	Sato memorial hospital	12.6 km	0
Spoke 3	Tajiri hospital	13.2 km	0
Spoke 4	Kaneda hospital	34.2 km	1 or 2
Spoke 5	Sayo central hospital	35.8 km	0

Table 2 Clinical characteristics of the patients who were consulted with the telemedicine network

Age	Sex	Date and Time	Time from Onset	Hospital	Initial Diagnosis	Outcome
84	M	2019/4/17 9:08	8 hours	Spoke 1	Metastatic brain tumor	Transferred to Tsuyama central hospital
86	M	2019/10/4 11:01	3days	Spoke 4	Brain infarction s/o Metastatic brain tumor s/o	Transferred to other hospital
74	M	2019/11/15 12:43	2 days	Spoke 3	Intracranial hemorrhage	Transferred to Tsuyama central hospital
84	M	2019/11/19 17:21	2 days	Spoke 4	left internal carotid artery plaque	Transferred to other hospital
60	M	2020/3/2 0:16	23 hours	Spoke 4	Cardiogenic cerebral embolism	Treated on site under specialist's advice