



Case Series

Task appeared in COVID-19 pandemic when tele-healthcare saved neurosurgical lives in rural area – A case reports and literature review

Takamitsu Sakamoto¹, Yasuhiko Fujita², Teruyoshi Amagai³

¹Department of General Medicine, Fukuoka Tokushukai Medical Center, Kasuga, ²Department of Medicine, Tokunoshima Tokushukai General Hospital, Kagoshima, ³Department of Clinical Engineering, University of Jikei Health Care Sciences, Osaka City, Japan.

ABSTRACT

In rural areas, the medical resources are extremely limited not only pandemic but non-pandemic period. Tele-healthcare system using digital technology-based telemedicine is widely used across various medical specialties. To solve limitation of medical resources in hospital located in remote isolated areas, tele-healthcare system using smart application has been applied to access expert opinions in pre-coronavirus disease (COVID-19) era since 2017. The COVID-19 has spread also in this island during COVID-19 period. We have experienced three consecutive neuroemergency patients. Their ages and final diagnoses were: 98 years with subdural hematoma (case 1), 76 years with post-traumatic subarachnoid hemorrhage (case 2), and 65 years with cerebral infarction (case 3), respectively. The tele-counseling could save two of three transportations to tertiary hospital and also save 6,000 US dollars per case for transportation by helicopter. From these three cases counseled through smart app which has been started to use 2 years before COVID-19 emerged in 2020, what this case series would report are the following two viewpoints: (1) medicoeconomic benefits exist in tele-healthcare system in COVID-19 era and (2) developing tele-healthcare systems must be prepared that is available even when the electricity system has been shut down, for instance solar system that could. This system must be developed when non-disaster period for disaster days of natural disasters and human-related disasters including wars and terrorisms.

Keywords: COVID-19, Tele-healthcare, Disaster

INTRODUCTION

In facing to disasters, it is of importance to maintain health-care system for both disaster victims and patients with acute and chronic diseases. In Japan, we have been affected triple disasters of mega-earthquake, tsunami, and nuclear power disaster in 2011. According to analyses of life line disturbances in that disaster, electricity showed the latest recovery among water and gas.^[1] In addition, the coronavirus disease first appeared in 2019 (COVID-19), an infectious disease caused by SARS-CoV-2 was declared a pandemic by the WHO and global health threat.^[2] This outbreak has made a health-care system facing disruption.^[3] For keeping social distancing in this pandemic, whereas the electricity system has been kept and has an advantage to send information of infected patients keeping social distancing from non-infected health-care givers. In geographically remoted areas such as hospitals in islands where is isolated from medically urbanized areas by raging oceans or rugged mountains, severe scarcity of necessary medical resources of equipment and professions exist. It must be common that these obstacles exist instead of disasters are or not. In our hospital located

in an isolated remote island named Tokunoshima, Japan, as it is over 200 kilometer and takes more 4 h door-to-door for transportation between hospitals, tele-healthcare for diagnosis and emergent treatments is essential especially during pandemic era to eliminate exposures to COVID-19 to the greatest extent. To examine usefulness and limitations of tele-healthcare in disaster period, we would share our experience of three neurosurgical cases with COVID-19 infection in 2021.

CASE DETAILS

During the year 2021 when COVID-19 pandemic was overwhelming our island, of which population was 20 thousand, as our hospital was lacking expert resources to provide high-quality healthcare for patients, tele-healthcare system has been employed using smartphone application (app.). This smart appl. has provided two different modes: One (expert)-to-Many (patients) and Many-to-One mode. In this report, we propose tele-healthcare of One-to-Many mode for neurotriage available not only in non-disaster, but in disaster period for instance, triple disasters occurred in

*Corresponding author: Teruyoshi Amagai, Department of Clinical Engineering, University of Jikei Health Care Sciences, Osaka City, Japan. amagaipedteruyoshi@gmail.com

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2011 in Japan or COVID-19 occurring over the world since 2019. In year 2021, we have experienced three consecutive neuroemergent outpatients visited ED. Their clinical details of three cases are shown [Table 1]. All of them had COVID-19 infection and were neuroemergency. As it costs over 6000 US dollars and takes 3 h for single transport to tertiary hospital in long distance by helicopter, quick and correct diagnostic decision-making for neurological triage was critical. Three years ago, we have started to apply smart app. for tele-counseling in pre-COVID period and this could save these three neurosurgical lives of patients and medical resources. To share, our neurotriage with tele-healthcare using smart app. developed in non-disaster period for disaster days seems to extend its scope in disaster period occurring at any time at anywhere such as natural disasters and human-related disasters including wars and terrorisms.

DISCUSSION

Preparing health-care system available in disaster period when during non-disaster period

What this case report would emphasize is that no system exists available in disaster period unless any system is available in non-disaster period. In other words, we must

prepare and ready to disasters that must come at any time at anywhere. Nowadays, the digital technology-based telemedicine is widely used across various medical specialties including pathology, psychiatry, ophthalmology, neurology, and triage as we showed in this report. This report might call necessity of preparing tele-healthcare systems available even when any electricity has been shut down. In this way, we are unanswered to these relevant questions.

An economic effect of smart tele-healthcare

Annual expense cost more than 1.8 million US dollars for annual 300 patients' transportations by helicopter. Calculating for a single use helicopter per patient, it costs 6,000 US dollars for a single helicopter usage. Unless its usage must be finalized by tele-consultation by neurosurgical experts, this transport expense is saved. In other words, obtaining expert tele-services using tele-healthcare system could save aforementioned transport expenses. This might be economic advantage of tele-healthcare system from viewpoint of whole medical economy even when COVID-19 pandemic has overwhelming over rural areas. The one possibility might be tele-healthcare system using solar storage system. This might be prepared in non-disaster period for disaster days.

Table 1: Comparison of clinical course in patients with neurosurgical problems.

Case	1	2	3
Age	98	76	65
Sex	Female	Male	Male
Chief complaints	Fever, hemiparesis	Right hand paresthesia	Falling down on the road with unconsciousness, right-sided conjugate deviation and left hemiplegia
CT findings	Right subdural hematoma associated with midline shift to the left	High-density area at left temporal lobe	Early sign of cerebral infarction
Consultation result	Unnecessarily of emergent operation	Enhanced CT, MRI*, MRA*, and MRV* for coexistence of aneurysms or arterial dissections, no these findings	Add MRI* and MRA*
COVID-19 infection Diagnosis	Positive Subdural hematoma	Positive Post-traumatic SAH (thrombolysis in cerebral infarction (TICI) grade 3)	Positive Cerebral infarction: M1 branch of MCA* occlusion
Urgent transport	No	No	Yes by self-defense army helicopter
Treatment	Elective operative removal of hematoma	Surgically washing-out	Thrombectomy after t-PA* infusion
Coexistence of ARDS	No	No	No
Where to treat	Here	Here	NOT here: Tertiary hospital
Outcome: alive or dead	Alive	Alive	Alive

ARDS: Acute respiratory distress syndrome, COVID: Novel coronavirus infection disease, MCA: Middle cerebral artery, MRI: Magnetic resonance imaging, MRA: MR angiography, MRV: MR venography, SAH: Subarachnoid hemorrhage, t-PA: Tissue plasminogen activator

Limitations of tele-healthcare system using smart application with wireless local area network (LAN)

To utilize tele-consultation in COVID-19 pandemic era, its limitations also must be recognized. This tele-health platform requires building of infrastructures and legal arrangements including reimbursement. In addition, as natural disasters might have possibility of interrupt electric communication, maintaining tele-health platform instead of natural disasters such as typhoon, earthquake, or tsunami that intercept electric communication,^[1] alternative methods must be readied as alternatives such as satellite phones, of which the governmental bodies prepare. When these barriers have been solved, blueprint for post-COVID-19 and unmet another pandemic build more rigid and reliable eHealth platform.^[4]

This presentation has some limitations. First, the number of neurosurgical cases must be too small to draw strongness of using smartphone application in telemedicine. In further studies, some technical problems might appear to be resolved. Second, there might be ambiguousness to prove advantages of our method to save neurological functions. In other words, case 1 and 2 might save their physical motor and sensory functions without our proposed telemedicine, because they were observed with no surgical interventions after transport. Third, it is uncertain whether this system could be available or not in the areas where wireless LAN circumstances are out of service or are broken down in disaster period. Especially, to overcome the third limitation, the digital technology-based tele-healthcare system including Internet of Things or blockchain to trace personal electric health records and medication records must be built solid against nature disaster and cyber terrorism.

CONCLUSION

In this case report, we presented the smart tele-consultation health-care system used in non-pandemic and non-disaster periods must be useful even in pandemic era. What this case report would report are the following two viewpoints: (1) medicoeconomic benefits exist in tele-healthcare system especially in COVID-19 period and (2) developing tele-healthcare systems must be prepared that is available even when the electricity system has been shut down, for instance solar system that could. This system must be developed when

non-disaster period for disaster days of natural disasters and human-related disasters including wars and terrorisms.

Statement of ethics

The three cases included in the present article were approved by the Ethics Committee of Tokunoshima Tokushukai General Hospital (21-02), and written informed consents were obtained from all three patients.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

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