A remote desktop-based telemedicine system

Yasushi Shibata, MD, PhD

Department of Neurosurgery, Mito Medical Center, University of Tsukuba

Mito, Ibaraki, 310-0015, Japan

Tel: +81-29231-2371

Fax: +81-29221-5137

E-mail: yasushishibatamd@yahoo.co.jp

Abstract

This manuscript details the construction of an almost cost-free telemedicine system using a remote desktop and the public internet system. Using this system, real time DICOM images were observed with their original spatial resolution without any delay. The system is secure for the protection of personal information. There is no risk of viral infection to either the host or the viewer's computer. No specific license, contract or initial investment is necessary. This system can help to make up for the present shortage of specialists.

Key words: telemedicine, remote desktop, DICOM, Neurosurgery

Introduction

Neurosurgical emergencies, including trauma and cerebrovascular diseases, are generally evaluated based on clinical information and images from emergency computed tomographic (CT) scans. Many telemedicine systems are commercially available. Most of these systems use specific server or communication systems. Because these systems are so expensive, they are not widely used at community general hospitals. I herein report the development, utility and obstacles to using an almost cost-free telemedicine system using the public internet system.

Method

A personal computer (PC) and web camera connected to the public internet were set up in the department of radiology. I first attempted to use the free net phone system to watch films of printed CT images. However, the image quality was suboptimal. In addition, because the free net phone system is very easy to connect to, it is not fully secure. I next tried a remote desktop system, which makes it possible to remotely control a PC using the web. Using a remote desktop, I could control the web camera, and observe the images. However the image quality was also poor using this system. I then separated the image and telephone communication systems and established a

remote desktop system to watch CT images. Since a static imaging system is sufficient for diagnostic needs, a dynamic imaging system is not required.

The CT images were saved on a compact disk (CD) in the Digital Imaging and Communication in Medicine (DICOM) format. DICOM images of the CT scans were transferred off-line to the internet-connected PC. The DICOM images were then opened using a free DICOM viewer on the PC. These images were observed from the remote site using the remote desktop.

Results

Using the remote desktop, all CT images were observed with their original spatial resolution. The operation of the DICOM viewer, including the ability to scroll, enlarge, screen slit, and change the level and width of images were possible without any time delay. (Fig 1)

The connections of this remote desktop system require input including an Internet Protocol (IP) address, user name and the password of the PC in the department of radiology. This system do not transfer each images or data, so the personal information is not preserved outside of the hospital. Thus, the system is secure for the protection of personal information. Neither of the PCs used for this system are directly connected to

the CT machine or image server in the hospital, so there is no risk of viral infection of the hospital properties.

Before the introduction of the system, sometimes doctors on duty (who were not experienced with neurosurgery or brain injuries) could not detect small cerebral contusions or bleeding. After the introduction of the system, the doctor on duty could suggest more appropriate treatment after obtaining the neurosurgeon's opinion. Some patients needed to undergo emergency surgery, and likely experienced a much better outcome as a result of this system. In addition, this system allows the operating room staff or intensive care units to prepare for a particular type of surgery or procedure in advance, before the neurosurgeon arrives at the hospital. In addition, some patients need to be sent to tertiary emergency hospitals in the region. This telemedicine system helps to determine the transfer and triage of the patients. Unnecessary hospital admissions were also prevented by this telemedicine system. This system contributes to the appropriate use of medical resources and decreases medical expenses.

I also use remote desktop software on the iPhone®. The same DICOM images can be viewed on iPhone (Fig. 2). Although the time delay of image display on the iPhone is significant with a standard telephone connection, wireless local area network connections provide for operation of the system without any significant delay. Wireless

telemedicine without a desktop PC is ideal for the immediate response to neurological emergencies.

Discussion

The introduction of telemedicine has led to significant improvements in the treatment of neurosurgical emergencies, such as stroke, head injury and pediatric neurosurgery (1-8). Telemedicine systems help improve the prognosis of patients, and can also be used to educate students and doctors-in-training.

Tissue plasminogen activator (tPA) is the most effective treatment for acute ischemic stroke, and should be administered within 3 hours after the onset of stroke according to current medical guidelines (9). Johnston reported that the indications for use of tPA can be completely determined using web transmission of CT images (2). The American Heart Association (AHA) has stated that teleradiology is effective for evaluating CT images, neurological findings, and to determine the indications for using tPA, and that the use of telemedicine can make up for the shortage of stroke specialists in stroke care units or emergency hospitals (6). Telemedicine is effective for the selection of patients for early administration of tPA for ischemic stroke. However, this treatment has a significant risk of bleeding, so special care must be taken before recommending the

treatment.

Image transfer systems using a digital camera built into a mobile telephone are useful and convenient (1). However, the image quality is often not as good as in the original images, thus limiting the interpretation of the images and making it difficult to provide a radiological diagnosis. Adjusting the window width and level, or scrolling among images, is not possible with image transfer systems using a digital camera. In order to detect subtle lesions, such as early ischemic CT signs or a small hemorrhage, an international standard DICOM image and the ability to view it using a specific DICOM viewer are therefore necessary. In addition, all of the camera-based image transfer systems pose problem regarding the protection of personal information, since images can be saved at the user computer outside the hospital. Our system does not allow data transfer, so the personal information is not stored outside of the hospital.

Our system consists of a general-purpose PC and public internet system. The images could be watched on any PC and many “smart phones” outside of the hospital using secure IP address and passwords. Running costs include only CDs to copy CT images, electricity, and a provider fee. No specific license, contract or initial investment is necessary. Therefore, the system is easy to introduce in deficit-ridden community general hospitals. The operation is simple, so the doctors and radiological technicians in

the emergency room will not need much training before the system can be used. Specialists outside of the hospital can watch the CT image at any time, allowing for possible consultations with other experts. After listening to the clinical information using the telephone, the specialists can give the doctor on duty immediate and appropriate instructions for the treatment of the patient.

Radiological examination is one of the most important supplementary diagnostic tools. However, we should not determine the diagnosis and the treatment based on a radiological diagnosis alone. Clinical information, including the patient's medical history, and the results of physical and neurological examinations should be carefully considered before starting therapy. Although the administration of tPA after a telemedicine consultation is reported to be feasible and safe (4), telemedicine should not be the only diagnostic tool.

One of the problems with the Japanese emergency medical system is that most doctors on duty in emergency hospitals are not emergency medicine specialists. They do not want to accept stroke or head injury patients. Our telemedicine system helped the doctors on duty successfully treat neurological emergencies. In addition, unnecessary hospital admissions were prevented by the use of this telemedicine system. This system thus contributes to the appropriate use of medical resources and suppresses medical

expenses.

At present, we use this system only for CT images, however, any DICOM image recorded on a CD can be used by the system. We plan to expand the system to include magnetic resonance imaging (MRI), angiography, echo, etc.

Unfortunately only a limited amount of telemedicine and remote image diagnoses are covered by the Japanese health insurance system. The neurosurgeon is thus called upon any time there is a question about a patient, and asked to check images. These consultations are considered volunteer work, and no fees are covered. Appropriate doctor fees and insurance systems will need to be established to cover and develop telemedicine systems that will benefit both the patients and expert physicians.

Figure legend

Figure 1: A remote desktop image of the DICOM viewer in the hospital from outside of the hospital. Full DICOM viewer control is possible without any time delay.

Figure 2: A remote desktop image in the iPhone.

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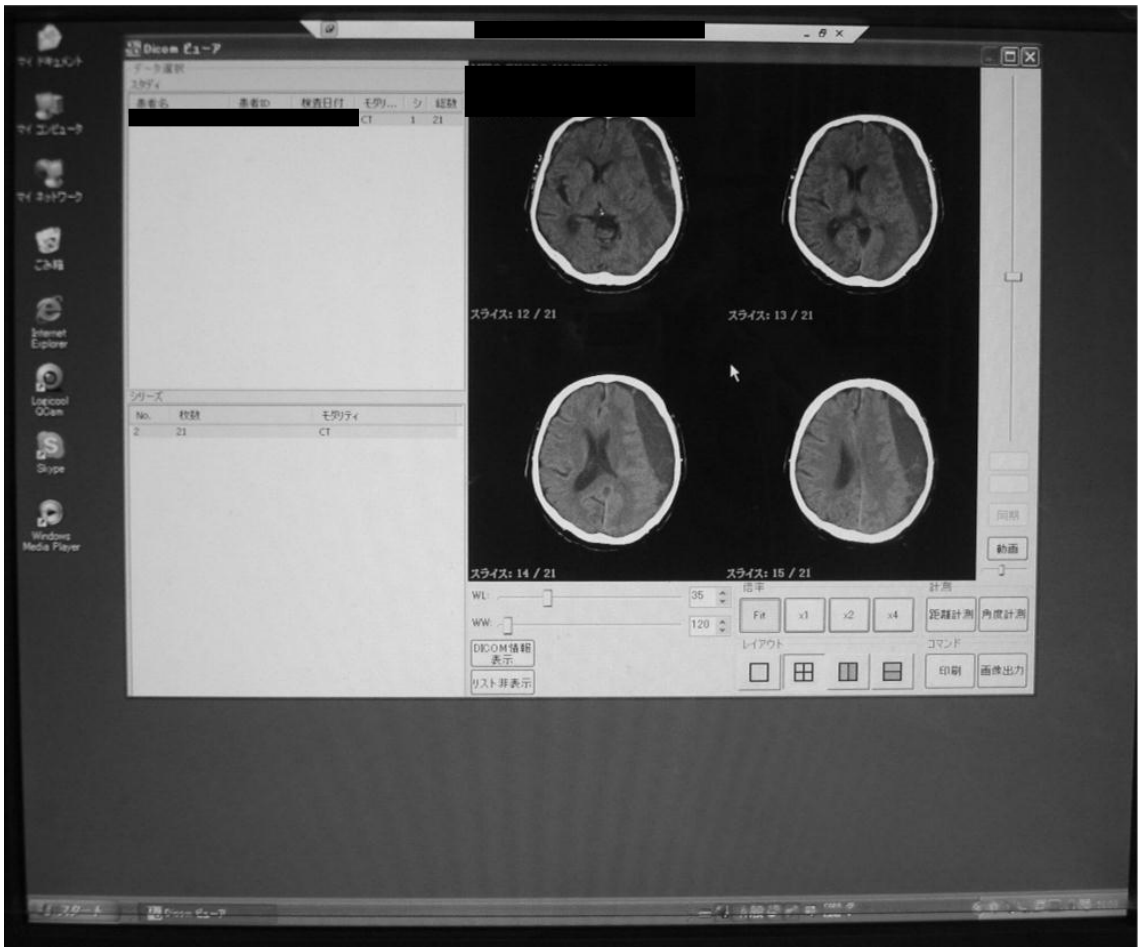
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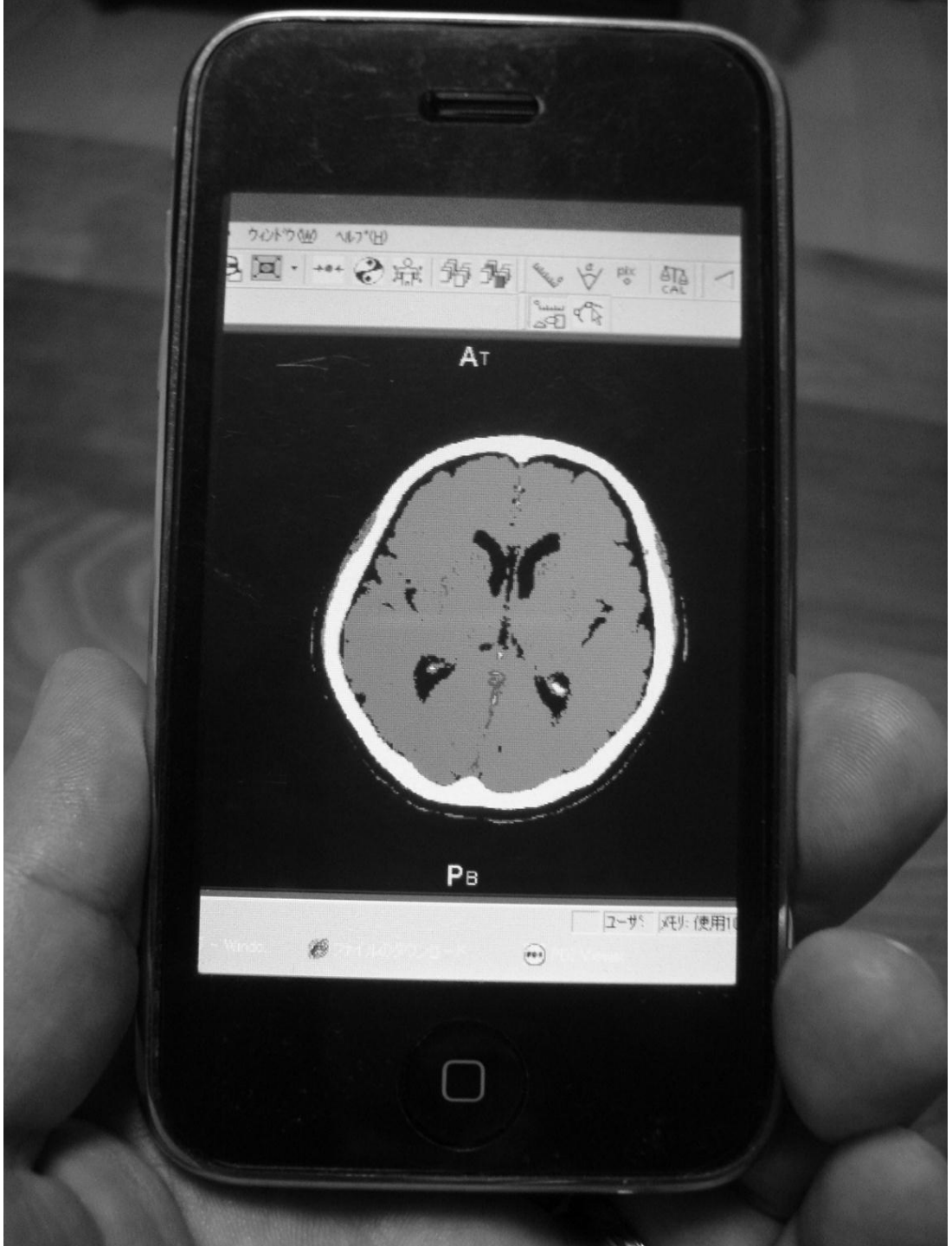
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