Development of Wireless Triage and Treatment System using Information Technology for Disaster Training

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SUMMARY

We developed a wireless triage and treatment system using information technology for disaster training. The system consists of a server, personal digital assistant (PDA) displays, exclusively designed software and a patient database. For realization of wireless triage and treatment, we designed chronological scenarios of standardized cases for installing in a computer server. The computer server provides information on the training field such as the localization, positioning, transportation and capacity of each facility. In this virtual training field, selected patient data is presented from the server computer to the PDA. Trainees perform a virtual triage and treat virtual patients on a PDA display. Also, they can request transportation. The trainer evaluates the virtual management performed by the trainees on the server computer.

Keywords: Disaster training, triage, treatment, wireless technology, information technology

INTRODUCTION

Disaster training is an essential tool for supporting disaster responses of the social system and reducing damage to society, and large-scale disaster training has become common (Fig.1).

The unprecedented complex disaster of the Great East Japan Earthquake with a huge tsunami and the melt down of Fukushima Dai-ichi Nuclear Plant has dramatically heightened the need for disaster training.

We developed a wireless triage and treatment system using information technology for mass casualty training. The system consists of a server, personal digital assistant (PDA) displays, exclusive designed software and patient database. Using patient data on a PDA display, trainees perform a virtual triage and initial treatment of a virtual patient in a virtual disaster field.

Fig.1 *Typical appearance of large-scaled disaster training in Kumamoto Airport: Cooperative training with Fire Agency and Self Defense Force.*

MATERIALS AND METHODS

To realize a wireless triage and treatment system using information technology for

disaster training, we designed the basic structure of the system, in a detailed scenario with a time factor. We launched the first version of the virtual desktop infrastructure (VDI) in April 2012 after a pilot study had been performed using a prototype over approximately 7 months, beginning in December 2011. The total system design of the first version is shown in Fig. 2.

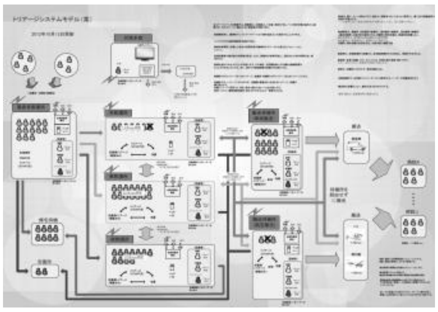

Fig.2 *System design of wireless triage and treatment system using information technology for disaster training: first version (2012)*

In July 2012, our project was adopted as a project of FUKUSHIMA medical development center (FMDC) to receive a special national budget, as one of the Fukushima recovery projects. The system can be used on all devices, including desktops, iOS-based tablet PCs and laptops. The VDI system was concurrently accessible by 50 users simultaneously.

We designed 50 typical cases (25 males and 25 females) for the database (Table 1). In each case, we make a scenario with chronological factors such as O2 inhalation, blood sampling, blood gas analysis, intubation, electric cardiac defibrillation, intravenous fluid resuscitation and wound management with hemostatic procedures (Fig.3).

Table 1 *Examples of 50 cases such as Case A, Case B and Case C*

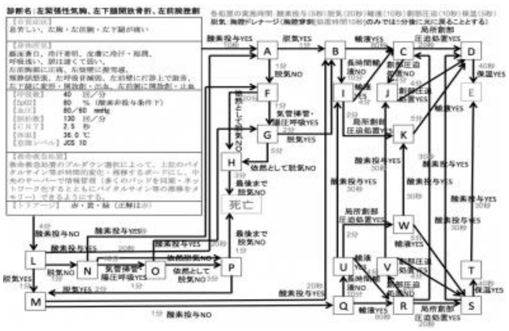

Fig.3 *Chronological algorithm of a case with left tension pneumonia, open fracture of left lower leg and laceration of left forearm*

To demonstrate an open injury case with reality, video images of “moulages” with special makeup techniques were introduced. (Fig.4)

Fig.4 *Moulages with special makeup technique*

In the server computer, a virtual field map with each facility element is installed. (Fig.5A, B).

Fig.5A *Virtual area map with first aid station and triage station*

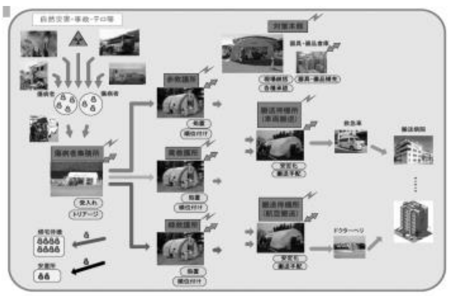

Fig.5B *Image of virtual area map using real world elements*

For trainees, the interface of an iOS-based tablet PC (iPad) was adopted as a naturally acceptable graphic user interface (GUI).

GUI of all aspects of triage is shown in Fig.6 A-I**.**

Fig.6A ***Fig.6B***

Interface for triage *Interface for transportation*

Fig.6C ***Fig.6D***

Resource station *Triage tag*

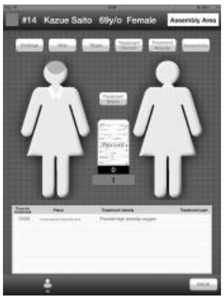

Fig.6E

Treatment selection

Fig.6F

Example of female patient with severe head injury

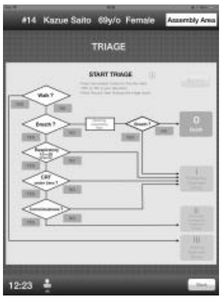

Fig.6G

Progress monitoring

Fig.6H

START triage chart

Fig.6I

Victim map

The GUI of a trainee iPad provides several clinical triage points such as check-in, resource view, victim map, triage tag, treatment option, female patient, monitor view, start triage.

DISCUSSION

Triage is the process of determining the treatment priority of patients based on the severity of their condition 1). This concept enables us to treat patients efficiently when resources are insufficient for everyone to be treated immediately. Triage may result in determining the order and priority of emergency treatment, the order and priority of emergency transport, or the transport destination for the patient. Triage may also be used for patients arriving at the emergency department. In the case of a complex disaster, triage should be performed repeatedly and recorded on each form.

In the earliest stages of an incident, such as when a paramedical team arrives to treat 20 or more patients, "simple triage" is used. Simple triage is usually used at the scene of an accident or mass-casualty incident (MCI), in order to sort patients into those who need immediate transport to the hospital with critical attention and those with less serious injuries. This step can be started before transport becomes available. Upon completion of the initial assessment by medical or paramedical personnel, each patient may be labeled, which may identify the patient, display assessment findings, and identify the priority of the patient's need for medical treatment and transport from the emergency scene. Pre-printed cards for this purpose are known as triage tags.

However, once a full response has occurred and many staff are available, paramedics will usually follow the model included in the national service policy and standing order.

In Japan, the triage system is mainly used by health professionals such as emergency medical technicians (EMT) and medical doctors. The categories of triage, in corresponding color codes, are; Category I (red) for viable victims with potentially life threatening conditions, Category II (yellow) for victims with non-life threatening injuries, but who urgently require treatment, Category III (green) for victims with minor injuries that do not require ambulance transport, and Category 0 (black) for victims who are dead, or whose injuries make survival unlikely.

As triage concepts become more sophisticated, triage guidance is also evolving into both software and hardware decision support products for use by caregivers in both hospitals and in the field.

Simple Triage and Rapid Treatment (S.T.A.R.T.) is a simple triage system that can be performed by lightly trained emergency personnel 2). It is not intended to instruct medical personnel or techniques. It was developed at Hoag Hospital in Newport Beach, California for use by emergency services. It has been taught to California emergency workers for use in earthquakes.

The use of advanced triage may become necessary when medical professionals decide that the medical resources available are not sufficient to treat all the people who need help. It is used to divert scarce resources away from patients with little chance of survival in order to increase the chances of survival of others who are more likely to survive. The treatment being prioritized can include the time spent on medical procedures, or other limited resources such as drugs. Advanced triage has been used in disasters caused by hurricanes, earthquakes, volcanic eruptions, and rail accidents.

In the case of the Asiana Airline Crash in San Francisco International Airport on July 6, 2013, 2 people died at the crash site and more than 180 of 307 people on board died 3). Among the injured, 49 were in serious condition, only 1 of whom died 6 days later. The disaster training and capacity for presenting quality trauma care should be a key factor in aiding the injured in this case.

Undertriage is the underestimating of the severity of an illness or injury. An example of this would be categorizing a Priority 1 (Immediate) patient as a Priority 2 (Delayed) or Priority 3 (Minimal). Historically, acceptable rates of undertriage have been deemed to be 5% or less.

Overtriage is the overestimating of the severity of an illness or injury. An example of this would be categorizing a Priority 3 (Minimal) patient as a Priority 2 (Delayed) or Priority 1 (Immediate). Acceptable overtriage rates have been typically up to 50% due to an effort to avoid undertriage. Some studies suggest that overtriage is less likely to occur when triage is performed by hospital medical teams, rather than paramedics or EMTs.

In-hospital triage is the key factor for successful management of an overwhelming number of patients in lack of treatment capacity. Kleber et al. 4) reported the results of in-hospital triage in 17 mass casualty training events with a focus on the underestimation of life-threatening injuries and the need for re-triage 3). The accuracy of in-hospital triage was low (61%). Predominately, the problem of overtriage (24%) due to insufficient triage training in contrast to undertriage (16 percent) occurred. They concluded that a standardized training program and triage algorithm for in-hospital triage should be established.

Smith J et al. 5) reported that a small percentage of US medical schools currently include disaster medicine in their core curriculum, and even fewer medical schools incorporated or adopted competency-based training within their disaster medicine lecture topics and curricula in 2012.

Risavi BL et al. 6) presented a study that assessed the effectiveness of written and moulage scenarios using video instructions for MCI triage by evaluating skill retention at six months post-intervention and a significant decrease in performance between initial and six-month testing, indicating skill decay and loss of retention of triage skills after an extended non-use period. There were no statistically significant differences between written and moulage testing results at either initial testing or at six months. Their results show that triage training should be easy to perform and repeatable.

Leow JJ et al. 7) reported that Surgeons OverSeas (SOS), an international non-governmental organization, partnered with the Office of National Security and Connaught Hospital in Sierra Leone, a low-income country, to develop a 2-day MCI workshop designed to meet needs specific to their resource-limited environment. In this trial, participants identified interagency coordination (46.3%; 63 of 136 responses) and triage (23.5%; 32 of 136) as the most valuable lessons learned.

With the development of information technology (IT), several trials using IT in disaster triage training have been reported. Avdreatta et al. 8) reported a comparison of the relative impact of two simulation-based methods for training emergency medicine (EM) residents in disaster triage using the Simple Triage and Rapid Treatment (START) algorithm, full-immersion virtual reality (VR), and standardized patient (SP) drill. The mean pretest scores were similar between the SP and VR groups. There were no significant differences between the triage performances of the VR and SP groups, but the data showed an effect in favor of the SP group performance on the post-test. Therefore, they concluded that virtual reality can provide a feasible alternative for training EM personnel in mass disaster triage, comparing favorably to SP drills.

As a game system for training of MCI information system for first responders, Yu et al. 9) presented the development of a Mixed Reality Triage and Evacuation game, MiRTE. They describe a game that can simulate various algorithms such as localization technologies, and interface with an actual user interface on PCs and smartphones when the information system hardware and software have been completed.

Cohen et al. 10) studied the feasibility of evidence-based design and the use of low-cost virtual world environments for preparation and training in multi-agency, multi-site, major incident response and pointed out that the major incident planners and trainers should explore this technology as an adjunct to existing methodologies. Glow et al. 11) presented a novel training model for using mass-casualty incident (MCI) scenarios that trained hospital and prehospital staff together using Microsoft Visio, images from Google Earth and icons representing first responders, equipment resources, local hospital emergency department bed capacity, and trauma victims.

We developed a wireless triage and treatment system using information technology for disaster training. The system consists of a server, personal digital assistant (PDA) displays, exclusive designed software and a patient database. For realization of wireless triage and treatment, we designed chronological scenarios of standardized cases for installing in a computer server. The computer server provides information on training fields such as localization, positioning, transportation and capacity of each facility. In this virtual training field, selected patient data is presented from the server computer to the PDA. Trainees perform virtual triage and treat the virtual patient on the PDA display. Also, they can request transportation. The trainer evaluates the virtual management performed by the trainees on a server computer. Our system enables us to train triage in several types of

MCI. Furthermore, various aspect of MCI training such as medical treatment, nursing care, logistic management and commander training can be given.

After the unprecedented complex disaster of the Great East Japan Earthquake with a huge tsunami and the melt down of Fukushima Dai-ichi Nuclear Plant, the requirements of disaster training have become more diverse to manage complex disasters. The wireless triage and treatment system using information technology for disaster training provides training on various aspects of mass casualty and complex disasters with diverse factors.

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