Medical Social Informatics Application of Human Computer Interface for Traumatic Brain Injury in the Rural Area

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Abstract

Medical social informatics is a framework to solve public health problems by using the information technology based on the public needs. In the field of neurosurgical services as part of public health, traumatic brain injury (TBI) is common in Indonesia. Roughly, 200 neurosurgeons in Indonesia are working for 250 million population. Most of them are working in the big city so that TBI in the rural and disaster area cannot be treated properly. To support the treatment of TBI during the absence of a neurosurgeon, we have developed a TBI supported information system focussing on the TBI graphic user interface (GUI). This system can be employed by general surgeons, doctors and nurses under a neurosurgeon's distant guidance. The human-computer simulation was performed using Lenovo T500 with finger touched mouse keyboard and Lenovo X201 with pen-tablet ThinkPad. A patient admitted to the emergency room was the candidate on this simulation. Data were assessed and recorded in the system simultaneously by nurses, doctors and general surgeons after they login according to their qualification. The speed of data comprehending and data entry was almost similar on both types of computer; however, the particular tablet PC was found more convenient and faster. Under neurosurgeon guidance, the paramedics were competent to provide early treatment, to stabilize the patient's condition and to perform minimal surgical intervention for saving patient's threatened life. Therefore, this system is expected to be useful for the rural and disaster area that has no neurosurgeon.

Keywords: medical social informatics, human computer interface, traumatic brain injury (TBI)

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Penerapan Medical Social Informatics pada Tampilan Perangkat Lunak Komputer untuk Kasus Cedera Kepala di Daerah Terpencil

Abstrak

"Medical social informatics" merupakan salah satu cara memecahkan masalah kesehatan dengan menggunakan teknologi informasi berdasarkan kebutuhan masyarakat. Dalam bidang pelayanan bedah saraf, yang merupakan bagian ilmu kesehatan masyarakat, cedera otak traumatika (COT) merupakan masalah kesehatan masyarakat di Indonesia. Terdapat kurang lebih 200 ahli bedah saraf di tanah air yang melayani 250 juta penduduk. Sebagian besar ahli bedah saraf berada di kota besar sehingga penanganan COT di daerah terpencil dan daerah bencana menjadi terlambat. Dalam rangka penanganan COT di daerah yang tidak memiliki ahli bedah saraf, kami mengembangkan suatu sistem informasi yang difokuskan kepada penggunaan "graphic user interface" (GUI) pada kasus COT, yang dapat dipergunakan oleh perawat, dokter umum dan ahli bedah umum dibawah supervisi jarak jauh ahli bedah saraf. Peralatan yang dipergunakan adalah komputer personal (PC) Lenovo T500 dengan "mouse-keyboard" dan Lenovo X201 "touch screen". Kandidat pasien pada penelitian ini adalah pasien COT yang datang ke unit gawat darurat. Data pasien dimasukkan ke dalam sistem oleh perawat, dokter dan ahli bedah umum setelah mereka "log in" ke dalam sistem sesuai dengan kualifikasi masing-masing. Kecepatan untuk memahami dan memasukkan data dengan menggunakan kedua tipe PC ternyata tidak jauh berbeda, namun "PC touch screen" dirasakan lebih nyaman dan lebih cepat. Di bawah pengawasan seorang ahli bedah saraf, para dokter dan paramedik yang bertugas terbukti kompeten dalam memberikan pengobatan awal, menstabilkan kondisi pasien dan melakukan tindakan bedah saraf sederhana dalam rangka penyelamatan nyawa. Sistem ini diharapkan berguna bagi penanganan pasien-pasien COT di daerah terpencil dan daerah bencana yang tidak memiliki ahli bedah saraf.

Kata kunci: *medical social informatics, human computer interface, cedera otak traumatika (COT)*

Introduction

Medical social informatics is an integrated and multidisciplinary approach to analyze and to prevent the emergence of a disease, with its main goal is to save more people's lives by using information technology. This framework is established by the fusion of social informatics and epidemiology.[1] One of the health problems in neurosurgical services is traumatic brain injury (TBI). It can be caused by a traffic accident and can happen when the skull is hit by fallen hard things, making internal bleeding inside the head. The bleeding will compress the normal brain tissue and the patient's condition will deteriorate if the blood cloth is not evacuated for surgical decompression. This problem becomes a burden in some developing countries like Indonesia since the number of neurosurgeons is still less compared to the population[2]. Therefore, in this study we developed a neurosurgical information system focussing on human computer interaction for TBI GUI as a part of medical social informatics framework to

solve health problems in the neurosurgical field, especially in the rural area in Indonesia.

Material and Methods

A GUI (Graphic User Interface) is a communication interface between computer and users. This GUI for supporting TBI is presented in this study according to the decision algorithm shown on Figure 1. If a skillful, well trained neurosurgeon is available, he or she may do independent onsite surgical treatment. If not, and if only a general surgeon, a general doctor (physician) and a nurse are available, and monitoring is necessary, it is suggested that they do mentored treatment under TBI user interface and information communication technology (ICT) support for telemedicine, supervised by a neurosurgeon from a distance. In some cases, when monitoring only is not adequate and the patient needs surgical intervention, the physician or nurse should refer the patient immediately to the neurosurgical center under TBI user interface support. However, if the onsite physician (e.g. general surgeon) can perform a surgery and has a deal with complications and post operative care, it will be possible for him/her to treat the patient with the guidance of a neurosurgeon who is equipped with teleneurosurgery. If the physician cannot deal with post operative care and complication after initial life survival surgery (e.g. craniotomy decompression), the patient should be transported to the medical center, supported by ICT. This system has been simulated by neurosurgeons, general surgeons, physicians and nurses in Japan and in several neurosurgical centers in Indonesia. Finger touched mouse-keyboard Lenovo T500 and pen-tablet Think Pad X201 interfaces were responsible for data entry by users with TBI GUI (Figure 2).

Results and Discussion

The successful speed of data entry, the time needed and the understanding of TBI GUI had depended not only on the computer literacy of users but also on the ability to know and recognize the TBI symptoms. We noted the time for data entry as shown in Table 1 and Table 2.

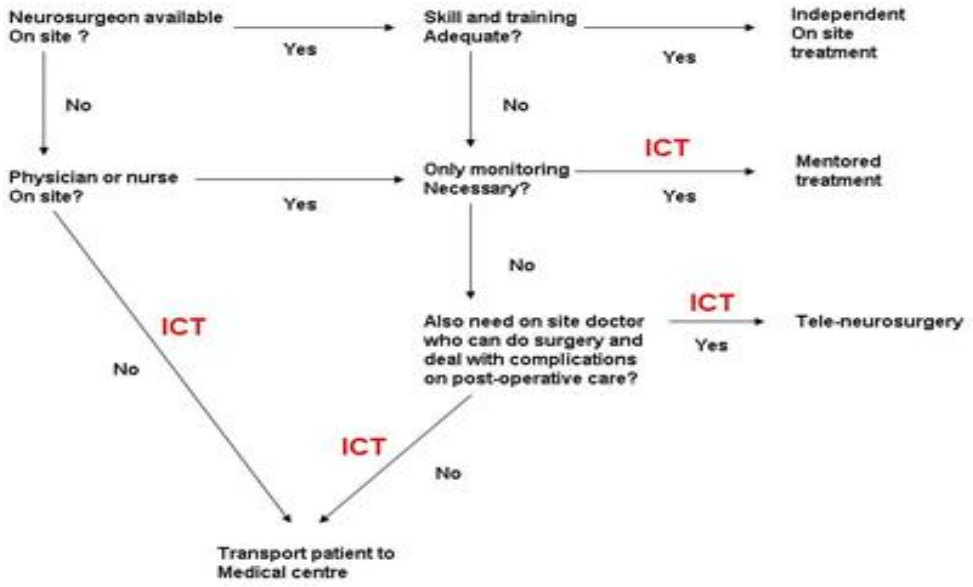

Figure 1. Decision Algorithm for TBI Patients in Rural and Disaster Area. ICT: Information Communication Technology Support

Figure 2. Graphic Users Interface Simulation in Japan and Indonesia

Table 1. Mean Time Needed Based on User Qualification and Computer Type in Keio University-Japan

User interface	Neurosurgeon		Surgeon/GP		Nurses	
	T500 (seconds)	X201 (seconds)	T500 (seconds)	X201 (seconds)	T500 (seconds)	X201 (seconds)
Login	10.43	8.25	13.85	8.51	12.12	14.14
Demography	24.25	16.39	27.47	26.39	51.21	46.16
Anamnesis - *vital sign*	21.67	17.54	38.63	22.58	68.18	52.18
Anamnesis- *GCS*	27.83	18.95	122.28	123.91	289.24	228.28
Anamnesis- *symptoms*	96.47	77.41	208.34	104.23	267.31	213.26
Anamnesis- *location*	25.12	18.76	23.61	37.84	29.22	38.38
Anamnesis- *diagnosis*	15.21	14.12	32.93	23.61	65.24	53.12
Treatment - *action*	112.76	98.36	134.29	114.37	243.26	146.42
Treatment- *medicine*	145.22	92.14	162.41	72.58		
Follow up	62.76	42.26	74.18	40.12	61.28	65.25
Total time (second)	541.72	404.18	837.99	574.14	1087.06	857.19
Total time (minutes)	9.03	6.74	13.97	9.57	18.12	14.29

T500 = Lenovo T500; X201 = Think Pad X201; GP = General physician; Time in second.

Table 2. Mean Time Needed Based on User Qualification and Computer Type in Universitas Padjadjaran-Indonesia

No	Qualification	Entry methods Lenovo T201X		Time (second)										Understanding GUI
				Demography		Anamnesis		Treatment		Follow up		Teleneurosurgery		
		mouse	TS PC	mouse	TS PC	mouse	TS PC	mouse	TS PC	mouse	TS PC	mouse	TS PC	
1	Neurosurgeon	v	v	55	60	66	60	62	60	32	25	22	20	Easy
2	Neurosurgeon	v	v	52	61	65	62	58	55	36	29	29	25	Easy
3	Neurosurgeon	v	v	57	63	59	64	55	56	34	30	31	30	Easy
4	Neurosurgeon	v	v	60	54	57	68	64	66	39	33	28	24	Easy
5	Neurosurgeon	v	v	51	50	62	66	55	58	26	24	36	38	Easy
6	Neurosurgeon	v	v	58	55	60	60	68	60	27	29	24	26	Easy
7	Doctor	v	v	48	52	78	75	78	68	33	30	34	33	Moderate
8	Doctor	v	v	44	49	73	78	88	80	37	38	31	35	Easy
9	Doctor	v	v	59	56	75	77	81	87	35	31	28	28	Easy
10	Doctor	v	v	60	56	68	65	74	82	31	35	25	27	Easy
11	Doctor	v	v	58	68	66	60	77	88	29	32	26	24	Easy
12	Doctor	v	v	52	63	74	80	69	78	25	36	29	26	Easy
13	Nurse	v	v	68	75	82	90	88	80	38	39			Moderate
14	Nurse	v	v	65	78	83	88	75	76	42	45			Moderate
15	Nurse	v	v	70	77	94	109	86	82	40	48			Easy
16	Nurse	v	v	59	64	99	128	81	86	39	38			Easy
17	Nurse	v	v	66	72	106	131	93	114	37	43			Easy

18	Nurse	v	v	74	79	93	90	82	108	36	37	Moderate

TS PC: Touch screen personal computer; GUI: Graphic user interface

Login interface

The response for user login was recorded using a timer, which needed 8 – 14 seconds. The login response was based on user qualification and was simply understandable since the text guidance was viewed on the login interface (Figure 3). Three groups of users were selected to interact with TBI GUI. This login interface was necessary due to different capability of treatment. It automatically restricted the user interface interaction since some of the buttons were reflecting the instruction to treat the patient. Due to the fact that neurosurgery is a discipline of medicine which provides the operative and non operative management such as the prevention of secondary brain injury (neurological deterioration), diagnosis, evaluation and or follow up treatment and critical care,[3] this GUI should be strictly well arranged, especially for an emergency scenario. The time needed on this interface was almost the same whether the respondent used Lenovo T500 or Think Pad tablet X201.

Demography interface

The content of demography interface was the patient's ID consisting of name, age, gender, and address, which was automatically numbered by the system. To do this interaction, the users need 16–52 seconds. During our simulation, the nurse group showed a delayed response when recording the data, probably because most of the nurses had less computer literacy for TBI simulation. However, the data entry for demography interface response was accomplished in less than 60 seconds, although in this interface the user should record the data by typing the patient's name and address (Figure 4).

Anamnesis interface

An anamnesis interface can greatly enhance the realization of the simulation through performing only necessary information on the TBI guidelines.[4] Within 17–68 seconds, the user could record the data that were divided into five frames, namely vital signs (blood pressure, heart rate, respiration), Glasgow coma scale (GCS), symptoms, location of wound (skull viewed) and clinical diagnosis which was confirmed by imaging (Figure 4). The vital signs are generally used to measure physiological condition in order to assess the most basic body function in a TBI patient. To aim a neurological scale and as an objective way of recording the consciousness state of the TBI patient, we facilitated Glasgow comma scale frame on the TBI GUI to reflect the level of consciousness after head injury occurrence. Based on this scale, we classified head injury into three types: mild (GCS>13), moderate (GCS = 9-13) and severe head injury (GCS $\leq$ 8).[5,6] This classification is very important since the management of treatment is also different. The time needed to record the treatment data and input medicine data was respectively 98–243 and 72–162 seconds. Basically, the treatment action frame was designed to support the moderate–severe TBI patient, whether for medical or surgical intervention. This was followed by the medicine frame, which consisted of drugs for the TBI patient. A typing box was also provided

for additional treatment medicine. The frame check box was made easy for the user to use during the experiment as the user was supposed just to click the check box. It was also suitable for the telecommunication with videoconference network design, which means that the neurosurgeons were enabled to guide the general surgeon to perform the operation from a distance for the life survival of the TBI patient.[7] Fully treatment tabs were decided by the neurosurgeon, but not by the general surgeon or physician and the nurse, who had more limitation interface. For the surgeon/general physician, the action of exploratory burr hole was possible to be done, but under a strict supervision from the neurosurgeon. This action was allowed to be done for the life threatening condition only, as shown in TBI algorithm referral systems. Some drugs administration such as manitol administration should be supervised by the neurosurgeon due to the potential complication that may occur.[8] For the nurse, the treatment tabs were substituted with nursery tabs, meaning that they were only expected to give assistance to the neurosurgeon or doctors, such as to prepare ICU, arrange bed into 30-45^{o}, do neurological examination, prepare intubation and O_2, perform IV line for normal saline administration and follow up ICP to give a report.

Figure 3. Login Interface for TBI System.

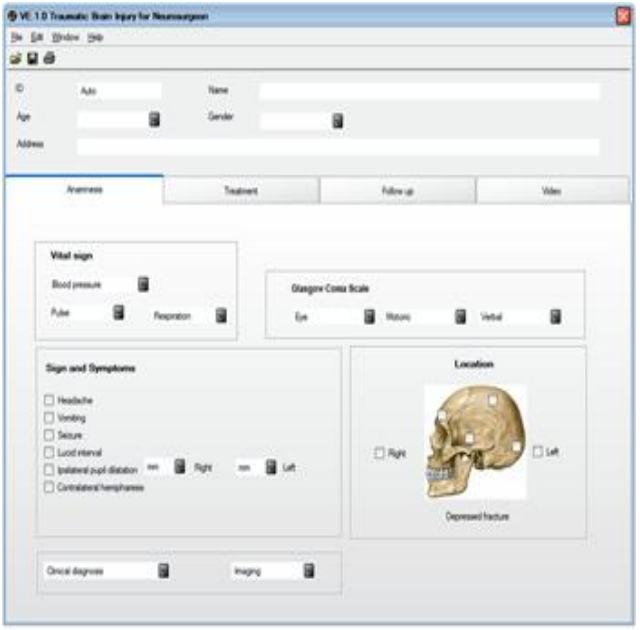

Figure 4. Demography and Anamnesis Interface for TBI System.

Figure 5. Teleneurosurgery Interface for TBI System.

Follow up and telemedicine interface

In order to facilitate follow up data display and teleneurosurgery, we designed the follow up tabs that consist of number, date/time, vital sign, GCS, medicine and action treatment for each patient. This interface aimed to provide communication display data among three kinds of users. Through this interface, we were able to observe the course of treatment and the patient's progress. If the condition of the patient was worsening, a treatment and a surgical intervention were to be done immediately under guiding teleneurosurgery tabs interface (Figure 5). Besides the video streaming interface, we provided the list of cases and neurosurgeon/doctor name, to inform us about the person performing the surgery. It took 40-74 seconds to view follow up data. Prior to using this interface, the explanation of using TBI GUI was provided and mandatory, then simulation activity was ready to be done by the neurosurgeon, surgeon or general physician and neurosurgical nurses. After assessing the patient in the emergency room or neurosurgical ward, they were asked to record the data in the TBI GUI. The video conference using internet free calling skype service or LAN video conference was employed from the operating room to the medical office or conference room. This entire scenario was being noted in the time series to evaluate the time needed, as the time was significantly important to save the patient's life. Two types of computer, Lenovo T500 and Think Pad tablet X201, were used in this experiment and we found that the Think Pad tablet X201 was practically more convenient since this type could be set up into a mobile notebook. All the patients participated in this study underwent proper treatment without any problems.

Conclusions

We have developed a prototype of TBI GUI to be implemented on the rural and disaster area. This system has been on trial in the emergency situation, and the human-computer interaction has been done to discuss how fast the system can interact with the users properly without any problems with the patient's treatment. There are five basic data types for simply TBI GUI, namely 1) demography, 2) specific anamnesis for TBI, 3) treatment action and medicine, 4) follow up data display and 5) teleneurosurgery for streaming video consultation. Compared to the computer mouse touching used for data entry, the Think Pad tablet X201 has been found more convenient and faster for the respondent. In order to implement this system, the available telecommunication network is mandatory, at least low bandwidth for basic data transmission or broadband connection will be preferable for video conference. It is also confirmed that medical social informatics framework is useful to solve health problems.

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