PUBLIC HEALTH PROBLEM AT EMERGENCY MEDICAL SITUATION IN NATURAL DISASTER IN INDONESIA

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PUBLIC HEALTH PROBLEM AT EMERGENCY MEDICAL SITUATION IN NATURAL DISASTER IN INDONESIA

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インドネシアの自然災害状況下での救命救急医療における公衆保健衛生問題に関する研究

アグング ブディ スティオノ

概要

本研究は、インドネシアでの実証実験や事例調査に基づき、被災後の段階に応じた公衆衛生問題を論じている。インドネシアにおける救命救急医療は、被災後の初期段階では重篤患者の搬送や感染症患者の施療が、その後の段階では伝染病患者の施療が、課題である。搬送問題に対しては、Emergency Medical Information Systemsにおけるヒューマン・インターフェイスの開発、実装、プロトタイプを用いたフィールド実験を行っている。感染症や伝染病に対する施療問題に対しては、病院の診療記録や患者への構造化インタビューにより収集したデータを解析し、公衆衛生問題におけるリスク・ファクタを抽出している。
Public Health Problem at Emergency Medical Situation in Natural Disaster in Indonesia

Agung Budi Sutiono

ABSTRACT

The experience of disaster emergency situation in Indonesia caused the health problems as well as the ICT problems that absolutely used to support health services. In the early period of disaster (<7 days), there are critically ill injured and tetanus patients who need to be evacuated therefore need ICT support from the disaster area to the referral hospital. Thereafter in the late period of disasters (>7 days), the health problem is infectious diseases. There are many kind of infection, but typhoid fever is the commonest infectious disease in Indonesia due to high morbidity and mortality.

We have developed the human interface design for the early period in large scale of disaster while the ICT infrastructure has been collapsed. It can be used for medical assistance on disaster situation. It is effectively conclude that EMCIS (emergency medical information systems) as a prototype is very useful in the early periods of a disaster in the event of a large scale impact whereas the ICT was collapsed. It enables VHF radio to be deployed, since satellite communication remains expensive in developing countries like Indonesia. The power supply for the VHF radio and notebook as well as brief training for the EMCIS installation must also be prepared and practiced before any disaster occurs. The minimum requirements in terms of developing a user interface are properly achieved in order to classify and represent critically ill patients by engaging in triage tagging, which can save the lives of more people.

The other fatal case in the early period of disaster is tetanus. We investigated the tetanus death case report from the earthquakes in Yogyakarta. We used the geographical information systems and statistical analysis methods for referral system consideration. We found that distance and type of hospital were important risk factors for live support in tetanus patients. To reduce the mortality rates, the local health government should proposed the referral systems which considering distance and type of hospital for tetanus patients.

Thereafter in the late period of disaster, infection cases exist. We investigated typhoid fever infection based on the social variables in three districts of disaster
affected area in Indonesia, that Aceh (post tsunami), yogyakarta (post earthquakes) and Bandung (Normal situation). It is the commonest infection case in the normal situation. To reinforce the prevention of typhoid complications, in the aftermath of the tsunami in Aceh, there were serious concerns regarding clean water supplies and the availability of drugs. Consequently providing a clean water supply and proper distribution of drugs is the priority during a tsunami, while reducing direct contact with typhoid patients among internally displaced persons (IDPs) during the earthquakes in Yogyakarta is a way to avoid typhoid. Meanwhile, with reference to the normal situation in Bandung, personally speaking, good hand washing is one line of defense against typhoid infection and supporting the free availability of drugs for patients also needs to be considered.

In our disaster experiences, the public health problems arose in the early period of disaster are the ICT supports for critical patients while evacuating to the referral hospital and tetanus fatality. Developing the ICT support that focus on the user interface will be helpful for the medical personnel who are not good in computer literacy in Indonesia. It is due to the user interface is the way of the interaction between the user and computer to send and save the information. We achieved the time needed to fill the data into the systems is reasonable and still represent the critical patient condition. It is based on our daily experience in emergency room Padjadjaran University School of Medicine Hasan Sadikin Hospital Bandung Indonesia. Tetanus was chosen in our study due to 70% open wound was presenting tetanus and also the high mortality in developing countries including Indonesia. Therefore by findings the risk factors of tetanus treatment outcomes from socio-demography-geography will improve the management referral tetanus patients in Indonesia as if the ambulance service has a good reputation.

The further public health problems on the late period of disaster are infectious diseases. The typhoid fever is the commonest infection in the normal situation. It remains the health problems causing complication, treatment difficulties, multidrugs resistance and socio-economic impact because of length of hospitalization period. Some complication case may need surgical treatment that might be difficult in disaster situation. Therefore findings the risk factors of typhoid fever complication will be able to reinforce rapid public health intervention to avoid the morbidity and mortality rate.
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Chapter 1
Introduction

Public health produces the research methods with the purpose of protecting and improving the health communities. In normal situation the public health methods such as medical statistic, psychology, sociology, economics, anthropology have been well performed, but not on disaster in Indonesia. Disaster emergency is a part of public health problems that gives a bad impact to the human and causing the health problems.

![Figure 1.1.Recent public health methods and disaster emergency problems](image)

It has many public health problems in the disaster emergency situation in Indonesia, including the communication and medical risk factors. The communication problems for medical assistance in disaster situation are loose network connection, base transmission destruction, no power supply and so on. Only satellite and radio amateur communications were still exist in the following early period of disaster. Satellite communication still remains very expensive for our country, Indonesia. Therefore, as alternative, the radio amateur communication was considered to be used, however it
needs a proper user interface for medical assistant who are not good in computer literacy to assist traumatic critical ill patients. The traumatic injury patient is dominant and may be followed by the tetanus infection due to open wound. By this reason, we would focus on user interface of the emergency medical care information systems (EMCIS) development. The tetanus study has many discussion in medical field, therefore the socio-demography-geography factors need to be explored for clinical care and public health necessity in the early period of disaster.

Thereafter the situation will be worst if the sanitation and hygiene are not being improved, and may cause infectious diseases, such as cough, common cold, respiratory infections, diarrhea and water borne disease like typhoid fever complications which has been known as high morbidity and mortality. That is the reasons why typhoid fever with complications were chosen in this study in order to reduce the morbidity and mortality risk in the late period of disaster.

Within December 2002 – March 2006 I experienced as disaster preparedness brigade, Ministry of Health Indonesia. The following duty are 1) landslide in Garut West Java on 2002, 2) severe acute respiratory syndrome in Singapore & Malaysia country border in Batam and 3)Bintan Island South Sumatra island on 2003, 4) Jakarta flood on 2003, 5) chemical company disaster explosion, Bandung West Java on 2003, 6) chemical sea contamination in Manado North Sulawesi island on 2004, 7) earthquake in Bam Republic Islamic Iran on 2004, 8) Tsunami Aceh Sumatra island on 2004, 9) earthquake in Nabire Papua Island on 2005, 10). earthquake Yogyakarta Central Java island on 2006.
Chapter 2
Objectives of the Research

Since the disaster emergency exists, the recent public health methods in normal situation may be difficult to perform in Indonesia. The medical statistic, psychology, sociology, economics, anthropology methods are need information and data collection. For example, statistical methods need patient information for recent condition and risk analysis; socioeconomic may need interview to obtain information; anthropology may need customs, culture information of health habit. Those information needs communication to explore public health problems. Meanwhile communication difficulties are usually found in disaster emergency situation. The involvement of ICT is necessary to collect the information from the internally displaced people to find public health problems.

Figure 2.1. Disaster period related public health problems and ICT
Disaster period can be divided into two time series, that early period (<7 days) and late period (>7 days). In early period, traumatic injury may cause critical condition and tetanus infection due to open wound. It usually lack of medical personnel/facilities and communication difficulties. On the late period, the disease pattern is infection due to lack of sanitation/hygiene and followed by medium-mild communication difficulties. In the large scale of disaster, the communication gap with normal situation occurs. It causes public health problems due to obstacles of requesting drugs, medical devices and referring patient (Figure 2.1).

Source: Agung Budi Sutiono's documentation, Ministry of Health Assignment, December 2004 and May 2006

Figure 2.2.A-B, Post tsunami situation in Aceh, December 2004 , C-D, post earthquake situation in Yogyakarta, May 2006, Indonesia.
We experienced the Indian Ocean tsunami in Aceh and earthquake in Yogyakarta province that suffered many people (Figure 2.2.). The devastating event revealed the lack of ICT support for medical assistance and enormous vulnerability of emerging infectious disease on post disasters in Indonesia. Developing ICT support and finding the risk factors of infectious disease are important task. This will serve information for public health methods on the critical patients and vulnerable infectious disease.

In tsunami Aceh Indonesia, only satellite communication was remained but very expensive for people in Indonesia. During early period, the traumatic injury could be critical. Therefore, communication support was required by medical personnel when evacuating critically ill patients to communicate with each other while in disaster affected areas, field hospitals and referral hospitals. However the medical personnel are not good in computer literacy and EMCIS must represent critical patient information such as vital sign, triage tagging, drugs needed and wound location interface. We will do field EMCIS trial in Garut county potential for landslide disaster. Developing an inexpensive and effective ICT prototype focus on the user interface is an expeditious idea to support the transport of critically ill patients from disaster affected areas to the relevant referral hospital (Figure 2.3.).

The tetanus is commonly found at disaster affected area due to entry through in 70% contaminated open wound with high morbidity and mortality in the early period disaster (Figure 2.4). In the earthquake Yogyakarta, we found 26 tetanus patients and 8 of them were died. There are many risk factors in medical field concerning tetanus treatment outcome. However, whether the socio-demography-geography risk factors will influence the treatment outcome has not been discussed. We will examine data from
eight hospitals to get patient’s age, gender, admission, hospitalization, distance and type hospital information to determine risk factors. GIS is used to obtain the geographical distance from patient’s house to the hospital. The GIS data will be used for medical statistical methods including socio-demography information. Tetanus case is a typical example to explore risk factor in clinical care and public health.

Source: Agung Budi Sutiono’s documentation, Ministry of Health Assignment, December 2004.

Figure 2.3.Critical patient and condition in post-tsunami, Aceh, Indonesia

At the late period, the public health problem was typhoid infection with high morbidity and mortality, as the commonest infection in Indonesia. Typhoid fever is the water borne, contacts through contaminated food (Figure 2.5.). It may cause complications to the other organ in the body. In disaster situation, the public health problems are worsening due to the lack of medical facilities. The people are frequently
difficult to acquire clean water for food preparation or daily activities as well as typhoid drugs. Socio-cultural background such as hand washing habit, contact closely to the typhoid patient, the awareness of sanitation and hygiene are typical example to be explored in clinical care and public health. We will discuss about the different characteristics and risk factors in post tsunami (Aceh), post earthquake (Yogyakarta) and normal situation (Bandung). It will be able to reinforce the need of rapid public health intervention in late period disaster to prevent typhoid fever with complications.

Source: Agung Budi Sutiono’s documentation, Ministry of Health Assignment, May 2006

Figure 2.4. Contaminated open wound in disaster

Source: Agung Budi Sutiono’s documentation, Ministry of Health Assignment, December 2004 and typhoid fever survey, 2007

Figure 2.5. The risk factors of typhoid fever in disaster and normal situation
In Chapter III, we will discuss about developing user interface of emergency medical care information systems which focused on the critical patient needs to support information exchange during evacuation. On Chapter IV, we will discuss about the fatal case of tetanus infection after earthquake in Yogyakarta. There are many medical study in tetanus infection, so that the risk factors of socio-demography-geographical background can be extended to improve referral systems in public health. In Chapter V, we will discuss the case of typhoid infection. We studied the risk factors of typhoid infection in three district, post tsunami (Aceh), post earthquake (Yogyakarta) and normal situation (Bandung).
Chapter 3

Information Communications Technology for Medical Assistance in Disaster Affected Area

3.1. Introduction

Disasters, which can either have natural or man-made causes, bring consequences of negative impacts on the environment and human life. Consequently, there will be injuries during the early disaster periods, which, in turn, affect critically ill patients who will require immediate transport. The larger scale consequences of disasters involve damage to the majority of the information and communication technology (ICT) infrastructure [1]. It is important to learn from the tsunami that occurred in Aceh Indonesia, in which ICT facilities were completely destroyed [2]. Meanwhile, communication and information support systems were required by medical personnel when evacuating critically ill patients, as well as the need for medical personnel to communicate with each other while in disaster affected areas, field hospitals and referral hospitals. Developing an inexpensive and effective ICT prototype seems to be a creative and expeditious idea to support the transport of critically ill patients from disaster affected areas to the relevant referral hospital.

Besides developing the hardware and application, designing the user interface for emergency medical situations has to be considered based on the needs of critically ill patient but must also be effective for common non-computer literate users [3]. The majority of user interface applications, however, are designed by engineers, making them difficult to learn and use [4]. Interaction between humans and computers via a user interface has had a significant impact on ease of use and initially involves critically ill
patients. In a complex emergency situation, the medical team working within a hospital could differ from that working in a field for medical assistance in terms of their concerns, perceived impact and readiness for patients who may be critically ill. Exchange of information is also necessary while transporting patients within disaster affected areas. For those reasons, the defining factors that will be used and implemented in the user interface must be focused on the monitoring of vital signs, data exchange and consultation with medical specialists. These systems will assist medical personnel in the field and ambulance by ensuring proper pre-hospital care management [5]. For difficult treatment, consultation between paramedics and medical specialists is possible via this application. In this study, we concerned ourselves with the nature of the minimum contents required to define the user interface based on the critically ill patient centre of needs in the early stages of the disaster affected area, making it effective and easy to use in order for medical personnel to save as many lives as possible.

3.2. Design user interface analysis and scenarios

Design analysis

Recently, the development of an application to support unusual events such as disasters has achieved sophisticated performance since the development of wireless connections and broadband facilities [5]. Nevertheless those facilities remain expensive for people in disaster-stricken developing countries, hence the continuing need for efforts to establish a prototype that is cost effective, representative for critically ill patients and easy to use for medical personnel. For this purpose, the application, which is known as an emergency medical care information system, will hereafter be abbreviated as EMCIS. Firstly, we must define the significant factors of critically ill
patients, this application is developed in order to support them during evacuation. On the patient side, EMCIS is mainly used to continuously acquire two types of data, namely the patient’s physiological signs and supporting medical care. The main features of critical patients can be obtained based on the chief complaints and vital signs [6] as shown in figure 3.1, from the medical records of Hasan Sadikin Hospital in Bandung, Indonesia. The initial data groups must be observed frequently, namely the level of consciousness, heart rate, respiratory rate, systolic and diastolic blood pressure and temperature.

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**Table 3.1.** Laboratory test at Hasan Sadikin University Padjadjaran Hospital

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb</td>
<td>gr/L</td>
</tr>
<tr>
<td>Leucocyte</td>
<td>mm/L</td>
</tr>
<tr>
<td>Thrombocyte</td>
<td>mm/L</td>
</tr>
<tr>
<td>ESR</td>
<td>mm/ld</td>
</tr>
<tr>
<td>SGOT</td>
<td>U/L</td>
</tr>
<tr>
<td>SGPT</td>
<td>U/L</td>
</tr>
<tr>
<td>Albumin</td>
<td>gr/dl</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>mg/dl</td>
</tr>
<tr>
<td>Urine</td>
<td>X rays</td>
</tr>
<tr>
<td>Creatinin</td>
<td>mg/dl</td>
</tr>
</tbody>
</table>

**Diagnosis:**

**Therapy:**

---

**Follow up:**

---

Figure 3.1. Emergency medical record at Hasan Sadikin University Padjadjaran Hospital
Subsequently, based on the vital signs, we classify the triage tags into four categories, namely green, yellow, red and black. The colored triage tags are significant in indicating the nature of the criticality, with the red tag indicating life-threatening, the yellow tag serious but not life-threatening, the green tag for minor ailments and the walking wounded and the black tag indicating no pulse or not breathing. The patient’s demography is used to classify the case prevalence, such as the age and gender group (Figure 3.2.), while the second data groups are support and treatment management during transportation, namely, solutions (ringer lactate, normal saline, colloid, blood transfusion) and the administration of drugs for resuscitation (adrenaline, sulfas atropine, dopamine, amiodarone, antibiotics, analgesics and anesthetics).

![Figure 3.2. Demographic user interface EMCIS](image)

Cardiopulmonary resuscitation (CPR) is reported, namely whether it is performed successfully/otherwise or not performed (Figure 3.3.). In resuscitation, multiple
interventions, both diagnostic and therapeutic, are performed simultaneously. Based on the emergency protocol which involves commencing with a primary survey, called ABCDE (Airway, Breathing, Circulation, Drugs and Environment), the rapid evaluation and management of cardiopulmonary and cerebral infarction is conducted, which the paramedics use to focus on the critical early interventions. Following the primary survey, a “resuscitation” period is begun if needed, which focuses on the acquisition of additional data and the continuation of emergent interventions initiated in the primary survey. The subsequent secondary survey involves a head to toe examination that may reveal abnormalities not yet noted and consequently alter further therapy (Figure 3.4.). The resuscitation enters the definitive care stage, which may continue over several days, as the patient moves from the emergency room to the operating room, intensive care unit and or other inpatient treatment area (Figure 3.5.) [7]. Based also on the ABCDE steps, the user interface was considered to develop the EMCIS user interface.
Scenarios

During mass casualty management in disaster affected areas, there are four main steps that should be implemented, namely: rescuing, triage, life support and evacuation (Figure 3.5.). All the information steps must be included in the user interface as completely as possible, although the completion is usually simple. During the rescuing steps, there is also a need for patient identification and demography, including name, age, address and gender, as initial data followed by triage labeling steps based on the severity of the patient conditions. On the triage area, vital signs and hemodynamic monitoring must be examined to classify the priority and label with red, yellow, green and black based on the classifications previously mentioned. Here, the working diagnosis can also be completed in order to prepare the treatments based on patient needs. Following classification at the triage area, patients labeled red requiring
temporary life support should be evacuated to the field hospital for stabilization unless there is an ambulance that can bring them to the referral hospital for advanced treatment. Those patients are the priority, due to their life threatening condition. Subsequently, the transport of such red labeled patients must be referred to the resuscitation room, operating room or intensive care unit at the referral hospital. The yellow-labeled patients, however, despite not having life threatening conditions, are still affected by an emergency, and should hence be evacuated to the emergency room for elective treatments, while the green-labeled patients can remain in the field hospital for more minor forms of treatment.

Figure 3.5.Scenario of emergency information systems
3.3. Prototype systems architecture

The main EMCIS devices consist of notebook computers or PCs (on which EMCIS software has been installed), VHF (very high frequency) radio modems at a frequency of 147.500 Hz (Indonesian amateur radio organizations use a bandwidth of 144.00–148.00 Hz), allocated for use in disasters, VHF radio and an omni antenna (Figure 3.6.). Those devices were designed for mobile use and are easily installed either indoors or out. The cable connection from the EMCIS modem to the computer and from the modem to the VHF radio is done using an RS-232 series cable, while each radio modem is subsequently assigned by using an identification number, called a target host, by clicking the target terminal while it wants to connect to the other target host (Figure 3.2.). Once transmitting data, it will broadcast to the other clients as well as each of them having an ID number.

Figure 3.6. EMCIS devices
The VHF radio transceiver modem uses FSK (frequency shift keying) and PCM (pulse code modulation) for data communication with a maximum capacity of 12 kbps or it can be upgraded up to ten times. For critically ill patients consultation between paramedics and doctors is facilitated by chatting and the transfer of images in order to determine the state of the wound on the body. EMCIS is also sustained by the human body wound check list used to locate the injury (Figure 3.4.). The database is supported by an SQL (Structured Query Language) server and visual basic is the programming language used to develop EMCIS software. Database architecture and structures are developed based on the relational databases as a common used on SQL. In this case, the relational databases are more practical and useful. The different data groups are separated into their own databases and linked together via complex query statements. Table databases are divided into three tables, that, demography, medical record and messages (Figure 3.7.).
This is very important due to if a user wished to determine to run a report based on the critically ill patients history, the databases server engine will be able to find the number of patients who need live support immediately through linked ID. Besides that, the preparation of drugs, IVFD (intravenous fluid drip), and trauma aids equipments can be dispatched as many as the number of patient’s needs. The last of two tables, namely, medical record and messages are editable data, while the last entry data are filled and transmitted to the server database automatically so that the patient history is always recorded during transport. Meanwhile, the demography table is consistent data, namely, ID number, name, age, gender, address and time/date occurrence.

3.4. Implementation and evaluation

The trial EMCIS implementation was performed in Garut city, with geographically mountainous contours, the evaluation of which was a significant challenge. A system network configuration was prepared, as shown in figure 3.8. In this simulation, the disaster affected area was allocated at Kadungora village, 20 km from Garut city, potentially subject to landslides and Cilawu village, 7.5 km from Garut city and prone to flooding. Geographically, the disaster simulation area included mountainous conditions that challenged us to evaluate the data transmission with geographical obstacles (Figure 3.9.). These disaster areas were equipped with EMCIS and attempts to complete patient data were made using the EMCIS, whereupon the data were transmitted to the Dr. Slamet General Hospital at Garut City, and subsequently forwarded to the Dr. Hasan Sadikin General Hospital as the medical command control centre in the city of Bandung. The wireless connections between Dr. Slamet Hospital in Garut and Dr. Hasan Sadikin Hospital in Bandung were made using the Code Division
Multiple Access (CDMA) method supported by Telkom Indonesia. During the transport of patients, two ambulances were also equipped with the mobile EMCIS system. Furthermore, data on critically ill patients from the hospitals was completed in disaster affected areas for simulation and evaluation purposes.

The time needed to fill EMCIS data on interfaces has been noted as shown on Figure 3.10. The time required to complete interface on demography, physical examination, transmission time and total time are achieved in approximately 2 min. The average time to fill all interfaces and transmit from the field to hospital is 125.7 s as well as time needed for demography interface in 34.60 s, physical examination interface in 46.65 s and transmission time in 44.45 s. This time performance is reasonable for disaster affected area since it is not time consuming and the quick response to the patients is a priority to save more lives.
Figure 3.9. Simulation map in west Java Indonesia

Figure 3.10. Simulation time period
3.5. Discussion

Recently, the development of an efficient and cost effective ICT device focused on the need to assist critically ill patients in disaster situations has not been established in disaster-prone developing countries. In this paper, we developed the “emergency medical information system” for use in disasters in Indonesia and abbreviated to EMCIS. It is a very useful device for the early periods of disasters, since it helps connect together information and communications infrastructures [8,9]. As shown by the experience of the tsunami in Aceh, Indonesia, there were only two ways of connecting network communications at that time, namely, via satellite connection and VHF/HF radio communication. Utilizing the VHF radio to form a wireless network for the transmission of data seems to be an expeditious idea that can be implemented in a disaster situation, as well as being cheaper than satellite communication, although it was hampered by limitations of data transfer. With this in mind, specifying the significant variables in the user interface is the key in representing the priorities of those injured during the five disaster steps, namely, rescue, triage, field hospitals for temporary life support, evacuation/transport and referral hospitals (Figure 3.5.). Choi et al (2007) explained that the fast and accurate collection and retrieval of critical data, such as incident condition and contact information for the intervention crew, is important [10]. The data report systems will focus on the patients’ needs and the number of medical personnel, both in the disaster area and hospitals, in order to save as many lives of critically ill patients as possible [11]. As regards the maximum hospital capacity to receive patients, there is also a need to manage this variable by distributing patients to the nearest alternative hospitals where required. All these events must be incorporated into the information and communication systems during the complex emergency.
Actually, the emergency information system was developed following significant concerns during a so-called normal situation. Chu Y. and Ganz A. (2004) proposed a mobile teletrauma systems using 3G networks. The aims of that experiment involved facilitating the efforts of physicians to mutually consult via the simultaneous transmission of patients’ images, videos and electrocardiograms, all of which are required throughout the pre-hospital period [5]. Lin Y. H. et al (2004), meanwhile, proposed bio-signal real time monitoring using a personal digital assistant (PDA). This system continuously monitored the patient’s vital signs, heart rate, three lead electrocardiography and SpO2 (oxygen saturation) [6]. Those devices are developed based on the norm situation, and thus seem unsuitable for implementation in a disaster situation. EMCIS, however, was designed for very complex disaster situations, and is usable within a very short period. With reference to the emergency medical record from Hasan Sadikin Hospital (Figure 3.1.), although such data must be completed for emergency cases, full completion is not always required during disasters. Only the key elements of such data must be chosen to reflect the patient’s priority and based on the critically ill condition. We employed the main physiological data on blood pressure, both systolic and diastolic, pulse and respiration in order to define triage tagging into red, yellow, green and black color codes. To obtain such data, the paramedics or rescuer requires only 1 min, including determining the level of consciousness as a common symptom on red tagged patients. Furthermore, consideration can be made as to whether or not CPR is necessary, hence on the EMCIS user interface, the main data should be employed by simply marking a tick in a checkbox, which is simple to perform, even for those who are non computer literate.
When a disaster occurs, the medical team must establish a field hospital as a front medical post for stabilization before transporting patients. The EMCIS also properly saves time, especially for users with minimal computer literacy, who can proceed by clicking/checking buttons in the user interface. Importantly the medical assistant must be trained in how to set up EMCIS. The set-up is very easy to learn, since EMCIS can be run by clicking the EMCIS icon, connecting to the modem and VHF radio via an RS-232 cable and then setting up an omni antenna within a car or hospital. Brief training can be given to users easily and quickly. Such training was given at the Garut General Hospital as well as the field trial within the 2 disaster areas of the Kadungora and Cilawu districts (Figure 3.9.). Those areas were geographically mountainous, which made them suitable for verifying the use of the systems within a disaster area to the Garut general hospital and transmitting the report to the Hasan Sadikin Hospital as a medical command control post. Since the time needed to fill the EMCIS interfaces is approximately 2 min, this system will be very useful to save more patients alive.

3.6. Conclusion

The EMCIS has been developed as a prototype and is very useful in the early periods of a disaster in the event of a large scale impact, which would otherwise destroy the ICT. The minimum requirements in terms of developing a user interface are properly achieved in order to classify and can support critically ill patients by engaging in triage tagging, which can save the lives of more people.
Chapter 4

Infectious Disease In Disaster: Research Notes In Tetanus Cases

4.1. Introduction

Tetanus is a devastating disease involving muscle spasms and autonomic instability and associated with a high incidence of mortality. Despite being easily preventable, with a highly effective vaccine, tetanus remains a significant source of morbidity and mortality worldwide [12, 13]. The majority of tetanus cases occur in third-world countries. Tetanus is caused by *Clostridium Tetani* [14, 15], a bacterium that infects open wounds commonly occurring in disaster-affected areas. Open wounds, such as lacerations, abrasions, and punctures, are a significant source of bacterial infection [14]. Earthquakes can strike quickly and without warning, forcing the evacuation of those who are injury-prone. On the other hand, increasing cases of tetanus observed in the elderly population are attributable to immune systems that decline with advancing age [16]. Elderly people, women and children are susceptible to injury, and consequently *Clostridium tetani* may enter the body through dirty open wounds (Figure 4.1.). Occasionally, tetanus affects only the part of the body where the infection originates, but in almost all reported cases, the infection spreads to the entire body. The incubation period from the time of injury until the appearance of the first symptoms ranges from 2 to 50 days. Symptoms usually occur within 5 to 10 days. The early appearance of symptoms is associated with an increased chance of death and the overall mortality rate is approximately 10%–50% [17, 18]. Whether the socio-demography and geographical conditions may influence the tetanus treatment outcome on the circumstances around earthquakes in Yogyakarta, Indonesia has not been investigated.
4.2. Methods

In this study, we examined twenty six tetanus patients who had been admitted to eight hospitals as part of the post-disaster responses in Bantul County, Yogyakarta province, Indonesia, eight of whom were dead. On June 14, 2006 (19 days after the earthquakes) data were collected from Sardjito General Hospital, Wates Hospital, Muhammadiyah Yogyakarta Hospital, Muhammadiyah Bantul Hospital, Harjo Lukito Hospital, Ludira Husada Hospital, Panembahan Senopati Hospital, and Walubi Field Hospital (run by the Indonesian Buddhist Society) through the Bantul County local health office.

Using the MapInfo professional 7.8 geospatial tool, the patient's location origin and the hospital's coordinates for latitude and longitude were used to determine the
distance from the patient's position origin to the hospital. The hospital coordinates were obtained from Wikimapia: Indonesia/Yogyakarta http://www.wikimapia.org, supported by Google Earth. The residences of the individual patients were geocoded using MapInfo Professional 7.8. based on their address. The distance was measured from the patient's origin to the hospital location by tracking the road map and geographical contours on the digital map via Global Mapper 7 (Figure 4.2.). The distance was classified in 2 groups (under 15 km and 15 km or more). The distance classification was related to the response time from the patient's origin to the hospital, since the ambulance service in Yogyakarta was considered to be good.

Admission means the length in terms of the number of days from the initial injuries and open wound contaminated by *Chlostridium tetani* until they were admitted to hospital and was classified into below 7 days and 7 days or more. Thereafter the hospitalization referred to the length of stay in the hospital, which was also classified into below 7 days and 7 days or more. The hospital type was classified based on the Ministry of Health of Indonesia (MOH) standard. There are 4 levels of hospital in Indonesia, specifically, types A, B, C and D (A representing the highest level and D the lowest). The hospital type is classified based on the standard of health services provided and the patient facilities for patients. The Sardjito Hospital is the top academic referral hospital in Yogyakarta and categorized as type B. Six of the remaining hospitals were categorized as type C, and one (Walubi field hospital) as type D. The characteristics of those eight hospitals were collected from the Indonesian hospital association, in the form of a data information website http://www.pdpersi.co.id.
Geospatial view by using MapInfo Professional 7.8. SCP. Geospatial view by using Global Mapper 7. road = red line. county border = dots and dashes.

Figure 4.2. Tetanus patient's origin, hospitals location and geographical 3D landscape on the earthquakes in Yogyakarta Indonesia.
SPSS 17.0 was applied by using the binary logistic regression analyses method. Logistic regression is particularly relevant, since the survival output as the dependent variable is binary, with the output coded as 1 = death and 0 = survival. Socio-demographic and geographical information data were also employed as independent variables, namely in the form of age, gender, distance, admission, hospitalization, and type of hospital. Age was classified into two groups, those under 60 and those of 60 years or more respectively, since immune systems decline in individuals aged over 60 years [16]. There was also gender separation as well.

Data was dummy into 1 and 0 value (\( \delta_{nxi} \)) according to the patient (n) response in each variable X1-X7. To determine risk factors, we use odds ratio (OR) that can be obtained from the logit model in logistic regression, as the following derivation of OR formula.

\[
\begin{array}{c|c|c|c|c|c|c|c}
\text{Patients} & \text{Variables} & \text{X Variables} \\
\hline
\text{n} & \text{X1} & \text{X2} & \text{Xi} & \ldots & \text{X7} \\
\hline
1 & & & & & & \\
\cdots & & & & & & \\
\delta_{nxi} & & & & & & \\
\cdots & & & & & & \\
26 & & & & & & \\
\end{array}
\]

(1)
if response of \( \delta n \) patient in the variable \( X_i \) to
the corresponding dependent variable live-die.

\[
\delta_{nxi} = \begin{cases} 
1 & \text{if response of } \delta n \text{ patient in the variable } X_i \\
0 & \text{otherwise}
\end{cases}
\]  

(2)

Odds ratio is a ratio of live and die odds as shown in formula (2):

\[
OR = \frac{odds_1}{odds_0}
\]  

(3)

And \( P \) is probability value that obtained from the general form logistic regression model

\[
P(X) = \frac{1}{1 + e^{-(\alpha + \sum \beta X_i)}}
\]  

(4)

Where odds is

\[
\frac{P(X)}{1 - P(X)} = e^{(\alpha + \sum \beta X_i)}
\]  

(5)

If \( odds_1 \) divided by \( odds_0 \) (5), we can obtain OR or risk factors for dependent variable \( X_1 \) and \( X_0 \) as the following equation

\[
\text{Odds ratio (OR)} = \frac{e^{(\alpha + \sum \beta X_{1i})}}{e^{(\alpha + \sum \beta X_{0i})}} = e^{(\alpha + \sum \beta X_{1i}) - (\alpha + \sum \beta X_{0i})}
\]

\[
= e^{\sum_{i=1}^{k} \beta(X_{1i} - X_{0i})}
\]  

(6)

Where \( \beta_i \) : corresponding coefficient of variable \( X_i \)

\( X_{1i} \) : variable \( X_i \) for dummy value 1 (live)

\( X_{0i} \) : variable \( X_i \) for dummy value 0 (die)

So that adjusted OR = \( e^{\beta} \)
4.3. Results

The characteristics of tetanus patients are shown in Table 4.1. The age classification of those 60 years or more included 15 patients (57.7%), ranging in age from 20 to 89 years. The total was predominantly male (n = 20, 76.9%), relative to female (n = 6, 23.1%). Distance was classified into two groups, with 69.2% of patients (n = 18) located under 15 km away and the remaining 30.8% patients (n = 8) located 15 km or more from their location to the hospital. In the early stages of tetanus, the majority of patients were admitted to the hospital for under 7 days (n = 17, 65.4%), with 9 patients (34.6%) admitted for 7 days or more. In most cases, the hospitalization periods were 7 days or more, for 69.2% n = 18. Thirteen patients (50%) were treated in
the type B hospital, eleven patients (42.3%) in the type C hospital and two patients (7.7%) in the type D hospital. The patient's distribution graph based on live and die in each hospital is described on figure 4.3. Most of patients were admitted to the Sardjito hospital. The death cases had been reported in Wates hospital, Sardjito hospital, Panembahan Senopati hospital, Ludira Husada hospital, Walubi field hospital, Muhammadiyah Yogyakarta hospital and Muhammadiyah Bantul hospital after admission and there was no dead case in Harjo Lukito hospital. In Table 4.2., the mean age of patients who died was 74.62 ± 13.43 years old; a figure which differed significantly (p = 0.013, significant level p < 0.05) from the mean age of the surviving patients, namely 54.94 ± 18.72 years old. The other mean values for those patients dying also differ significantly to those surviving, namely in terms of distance 29.83 ± 6.74 Km (p < 0.0001), admission 18.12 ± 3.44 days (p < 0.0001), hospitalization 3.12 ± 1.64 days (p < 0.0001), and type of hospital 2.25 ± 0.46 (p < 0.0001).

Table 4.1. Characteristic tetanus patients in the earthquake Yogyakarta Indonesia

<table>
<thead>
<tr>
<th>Variables</th>
<th>Category</th>
<th>Number of patients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (20-89 years old) Range 69</td>
<td>&lt; 60 years old</td>
<td>11</td>
<td>42.3</td>
</tr>
<tr>
<td></td>
<td>≥ 60 years old</td>
<td>15</td>
<td>57.7</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>20</td>
<td>76.9</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>6</td>
<td>23.1</td>
</tr>
<tr>
<td>Distance</td>
<td>&lt; 15 km</td>
<td>18</td>
<td>69.2</td>
</tr>
<tr>
<td></td>
<td>≥ 15 km</td>
<td>8</td>
<td>30.8</td>
</tr>
<tr>
<td>Admissions</td>
<td>&lt; 7 days</td>
<td>17</td>
<td>65.4</td>
</tr>
<tr>
<td></td>
<td>≥ 7 days</td>
<td>9</td>
<td>34.6</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>&lt; 7 days</td>
<td>8</td>
<td>30.8</td>
</tr>
<tr>
<td></td>
<td>≥ 7 days</td>
<td>18</td>
<td>69.2</td>
</tr>
<tr>
<td>Type hospital</td>
<td>Type B</td>
<td>13</td>
<td>50.0</td>
</tr>
<tr>
<td></td>
<td>Type C</td>
<td>11</td>
<td>42.3</td>
</tr>
<tr>
<td></td>
<td>Type D</td>
<td>2</td>
<td>7.7</td>
</tr>
<tr>
<td>Live-die</td>
<td>Live</td>
<td>18</td>
<td>69.2</td>
</tr>
<tr>
<td></td>
<td>Die</td>
<td>8</td>
<td>30.8</td>
</tr>
</tbody>
</table>
Statistical analysis using the binary logistic regression method showed that the variables of distance and type of hospital were significant (at level $P < 0.05$) on $P = 0.026$ ($OR = 1.740$, 95% CI = 1.068–2.835) and $P = 0.018$ ($OR = 0.067$, 95% CI = 0.001–3.520) respectively. Meanwhile age, gender, admission and hospitalization were not statistically significant for tetanus cases during the earthquakes in Yogyakarta (Table 4.3). The characteristic of hospital are different based on the type B, C and D in term of human resources and facilities. The Sardjito hospital is the biggest hospital with 631 beds, 24 general practitoners (GP), 198 medical speisalist, 564 residents, 799 nurses and many facilities such as X-ray, CT scan, USG, ECG, EEG, EMG, emergency room, operating room and ICU (intensive care unit) are also available in comparison to the other hospital http://www.pdpersi.co.id.
Table 4.3. Logistic regression analysis tetanus cases in Yogyakarta Indonesia

<table>
<thead>
<tr>
<th>Variables</th>
<th>OR</th>
<th>95% Confidence Interval</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.995</td>
<td>0.866</td>
<td>1.142</td>
</tr>
<tr>
<td>Gender</td>
<td>0.422</td>
<td>0.002</td>
<td>93.369</td>
</tr>
<tr>
<td>Distance</td>
<td>1.740</td>
<td>1.068</td>
<td>2.835</td>
</tr>
<tr>
<td>Admission</td>
<td>0.981</td>
<td>0.411</td>
<td>2.343</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>1.316</td>
<td>0.284</td>
<td>6.091</td>
</tr>
<tr>
<td>Type hospital</td>
<td>0.067</td>
<td>0.001</td>
<td>3.520</td>
</tr>
</tbody>
</table>

*(Significant at level p < 0.05)

4.4. Discussion

Tetanus is an infectious disease caused by a toxin produced by *Clostridium tetani*, which is found in soil, human feces, and objects lying on the ground. Tetanus infections are common in disaster-affected areas. Tetanus cases were also reported by Australian humanitarian assistance 13 days after the tsunami of 26 December, 2006 [19]. Open wounds are the general entry points for bacteria. In developing countries, where there is normally a lack of facilities, tetanus can be fatal by paralyzing the breathing muscles, causing sudden death in disaster-affected areas. In this study, 26 tetanus cases after the Yogyakarta earthquakes were examined in order to establish the associated factors, with a view to minimizing mortality due to the disease. In 26 tetanus patients, 8 were dead and binary logistic regression analysis by SPSS 17.0 and GIS geospatial tools were applied to analyze the socio-demography and geographical information. We restricted the analysis to cover solely the disaster-affected areas, socio-demography and GIS.
The characteristic findings showed that most patients were male (76.9% n = 20), aged 60 years or more (57.7%, n = 15), while in a previous study, gender and age were applied as standard demographic variables. Following the tsunami in Banda Aceh, Jeremijenko et al. reported 106 tetanus cases, 79% of whom came in individuals over 25 years (median age of 40 years) and 62% of whom were male [20]. However, no tetanus studies were performed in relation to socio-demography and geographical variables, such as distance to the health facilities, admission, hospitalization and hospital type [20]. During natural disasters, a history of injury is recorded in more than 70% of patients presenting with tetanus [21]. The majority of patients are inadequately immunized against tetanus [22], particularly the elderly population. Tetanus toxoid immunization is believed to be nearly 100% effective in preventing tetanus infections [23, 24]. Some individuals may be protected for life, but most people have antitoxin levels that approach the minimal protective level 10 years after the previous dose. Since patients were predominantly 60 years or more (57.7%), their immune systems were in decline and a booster was essential to prevent tetanus. The previous study in the United States reported 3.8% of tetanus cases treated by the disaster medical assistance team after earthquakes [25]. There was no report of deaths attributable to the treatment administered, including tetanus boosters [26]. Concerning gender, males seemed to be more active during the disaster, during which they had to evacuate their relatives, meaning they (76.9%) were more susceptible to infection than females (23.1%).

In our findings, the distance and type of hospital are significant risk factors when considering the survival of tetanus patients following an earthquake scenario. The greater the distance or time involved (OR = 1.740, 95% CI = 1.068–2.835), the greater the risk of mortality for tetanus cases. This is related to the ambulance service in
Yogyakarta province, which has a good reputation. We assumed that average ambulance speed of 50 km/hour, the time required to transport patients from their residence to the nearest hospital within a radius of under 15 km is approximately 18 minutes. It is still reasonable to consider whether the paramedics should perform CPR (cardiopulmonary resuscitation) during the evacuation while the consideration to stop times taken to try CPR is as simple as an isolated time interval (around 30 minutes).

Nevertheless the clinical judgment and respect for human dignity must also enter for this decision [27]. Meanwhile, upgrading the type (level) of hospital will significantly (OR = 0.067, 95% CI = 0.001–3.520) decrease the mortality risk for tetanus patients. The characteristics of the hospital differ completely depending on its type B, C or D in terms of human resources and facilities. Sardjito hospital is the biggest of those covered, with 631 beds, 24 general practitioners (GPs), 198 medical specialists, 564 residents, 799 nurses and many facilities such as X-rays, CT scans, USG, ECG, EEG, EMG, emergency room, operating room and ICU (intensive care unit) in comparison to the other hospitals http://www.pdpersi.co.id. Nevertheless successful treatment also depends on numerous other factors. Based on an analysis of tetanus cases after the Yogyakarta earthquakes, proposed referral systems for critically ill tetanus patients should be considered as well as the ambulance systems, which have been effective in Yogyakarta. GIS was significant in logistic regression, and will hence be useful for distance analysis on this study. We realize that analysis of other independent variables must be lacking due to the limited variables in this study. For those reasons we restricted this study to the circumstances of the earthquakes, socio-demography and geographical data setting.
4.5. Conclusion

We found that in order to reduce the mortality rates, performing triage systems based on the distance and type of hospital priority for critical tetanus patients could be proposed as well as making provisions for the generally old population in order to prevent an outbreak of tetanus following earthquakes in Yogyakarta, Indonesia.
Chapter 5
Risk Factors for Typhoid Infection in Disasters and Normal Situation for Rapid Public Health Intervention

5.1. Introduction

Natural and man-made disasters have a negative impact on society and the environment [28, 29]. On December 26, 2004, an earthquake that measured 9.0 on the Richter scale occurred 150 km off the coast of Sumatra–Indonesia in the Indian Ocean, and triggered a widespread tsunami that hit Aceh 45 minutes later and devastated an 800-km coastal strip. Approximately 130,000 people died, and a further 37,000 went missing presumed dead [30, 31]. On May 27, 2006, an earthquake struck about 25 km south-southwest of Yogyakarta city, which affected 36,299 people, with 5782 fatalities, and caused damage to 135,000 homes [32, 33].

Typhoid infection is the commonest annual disease in the normal situation [34]. It is caused by Salmonella typhi and cause serious complications. It is a water-borne disease that is transferred to food from human excreta via hands [35]. Post-disaster typhoid fever outbreaks were reported in Puerto Rico following Hurricane Betsy in 1956 and in Mauritius following a cyclone in 1980 [36]. The biggest epidemic of typhoid fever following a complex disaster in two decades occurred in Tajikistan in 1992–1997, during which, around 21,000 internally displaced persons (IDPs) were created [29]. After a natural disaster in Calamba, near Manila, Philippines in March 2008, approximately 1400 people displayed typhoid symptoms, with the most serious complications being intestinal bleeding and typhoid perforation [37].

For IDPs in disaster-affected areas, it is frequently difficult to acquire clean
water for food preparation or daily activities [28, 34]. The characteristics and risk factors of typhoid fever with complications in any type of disaster might require different priorities to reduce the risk factors compared with the normal situation. The analysis, surveillance and control of risk factors for infectious diseases are important functions in public health [38, 39]. The lack of facilities, difficult access to health services, and changing risk factors emphasize the need for rapid public health intervention to prevent typhoid fever in disaster-affected areas.

5.2. Material and methods

Study area

This study was conducted in three districts: post-tsunami Banda Aceh; post-earthquake Bantul, Yogyakarta; and Bandung under normal circumstances (Figure 5.1). We choose these three districts due to it may have different risk factors of typhoid complication based on the type of disaster compare to the normal situation. Demographically, Banda Aceh city is occupied by 220,737 inhabitants with a population density 4.25 per km$^2$ [40, 41]. Bantul city, Yogyakarta has 813,087 inhabitants in an area of 3186 km$^2$, with a population density of 255.21 per km$^2$ [40]. Bandung city has 2,510,982 inhabitants in an area of 34,597 km$^2$, with a population density of 72.58 per km$^2$ [42].

Variables definition

We defined the independent variables based on a previous study, namely age, sex, educational level, clean water, hand washing, contact with other typhoid patients [43], and typhoid complications/no complications as dependent variables.
Educational level was classified as primary school (up to junior high school level, which is compulsory in Indonesia) [44], and secondary school (senior high school level and above). Rechecking variables is dependent on patient behavior. Doctors suggest that patients submit themselves for rechecking after being discharged home, and it is up to the patients to decide to go [45]. Drug availability seems to be a problem in disaster areas, in relation to where patients can obtain the required drugs and in administering them correctly. The first drugs of choice for *S. typhi* are chloramphenicol, ampicillin, ciprofloxacin and third-generation cephalosporins [46]. Since typhoid fever is water-borne, clean water is important, and drinking water from sources such as wells and municipal water points should be boiled before being drunk. Clean water checking involves ascertaining whether there is a chlorination program, and bacterial examination of water samples in the disaster-affected area. Patients should wash their hands in clean water before eating [47]. Contact with other typhoid patients refers to contact time of
>14 days when patients stayed with relatives/friends or with a typhoid patient and shared food from the same plate [48]. Typhoid complications refer to the manifestations of typhoid fever, whether intra- and/or extra-intestinal (such as intestinal bleeding, typhoid perforation, toxic typhoid, and typhoid encephalopathy) [49–52]. The selection criterion of typhoid fever is positive *Salmonella typhi*, as identified by blood/bone marrow culture that confirmed in the medical records. The typhoid complications were found from medical records.

*Data collection and selection criteria*

Ethical approval to perform the study was obtained from the ethics committee at Zainoel Abidin Hospital in Banda Aceh, Sardjito Hospital/Bantul Health Office, Yogyakarta, and Hasan Sadikin Hospital, Bandung. Typhoid fever was confirmed by positive blood/bone marrow/feces culture for *S. typhi* [48]. Patient data were taken from their medical records, and a survey was subsequently conducted to verify the situation. The questionnaire was developed based on previous studies [43, 47, 48] and tested in small samples (20 individuals from Banda Aceh, Yogyakarta and Bandung). The selection criteria flowchart is shown in Figure 5.2. Informed consent was obtained from the respondents. Brief training and explanation of the study were given to fourth-year medical students from Syiah Kuala University, Banda Aceh, Gajah Mada University, Yogyakarta, and Padjadjaran Hasan Sadikin University Hospital, Bandung before surveillance and interviewing respondents. Interviews were performed at patients’ homes. In case patients were uncooperative, e.g. children, questions were directed towards the mother or another family member. Socio-cultural issues and customs vary between provinces in Indonesia, and this had to be taken into account. Data were stored
anonymously and confidentially.

**Interview**

This interview was conducted because of the lack of disaster information in medical records. The participants in all the three groups responded to the same questionnaire after giving their informed consent. The responses of the patients were used to obtain a full description of the disease and disaster situation. The questionnaires were used to guide the interviewers to explore the patients’ experiences retrospectively.

Sample questions were as follows:

- “Did the doctor suggest that you to go for a check-up after recovery?”
- “Did you go for a check-up as the doctor suggested?”
- “Did you obtain the required drugs and take them correctly?”
- “Did you obtain clean water and check that it was clean?”
- “Did you wash your hands before eating?”
- “Did you have contact with other typhoid patients?”

The responses were coded as 0 for “no” and 1 for “yes”.

**Statistical analysis**

The typhoid variables from the questionnaires were entered on a Microsoft Excel 2003 spreadsheet, and SPSS version 17.0 was applied for logistic regression analysis to determine the significant independent risk factors for typhoid complications in each district. The risk factors can be calculated by derivation of odds formula from logit model in logistic regression.
Data were dummy ($\delta_{ijk}$) into 1 and 0, depend on the participant ($j$) response in each variable ($k$) in every district ($i$).
\[ \delta_{ijk} = \begin{cases} 
1 & \text{if response of } \delta_j \text{ respondent in the variable } k \text{ to the corresponding dependent variable in each district } i. \\
0 & \text{otherwise} 
\end{cases} \] (2)

Furthermore each district was analyzed by logistic regression to acquired odds ratio, as the following derivation formula with dependent variable complication and no complication in typhoid fever. We divide odds\(_i\) for complication and odds\(_0\) for no complication in each district \((i)\).

\[
\text{Odds ratio (OR)} = \frac{\text{odds}_i}{\text{odds}_0}
\] (3)

Where probability \(P(X)\) formula in each district \((i)\) for variable \((k)\) can be revealed from logistic model:

\[
P(X) = \frac{1}{1 + e^{-(\alpha + \sum \beta k X 0ik)}}, \quad \text{or} \quad \frac{P(X)}{1 - P(X)} = e^{(\alpha + \sum \beta k X 0ik)}
\] (4)

\[
\text{Odds ratio (OR)} = \frac{e^{(\alpha + \sum \beta k X 1ik)}}{e^{(\alpha + \sum \beta k X 0ik)}} = e^{(\alpha + \sum \beta k X 1ik) - (\alpha + \sum \beta k X 0ik)}
\]

\[
\text{General OR formula} = e^{\sum_{l=1}^{k} \beta l (X 1ik - X 0ik)}
\] (5)
Where $\beta_i$ : corresponding coefficient of variable $X_k$ in district $i$

$X_{1i}$ : variable $X_i$ for dummy value 1 (complication) in district $i$

$X_{0i}$ : variable $X_i$ for dummy value 0 (no complication) in district $i$

So that adjusted OR in each district $(i)$ for variable $(k) = e^{\beta_k}$

(6)

5.3. Results

In Aceh, data were collected 2 months after the tsunami, in Yogyakarta, 1 month after the earthquake, and in Bandung, data were collected from August 2006 to January 2007. We found 232 patients with fever in the three districts. There were 66 post-tsunami patients in Banda Aceh. Nineteen patients were excluded because of negative blood/bone marrow culture for $S. \text{typhi}$, and 5 were untraceable because of an unclear address, or they had moved house. Therefore, the final number of patients interviewed was 42, including 5 with typhoid complications. A similar pattern emerged in Yogyakarta, where there were 53 patients with fever; 14 were excluded and 39 were interviewed, including 8 with typhoid complications. Under normal conditions at Bandung, we found 113 cases of typhoid, with 33 patients excluded and 70 interviewed, including 13 with complications (Figure 5.2). Three patients died from typhoid encephalopathy. All respondents answered our questionnaire after giving their informed consent. For questions to children aged <13 years, responses were given by their mother or other family members, who were fully aware of the condition of their children during hospitalization and discharge.

Typhoid fever was found in 42 patients following the tsunami at the Zainoel Abidin Hospital in Banda Aceh, in 39 patients following the earthquake in the Bantul Health Office, Yogyakarta, and in 70 patients under normal circumstances in the Hasan
Sadikin Hospital in Bandung. The mean ages in Aceh, Yogyakarta and Bandung were 36.1±15.4 years (range 11–65), 35.5±14.5 years (range 13–80) and 19.3±13.7 years (range 7–61), respectively. In the Aceh tsunami and the Yogyakarta earthquake, the number of male patients dominated, with 25 (59.5%) and 20 (56.4%), respectively. On the other hand, Bandung had more female patients, at 42 (60.0%). Complications emerged in 5 cases (11.9%) after the Aceh tsunami, 8 (20.5%) after the Yogyakarta earthquake, and 13 (18.6%) in Bandung under normal circumstances. The subject characteristics for typhoid cases in the three districts are presented in Table 5.1.

Figure 5.2. Selection criteria typhoid fever with complications in post-tsunami (Aceh), post-earthquake (Yogyakarta) and normal situation (Bandung), Indonesia
Table 5.2. describes the type of complications that occurred post-tsunami in Aceh, post-earthquake in Yogyakarta, and under normal circumstances in Bandung. In Aceh, the complications included 2 cases of intestinal bleeding, 2 of typhoid perforation and 1 of toxic typhoid. In Yogyakarta, we found 4 cases of intestinal bleeding, 1 of typhoid perforation, and 3 of typhoid encephalopathy. In Bandung, there were 2 cases of intestinal bleeding, 3 of typhoid perforation, 4 of typhoid encephalopathy, and 4 of toxic typhoid. Patients with intestinal bleeding explained that their chief complaints included occult bleeding in their stools and acute abdominal symptoms associated with typhoid perforation. Meanwhile, the chief complaint of patients with typhoid encephalopathy and toxicity was a loss of consciousness.

Bivariate correlation analysis showed that education (p=0.011), drug availability (p<0.0001) and clean water (p<0.0001) were significant for typhoid complications after the tsunami in Aceh. After the earthquake in Yogyakarta, education (p=0.048) and contact with other typhoid fever patients (p<0.0001) were found to be significant. Under normal conditions in Bandung, the significant bivariate correlation was for education (p=0.005), drug availability (p=0.025) and hand washing (p=0.001).

Logistic regression analysis revealed that clean water (OR=0.049, 95%CI: 0.005–0.471) and drug availability (OR=0.234, 95%CI: 0.023–2.430) were significant risk factors after the tsunami in Aceh, and contact with other typhoid patients (OR=20.301, 95%CI: 1.935–213.021) and education (OR=0.081, 95%CI: 0.007–0.985) were significant after the earthquake in Yogyakarta. Under normal conditions in Bandung, we found that hand washing (OR=0.073, 95%CI: 0.011–0.502) and education (OR=0.078, 95%CI: 0.006–0.644) were significant risk factors.
Table 5.1. Characteristic of typhoid fever patients in tsunami (Aceh), earthquakes (Yogyakarta) and normal situation (Bandung)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Classification</th>
<th>Tsunami (Aceh) n=42 [%]</th>
<th>Earthquake (Yogyakarta) n=39 [%]</th>
<th>Normality (Bandung) n=70 [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age [years]</td>
<td>Mean ± SD</td>
<td>36.1 ± 15.4</td>
<td>35.5 ± 14.5</td>
<td>19.3 ± 13.7</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>11-65</td>
<td>13-80</td>
<td>7-61</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>25[59.5]</td>
<td>20[56.4]</td>
<td>28[40.0]</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>17[40.5]</td>
<td>19[43.6]</td>
<td>42[60.0]</td>
</tr>
<tr>
<td>Education</td>
<td>Primary</td>
<td>13[31.0]</td>
<td>22[56.4]</td>
<td>47[67.1]</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>29[69.0]</td>
<td>17[43.6]</td>
<td>23[32.9]</td>
</tr>
<tr>
<td>Recheck</td>
<td></td>
<td>38[90.5]</td>
<td>36[92.3]</td>
<td>64[91.4]</td>
</tr>
<tr>
<td>Go to recheck</td>
<td></td>
<td>30[71.4]</td>
<td>30[76.9]</td>
<td>51[72.9]</td>
</tr>
<tr>
<td>Drug availability</td>
<td></td>
<td>28[66.7]</td>
<td>28[71.8]</td>
<td>50[71.4]</td>
</tr>
<tr>
<td>Clean water</td>
<td></td>
<td>34[81.0]</td>
<td>32[82.1]</td>
<td>58[82.9]</td>
</tr>
<tr>
<td>Hand washing</td>
<td></td>
<td>38[90.5]</td>
<td>35[89.7]</td>
<td>64[91.4]</td>
</tr>
<tr>
<td>Contact with other typhoid</td>
<td></td>
<td>19[45.2]</td>
<td>17[43.6]</td>
<td>36[51.4]</td>
</tr>
</tbody>
</table>

Table 5.2. Type of complications on typhoid fever in tsunami (Aceh), earthquakes (Yogyakarta) and normal situation (Bandung), Indonesia

<table>
<thead>
<tr>
<th>Post tsunami (Aceh) n=5</th>
<th>Post earthquake (Yogyakarta) n=8</th>
<th>Normal situation (Bandung) N=13</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Intestinal bleeding</td>
<td>4 Intestinal bleeding</td>
<td>2 Intestinal bleeding</td>
</tr>
<tr>
<td>2 Typhoid perforation</td>
<td>1 Typhoid perforation</td>
<td>3 Typhoid perforation</td>
</tr>
<tr>
<td>1 Typhoid Toxic</td>
<td>3 Typhoid Encephalopathy</td>
<td>4 Typhoid Encephalopathy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 Typhoid Toxic</td>
</tr>
</tbody>
</table>

5.4. Discussion

The main finding of this study was that there were different characteristics and risk factors associated with typhoid complications after the tsunami in Aceh, after the
earthquake in Yogyakarta, and under normal conditions in Bandung (Tables 5.3 and 5.4). The risk factors after the tsunami were lack of clean water and availability of drugs. These factors might have increased the risk of typhoid complications at the time when the level of destruction caused by the tsunami was large [30–32]. The tsunami destroyed the usual sources of clean water in Aceh, e.g. wells, municipal water and other clean water sources.

Table 5.3. Bivariate correlation with grouping variable complication and non-complication in tsunami (Aceh), earthquakes (Yogyakarta) and normality (Bandung)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Tsunami (Aceh)</th>
<th>Earthquake (Yogyakarta)</th>
<th>Normality (Bandung)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sig.</td>
<td>Mean</td>
<td>95 % CI</td>
</tr>
<tr>
<td>Age</td>
<td>0.332</td>
<td>0.232</td>
<td>-0.246</td>
</tr>
<tr>
<td>Gender</td>
<td>0.843</td>
<td>-1.481</td>
<td>-16.528</td>
</tr>
<tr>
<td>Education</td>
<td>0.011</td>
<td>0.557</td>
<td>0.137</td>
</tr>
<tr>
<td>Recheck</td>
<td>0.408</td>
<td>-0.097</td>
<td>-0.542</td>
</tr>
<tr>
<td>Drug availability</td>
<td>0.000</td>
<td>0.757</td>
<td>0.359</td>
</tr>
<tr>
<td>Clean water</td>
<td>0.000</td>
<td>0.919</td>
<td>0.666</td>
</tr>
<tr>
<td>Water checking</td>
<td>0.192</td>
<td>0.270</td>
<td>-0.141</td>
</tr>
<tr>
<td>Hand washing</td>
<td>0.048</td>
<td>0.119</td>
<td>-0.168</td>
</tr>
<tr>
<td>Other typhoid</td>
<td>0.808</td>
<td>0.059</td>
<td>-0.431</td>
</tr>
</tbody>
</table>

Statistically significant associations are in bold

Transmission of *S. typhi* was introduced into the camps of IDPs as a result of their inability to carry out proper food preparation, which was associated with the need for clean water, or bacterial contamination of drinking water [61]. Consistent with this disaster situation caused by the tsunami, the independent risk factors for IDPs included problems with drug distribution and availability. This was because destruction of all the
main roads, bridges, sea ports, and airports rendered surface transportation impossible, and reconstructing such facilities took considerable time. At the time, there was only one way to distribute drugs and other logistics to the IDPs camp, namely by helicopter. The lack of typhoid drugs was not caused by the type of antibiotics involved, because there was government or non-government support for the first-line drugs of choice for typhoid fever (chloramphenicol, ampicillin, ciprofloxacin and third-generation cephalosporins), but rather by the cumbersome distribution of the drugs.

After the earthquake in Yogyakarta, the significant risk factors included contact with other typhoid patients and education. Patients were unaware that \textit{S. typhi} had infected their relatives or friends and this would only have emerged once the patient came to the medical facilities and was diagnosed with typhoid fever.

Table 5.4. Risk factors by logistic regression analysis with dependent variable complication and non complication in tsunami (Aceh), earthquakes (Yogyakarta) and normal situation (Bandung)

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Aceh</th>
<th></th>
<th>Yogy</th>
<th></th>
<th>Bandung</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR 95% C.I.</td>
<td></td>
<td>OR 95% C.I.</td>
<td></td>
<td>OR 95% C.I.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower</td>
<td>Upper</td>
<td>Lower</td>
<td>Upper</td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>Age</td>
<td>1.012</td>
<td>0.914</td>
<td>1.012</td>
<td>1.023</td>
<td>0.939</td>
<td>1.113</td>
</tr>
<tr>
<td>Gender</td>
<td>0.745</td>
<td>0.046</td>
<td>0.745</td>
<td>0.369</td>
<td>0.031</td>
<td>4.41</td>
</tr>
<tr>
<td>Education</td>
<td>0.615</td>
<td>0.014</td>
<td>0.615</td>
<td>0.081</td>
<td>0.007</td>
<td>0.985</td>
</tr>
<tr>
<td>Recheck</td>
<td>0.099</td>
<td>0.000</td>
<td>0.099</td>
<td>1.301</td>
<td>0.014</td>
<td>121.361</td>
</tr>
<tr>
<td>Go to recheck</td>
<td>6.153</td>
<td>0.149</td>
<td>6.153</td>
<td>0.375</td>
<td>0.023</td>
<td>6.156</td>
</tr>
<tr>
<td>Drug availability</td>
<td>0.234</td>
<td>0.023</td>
<td>2.430</td>
<td>1.22</td>
<td>0.064</td>
<td>23.214</td>
</tr>
<tr>
<td>Clean water</td>
<td>0.049</td>
<td>0.005</td>
<td>0.471</td>
<td>0.418</td>
<td>0.025</td>
<td>6.861</td>
</tr>
<tr>
<td>Water checking</td>
<td>1.191</td>
<td>0.027</td>
<td>1.191</td>
<td>0.568</td>
<td>0.037</td>
<td>8.704</td>
</tr>
<tr>
<td>Hand washing</td>
<td>2.613</td>
<td>0.032</td>
<td>2.613</td>
<td>3.009</td>
<td>0.047</td>
<td>190.91</td>
</tr>
<tr>
<td>Contact with other typhoid</td>
<td>3.154</td>
<td>0.122</td>
<td>3.154</td>
<td>3.010</td>
<td>1.935</td>
<td>213.021</td>
</tr>
</tbody>
</table>

Significant level at \textit{P}<0.05* and \textit{P}<0.01** (Statistically significant associations are in bold)
The Indonesia Health Profile 2006 found that the number of people who lacked any certificate education in Yogyakarta was higher than in Aceh and Bandung. This reflects the fact that educational level is a significant risk factor during an earthquake, as in Yogyakarta (Figure 5.3 and Table 5.3).

![Graph showing socio-economic factors in tsunami (Aceh), earthquake (Yogyakarta), and normal situation (Bandung), Indonesia.](source)

Source: Indonesian Health Profile 2006, Ministry of Health Indonesia.

Figure 5.3. Characteristic socioeconomic in tsunami (Aceh), earthquake (Yogyakarta), Normal situation (Bandung), Indonesia

Under normal conditions in Bandung, we found that hand washing and education were significant risk factors. Hand washing may reflect different habits and behavior in society. The majority of those in west Java (Bandung) prefer to eat non-boiled vegetables, called “lalap”, like salad without sausages [58], and sometimes after not washing their hands [59]. With this in mind, the government recently has promoted hand washing with soap as a national campaign in Indonesia to help prevent
the transmission of infectious diseases such as typhoid fever [60]. Moreover, over 30% of persons in Bandung have no educational certificate, according to the Indonesian Health Profile (Figure 5.3), which also emerged consistently as a significant independent risk factor for typhoid complications.

To reach conclusions concerning the distinct risk factors in each district, we compared characteristic cases of typhoid complications in Aceh, Yogyakarta and Bandung, based on the geographical and socio-demographic differences in a typical disaster (Figure 5.1, Tables 5.1 and 5.2). The reasons to determine the risk factors for typhoid complications are that the first-line drugs commonly used in Indonesia have become ineffective [51, 53–55], thus hampering treatment of the condition [50, 51, 56] and causing many complications [50–52, 57] under normal and disaster conditions. The tsunami disaster in Aceh was characterized by the high level of destruction, swift onrushing seawater that affected humans and the environment, the high probability of contamination of clean water, and the long time required for reconstruction and rehabilitation. Based on our findings, the lack of clean water and available drugs were found to be related significantly to the other tsunami background factors. In comparison, during the earthquake in Yogyakarta, there was no mass of water that was likely to cause contamination to wells, municipal water and other sources of drinking water. There was no mud after the earthquake and the level of destruction was also relatively low. However, although both calamities were mainly caused by earthquakes, geographically speaking, Aceh is located on the shoreline and Bantul, Yogyakarta is located in the middle of Java Island (Figure 5.1).

Nevertheless, the population density in Yogyakarta was the highest (255.21 per km²) in this study (Table 5.5), which means that contact with others, like relatives or
friends with typhoid fever seemed more frequent in Yogyakarta than in Aceh and Bandung [40]. Although Bandung is located in the centre of West Java, it is at an elevation of 765 m above sea level, which is higher than Yogyakarta and Aceh. Surrounded by mountains, Bandung has the potential for flooding in the rainy season [42], which increases the likelihood of typhoid transmission. Demographically, the ethnic origin of the people in Bandung, West Java is Sundanese, and typically, they prefer to eat lalap (which are prone to \textit{S. typhi} contamination), such a salad without sausages [58], and they sometimes eat without washing their hands [59]. The educational level may also influence personal habits and efforts to avoid typhoid fever with complications, such as a lack of awareness of and/or performing hand washing properly. These differences allowed us to determine the prevalence of risk factors between normal and complex emergency situations based on the type of disaster involved.


<table>
<thead>
<tr>
<th>Variables</th>
<th>Tsunami Aceh</th>
<th>Earthquakes Yogy</th>
<th>Normal Bandung</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Province*</td>
<td>4.031.589</td>
<td>3.343.651</td>
<td>38.965.440</td>
</tr>
<tr>
<td>Pop. City/county*</td>
<td>220.737</td>
<td>813.087</td>
<td>2.510.982</td>
</tr>
<tr>
<td>City/county area km$^2$*</td>
<td>51.937</td>
<td>3.186</td>
<td>34.597</td>
</tr>
<tr>
<td>Pop density / km$^2$*</td>
<td>4.25</td>
<td>255.21</td>
<td>72.58</td>
</tr>
</tbody>
</table>

*Source: BPS 2005 (Indonesian Statistical Bureau) and medical record

We confirmed cases of typhoid fever by positive blood/bone marrow culture of \textit{S. typhi}. Typhoid complications were determined from medical records. Patients were asked to describe their symptoms during hospitalization, as well those reported in their
medical records. We found 42 patients with typhoid fever after the tsunami in Aceh, 5 of whom had complications (11.9%). Two cases each of intestinal bleeding and typhoid perforation and one of toxic typhoid were reported as complications in the post-tsunami situation, which was caused by the lack of drug availability and clean water distribution. The number of complications in Yogyakarta was 8 of 39 cases (20.5%). We found four cases of intestinal bleeding, one of typhoid perforation and three of typhoid encephalopathy. However, there was not death case report in both of disaster situation. In Bandung, typhoid complications were found in 13 of 70 cases (18.6%), with two of intestinal bleeding, three of typhoid perforation, four of typhoid encephalopathy, and four of toxic typhoid. We excluded three fatalities caused by typhoid encephalopathy (Tables 5.1 and 5.2).

As shown in Table 5.3., education was a significant factor in bivariate correlation analysis in the three districts. Gasem et al in 2001 in Semarang [47] and Velema et al in 1997 in Ujung Pandang [43] reported that educational level was a significant risk factor for typhoid fever in Indonesia. A proposal to improve the quality of public education campaigns and stressing the importance of sanitation and hygiene whether in disaster or normal circumstances still appears to represent a realistic approach to infection prevention.

5.5. Conclusion

Determination of the risk factors after the tsunami in Aceh (availability of clean water and drugs) and after the earthquake in Yogyakarta (education level and avoiding contact with other typhoid patients) will reinforce the need for rapid public health intervention in complex disasters compared with normal circumstances in Indonesia.
Chapter 6
Discussion

The main purpose of this study is to discuss the most difficult public health problems in emergency disaster situation which refers to the commonest disease cases in Indonesia. We divided the health problems based on the disaster period, that the early period in less than 7 days and the late period in more than 7 days. Trauma critical injury, lack of medical personnel, high communication difficulties are the most cases in early period followed by infection disease due to lack of sanitation hygiene in shelter and medium-mild communication difficulties in the late period. Within disaster period, ICT is needed to connect between disaster area and normal situation for the purpose, such as requesting medical team, medical devices, drugs, referring patient, reporting for disease control and so on, for the public health impact.

6.1. Early period of disaster

In the early period of disasters, the most medical cases are trauma, for example, due to the injury from fall down hard things and hit the body when earthquakes, drowning in tsunami water, stab wound by sharp iron and so on. All of those trauma injuries may cause massive or occult bleeding and become critical live threatening. Therefore the critical patients are the priority one to be concerned and cured. However there is facilities limitation since it is destructed by the earthquake and tsunami. Disaster is not only influence the human being but also the public facilities, such as, governmental office that consist of community data, health facilities and telecommunication infrastructures. We have learned from the large impact tsunami in
Aceh, Indonesia. In our experience, almost survived people will try to help the injured people and save them a live. They will go to the nearest existing health facilities after triage the victims. At the same time, the communication is down, like in tsunami Aceh. There was no communication, except satellite and radio amateur. The BTS (based transmission station) was collapse, no signal for mobile telephone. This condition will be burden when the human resources in the health sector are still lack of education, as well as not good in computer literacy.

For that certain condition in the early period of disaster, we have developed the emergency medical care information system (EMCIS) which focuses on the user interface. The purpose is to support the referred critical patients from the field to the hospital in a specific limited early time of disaster while no ICT facilities, for the non computer literacy users, by utilizing VHF (very high frequency) radio amateur which considered as cost effective for disaster in Indonesia. This prototype will be very useful with give some advantages, that, easy to set up, user friendly for non computer literacy person. Although it uses narrow bandwidth, small data set but representing the critical patient condition due to the physiological data is also classified and easy to be interpreted by medical personnel. The treatment intervention is added to provide the information and to prevent over treatment when arrive in the hospital. In the real trial, we achieved the total time to fill the data into the systems and transmit it, approximately 3-4 minutes. The time needed is fast after assessing the critical patients in the field that usually takes 1 minute to determine critical or not. It is due to the systems is using radio button for single choice like gender, tagging color, vital sign classification and option button for multiple choice like type of infuse solution and drugs that commonly use in more than one items.
To practice how to input the data, we have implemented in our emergency room when the patients is being evacuated from the general room to the resuscitation and operating rooms. This is also to train the emergency medical team in the hospital before they are dispatched to the real disaster situation. To input the data, we can assign someone from the team, and called as emergency medical technician (EMT). After assessing the patient to determine critical condition within 1 minute, the EMT will input the data into the systems. It can be done after select the critical patient with condition of no response in voice, no breathing but the pulse is still in beat and unconsciousness. Out of those symptoms will become second or third priority. However we have the obstacles when deploying EMCIS, like mountainous area where the hospital location is covered. Basically it can be solved by using multiple EMCIS link which functioning as repeater but we have not tried it. The EMCIS will be good in point to point direct connection with maximum distance around 20 km that has been simulated in Garut County.

Tetanus infection is chosen because 70% open wound is presenting tetanus in the early period of disaster. We found that eight of twenty six patients were death in 19 days after the following earthquake Yogyakarta Indonesia. The association of death case was shown after obtaining the distance from patient’s house to the hospital by GIS (geographical information systems). It is significantly found as risk factors for the treatment outcomes. In our study the respondent’s age was dominated by old people, >60 years old. They were considered low immune system, therefore the need of booster vaccine was a must. Otherwise those infected patients will become a spasm or convulsion which needs advanced treatment in the proper hospital. The ambulance will play a role for transporting patients. Time response coming from ambulance service has a good achievement in Yogyakarta. However we found that the patient was not
transported to the nearest one and not considering the level of hospital either. The level of hospital refers to the facilities and services, means the high level of hospital has high level of subspecialties and equipments. We have found that, when we manage the tetanus patient in the disaster, considering the distance and type of hospital is the other risk factors instead of medical risk. If vaccination were to be considered and performed in the early period of earthquake, means it can avoid tetanus infection, maybe the death case will not happen. The direct tetanus immunization in just after disaster occurrence becomes a good proposal to prevent tetanus in Indonesia.

6.2. Late period of disaster

In contrast with the emergency case in the early period, we have studied the infection disease which usually emerges after 7 days. The 5 top infectious disease in disaster Indonesia are common cold, cough, diarrhea, typhoid fever and measles. The specific typhoid infection was introduced with high morbidity and mortality rate in the normal situation. The typhoid fever is chosen for study due to typhoid is the commonest disease, emerge annually in the normal situation. It may cause difficult complication which has to do surgical intervention to stop the bleeding. A multidrug resistant of typhoid fever is another issue that has to be concerned in the normal situation. It will be a very difficult case in disaster scenario since it is lack of facilities and human resources. Some of previous studies have determined the risk factors in some cities in Indonesia. However the characteristic and risk factors of typhoid fever in disaster may have a different pattern compare to the normal situation. Typhoid fever can be transmitted by water through oral by Salmonella typhi contaminated food. All the factors related to its, is an important findings to prevent typhoid complications, that, availability clean water
and drugs, contaminated hand, direct contact with typhoid patients and educational level.

Apart from those findings, some additional observation and public health surveillance in emergency medical disaster has to be created for typhoid control after disaster. In the real example, the drugs availability problem in post tsunami was not because of the stock of drugs, but mainly due to the distribution problems. In our experience, the only helicopter can be used to distribute the logistic to the refugees. The road was broken and made using cars was impossible, enlargement shore line has made the ship can not anchor, broken landing area for the airplane. Of course, the clean water is another concerned in tsunami. We suggest to develop the portable clean water systems that can be deployed easily. Regarding the educational risk factors in the earthquake Yogyakarta and normal situation Bandung, the educational system should be improved due to the number of people who has no primary certificate education is higher in this study. Health promotion by local health officer may be useful to upgrade their knowledge instead of formal school. Hopefully, the awareness of not being contact with other typhoid patient and doing proper hand washing will be better. There may have relation with the local customs, like in Yogyakarta, that, the people are very close to their neighbor, not only family. High population density might be suspected as the other factor that causes the direct contact with typhoid fever. Meanwhile in Bandung (Sundanese ethnic), the most people prefer to eat raw vegetables that sometimes are not properly cleaned followed by improper hand washing. Proposal to the government to actualize the hand washing campaign in Indonesia, promoted by the Ministry of Health and Coordinating Ministry of Public Welfare will be good. The risk factor findings in typhoid fever can reinforce rapid public health intervention in disaster affected area to
reduce the morbidity and mortality rate.

6.3. The health problems oriented in disaster emergency

We observed the main public health problems in the following natural disaster in Indonesia can be divided into two time periods. Each period has priority public health problems regarding the high morbidity and mortality risk. The development of user interface in emergency medical care information systems will be able to support medical assistance for the critical patient in disaster. This prototype will be reported to the Ministry of Health (MOH) and be implemented by Crisis Centre MOH.

Although there are many other risk factors in tetanus cases, but the risk factors findings of distance and type of hospital might be able to reduce the morbidity and mortality rate in the earthquake Yogyakarta. Type hospital is related with the facilities and human resources. For example, it possibly occurs that the number of bed that can accept tetanus patient is less, neurologist is absent, patient distribution is improperly done although they admitted to the same type hospital so that the distance becomes longer. Therefore the referral hospital consideration by using GIS can be useful. Detail preparation should be proposed to the local government as contingency disaster preparedness planning in Indonesia. Collaboration among multidiscipline aspects are very important, not only medical officers but involving the IT engineers, sociologist, epidemiologist, and other experts are necessary to develop disaster preparedness team before occurrence.

There are many infectious diseases in the late period of disaster, but the high morbidity and mortality rate are found in Typhoid fever. The other diseases such as cough, common cold, and diarrhea are not fatal, so that findings the risk factors of
typhoid fever with complication are necessary. Drugs difficulty in tsunami was caused by the distribution transport. The transportation problems in the large scale of disaster can be satisfied by helicopter to reach the isolation disaster area because the road, harbor, airport are usually broken. The technology of water purification device is needed to serve refugee after tsunami and easy to deployed. Education level should be improved concerning the sanitation hygiene awareness. The local health officers and ministry of health may give health promotion to prevent disease transmission through hand washing campaign and teaching the typhoid risk factors such as less contact with them.

The previous public health methods are mostly employing conventional approaches such as medical statistic, health psychology, medical sociology, health economics and medical anthropology. Although health informatics has been performed in developed countries to assist public health problem solving, in Indonesia is still remain unused. Our findings will be proposed to the Ministry of Health in order to improve the public health methods in Indonesia. We will persuade to the stakeholder and government through Indonesian Ministry of Health in order to reduce the morbidity and mortality rate in disaster affected area. However the dissemination of our findings will need effort due to Indonesia has around 15,000 islands with different potential of disasters. Gradually it may improve the public health method of disaster in Indonesia.
Chapter 7

Research Conclusion

We developed user interface in emergency medical care information systems (EMCIS) to support critically ill patient evacuation at the early period from disaster area to the referral hospital. It fulfilled after field trial in mountainous area, Garut county west Java Indonesia. It will be able to sustain the critical patient data collection for public health if the communication facilities collapse and satellite remains expensive for Indonesia.

At the earthquake in Yogyakarta, considering the type of hospital and distance to refer the critically tetanus patient will significantly reduce mortality risk since the ambulance service has a good reputation to evacuate the patients by Ministry of Health Indonesia. GIS tools can support public health data for statistical analysis in disaster.

Emphasizing drugs & clean water availability in the tsunami, educational level & contact with typhoid patient in the earthquake will reinforce the need of rapid public health intervention in disaster. Whereas, the hand washing and educational level are the significant risk factors in the normal situation, Bandung. Those socio-demography public health methods will be necessary to prevent typhoid complication.

To improve the public health methods in disaster Indonesia, we will propose to stakeholder in Ministry of Health, that public health problem is divided into two time periods. Traumatic critical ill patients and tetanus are priority in the early period and typhoid complication is in the late period. ICT is useful for information exchange and data collection to support public health methods in disaster affected area, Indonesia.
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Refereed research notes

Refereed proceedings


**Proceedings**
