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Review

Prevention of Tetanus Outbreak Following Natural Disaster in Indonesia: Lessons Learned from Previous Disasters

Dyshelly Nurkartika Pascapurnama,[1,2] Aya Murakami,[1] Haorile Chagan-Yasutan,[2,3] Toshio Hattori,[2,3] Hiroyuki Sasaki[1] and Shinichi Egawa[1,2]

[1]Division of International Cooperation for Disaster Medicine, International Research Institute of Disaster Science (IRIDeS), Tohoku University, Sendai, Miyagi, Japan
[2]International Post-Graduate Program in Human Security, Tohoku University, Sendai, Miyagi, Japan
[3]Division of Disaster-related Infectious Diseases, International Research Institute of Disaster Science (IRIDeS), Tohoku University, Sendai, Miyagi, Japan

In Indonesia, the Aceh earthquake and tsunami in 2004 killed 127,000 people and caused half a million injuries, while the Yogyakarta earthquake in 2006 caused 5,700 deaths and 37,000 injuries. Because disaster-affected areas are vulnerable to epidemic-prone diseases and tetanus is one such disease that is preventable, we systematically reviewed the literature related to tetanus outbreaks following previous two natural disasters in Indonesia. Based on our findings, recommendations for proper vaccination and education can be made for future countermeasures. Using specified keywords related to tetanus and disasters, relevant documents were screened from PubMed, the WHO website, and books. Reports offering limited data and those released before 2004 were excluded. In all, 16 publications were reviewed systematically. Results show that 106 cases of tetanus occurred in Aceh, with a case fatality ratio (CFR) of 18.9%; 71 cases occurred in Yogyakarta, with CFR of 36.6%. For both outbreaks, most patients had been wounded during scavenging or evacuation after the disaster occurred. Poor access to health care because of limited transportation or hospital facilities, and low vaccination coverage and lack of awareness of tetanus risk contributed to delayed treatment and case severity. Tetanus outbreaks after disasters are preventable by increasing vaccination coverage, improving wound care treatment, and establishing a regular surveillance system, in addition to good practices of disaster management and supportive care following national guidelines. Furthermore, health education for communities should be provided to raise awareness of tetanus risk reduction.

Keywords: disaster-related infectious diseases; health education; outbreak; prevention; tetanus
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Introduction

Tetanus, a wound-related infectious disease, is caused by tetanospasmin and tetanolysin. The latter is a neurotoxin released by *Clostridium tetani*, an obligate anaerobic gram-positive tetanus bacillus. The spores of bacteria flagella, which contain exotoxin, are widely distributed in contaminated soil, debris, and animal feces. Infection begins when bacteria enter the human body through a puncture or laceration and release the neurotoxin (Ritchie and Pearce 2005). Tetanolysin damages surrounding tissues. Then the bacteria release tetanospasmin (tetanus toxin, designated as TeTx or TeNT), which causes the disease. The toxin itself is distributed from the infection site to the bloodstream, where it spreads to other peripheral areas and the central nervous system (CNS) resulting in tetanic muscular spasms (Bleck and Brauner 2004). The incubation period from the time of injury until the first symptoms is 2-50 days, although symptoms usually occur within 5-10 days. The probability of death increases when the symptoms appear earlier than 5 days after injury. Death is usually caused by spasms, hypoxia, and pain (Sutiono et al. 2009). Tetanus severity depends on proper wound care and the level of medical facilities available. In developing countries, it is considered that the mortality rate is between 10 to 50%. The risk becomes greater in cases of late and inappropriate treatment (Ritchie and Pearce 2005). Tetanus, however, is preventable through effective vaccination. During child age, people should receive three doses of diphtheria, tetanus, and pertussis (DTP) vaccine to prevent those diseases.

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Correspondence: Dyshelly Nurkartika Pascapurnama, International Post-Graduate Program in Human Security, and Division of International Cooperation for Disaster Medicine, International Research Institute of Disaster Science (IRIDeS), Tohoku University, 2-1 Seiryo-machi, Aoba-ku, Sendai, Miyagi 980-8573, Japan.
e-mail: dyshelly.nurkartika@gmail.com

Indonesia has a high risk of natural disasters. Two major natural disasters have occurred in Indonesia: an earthquake and tsunami in Aceh Province in December, 2004 and an earthquake in Yogyakarta in May, 2006. Following such natural disasters, aside from direct losses and victims, threats from infectious diseases outbreaks arise. Tetanus has been a serious major public health problem as survivors develop the disease after experiencing puncture wounds, lacerations, and crush injuries (Kouadio et al. 2012). Although results suggest that the main cause of outbreak is a lower coverage of tetanus vaccine in Indonesia (Bastian 2005), that cause has not been investigated further. Therefore, we systematically reviewed the main reasons underlying tetanus outbreak in the aftermath of two major natural disasters in Aceh Province and Yogyakarta Province, Indonesia to elute some recommendations in line with government efforts to increase vaccination coverage and education of the community to prevent recurrence of tetanus outbreak in Indonesia following natural disasters in the future.

Materials and Methods

Literature review

Original publications such as articles, documents and reports were screened during May 14, 2015-June 4, 2015 using PubMed and World Health Organization (WHO) websites, textbooks of disaster medicine, and the Sphere Project Handbook as available resources using 'Indian Ocean Tsunami 2004', 'Yogyakarta Earthquake 2006', 'tetanus', 'disaster', 'wound infection', 'outbreak', 'prevention', and 'health education' as keywords.

Selection criteria

Only publications specifically describing 'tetanus case, outbreak, health education, and prevention related to natural disasters' and 'disaster-related infectious diseases, especially in Indonesia' were examined in this study. Reports with limited data or which did not describe disaster-related infectious diseases (not followed by tetanus) as well as those that were released before 2004 were excluded. After screening, there were 16 publications, with the addition of 'The Sphere Project' Handbook, 'Infections of the Central Nervous System Third ed.' and 'Koenig and Schultz's Disaster Medicine' used for this review.

The references were critically identified and selected if they included the number of tetanus patients, valid data related to treatments and outcomes, and explanation of the outline of outbreaks and responses.

Results of Review

Tetanus outbreak following earthquake and tsunami in Aceh Province

On the morning of December 26, 2004, a magnitude 9.3 earthquake struck off along the northern island of Sumatra, Indonesia, with an epicenter off the west coast of the island (Guha-Sapir and van Panhuis 2010). It was the third-largest earthquake ever recorded on a seismograph. The undersea megathrust earthquake triggered a devastating tsunami along the coasts, killing approximately 175,000, leaving thousands missing, and millions of people displaced. The worst affected area was Aceh Province, located on the northwestern coast of Sumatra, with around 127,000 dead, tens of thousand missing, and half a million people left homeless (Brennan and Rimba 2005).

Following the disaster, the Aceh Epidemiology Group (2006), consisting of staff of the Provincial Health Office (PHO), Ministry of Health Republic of Indonesia (MoH), and WHO, as well as members of international institutions, collected case report forms and data related to epidemic-prone diseases from a post-disaster surveillance report. For the tetanus case, the case definition was the acute onset of a painful muscle contraction and muscle spasms. In all, 106 cases of tetanus were recorded in four districts in Aceh Province during a month. The first tetanus patient was admitted to hospital on December 30, 2004 (4 days after the tsunami). The last admission was on January 28, 2005, with peak admission occurring 17 days after the tsunami (Aceh Epidemiology Group 2006). All other reports of the relevant literature refer this reported figure as the total number of cases of the tetanus outbreak.

According to Jeremijenko et al. (2007), patients who met the case definition of tetanus were hospitalized in eight hospitals located in Meulaboh, Blangpidie, Tapak Tuan on the west coast (n = 34), Sigli on the northern coast (n = 13), and Banda Aceh (n = 59). The largest cohorts with detailed descriptions were in Zainal Abidin Hospital (n = 35) (Jeremijenko et al. 2007) and Fakinah Hospital (n = 10), located in Banda Aceh (Ritchie and Pearce 2005).

The collected medical reports showed that the median age of patients was 40, with a range of 1-70 years. Seven cases of children younger than five years old, and 16 cases of 5-15 years old were treated, although most cases occurred in adults of more than 25 years old. No neonatal case was reported (Aceh Epidemiology Group 2006). Tetanus mostly occurred in males, the ratio between male and female patients was 1.7 (67/39 62% male). Fifteen male patients and five female patients died of tetanus: most were older than 50. The total case fatality ratio (CFR) was 18.9% (20/106), where the rate is higher among patients aged 50 and older (40%). Diagnosis was made with clinical symptoms, no bacteriological confirmation, and no antibody titration. The disease was identified among patients through following signs such as trismus (lockjaw, reduced opening of jaw), risus sardonicus (sustained spasm on facial muscles appear as grinning), and painful muscular contractions (spasms) (Table 1). All patients had injuries, puncture or laceration wounds sustained during or after tsunami disaster, mostly in the lower limbs, which subsequently caused infection (Jeremijenko et al. 2007).

At Zainal Abidin Hospital, treatment included tetanus immunoglobulin (TIG) and/or anti tetanic serum (ATS) to neutralize the toxin, absorbed tetanus toxoid (ATT) for prevention, sedation for relief of severe pain caused by spasms, surgical debridement for several severe cases and antibiotic medication. The hospital also provided special rooms with

Table 1. Tetanus outbreak in two natural disasters.

Variable		Earthquake and Tsunami Aceh Province Dec. 26, 2004	Earthquake Yogyakarta Province May 27, 2006
Number of cases		106	71
Cases by gender	Female	39	6
	Male	67	20
	Unknown	–	45
Admission period		Dec. 30, 2004-Jan. 26, 2005	during June, 2006
Age range	< 5 y.o.	7	N/A*
	5–50 y.o.	71	11
	> 50 y.o.	25	15
	Unknown	3	45
Common symptoms		Muscle rigidity (trismus, dysphagia, risus sardonicus, neck rigidity, opisthonus) and spasms	Muscle rigidity (trismus, dysphagia, risus sardonicus, neck rigidity, opisthonus) and spasms
Common cause		Superficial wounds with history of immersion, laceration	Open wound in limb area, punctured wound
Treatment		Tetanus Immunoglobulin (TIG)	Tetanus Immunoglobulin (TIG)
		Tetanus Toxoid (ATT)	Tetanus Toxoid (ATT)
		Antibiotics (metronidazole, cephalosporin)	Undescribed
		Sedation (diazepam, morphine)	Undescribed
		Oxygen therapy	Undescribed
		Magnesium infusion	Undescribed
		Tracheotomy	Undescribed
		Isolation (quiet, dark room)	Undescribed
Average length of stay	Mild	6.8 days	Average 16.83 days
	Moderate	9.16 days	
	Severe	18.2 days	
Number of deaths		20 (15 male, 5 female)	26
Case fatality ratio (CFR %)		18.90%	36.60%
Cause of death		Continuous spasms and pain, asphyxia, hypoxia, comorbidity with malaria / TB	Continuous spasms and pain, asphyxia, late admission to hospital
Vaccination coverage		N/A*	N/A*

*Data are not available.
(Aceh Epidemiology Group 2006; IFRC 2006; Jeremijenko et al. 2007; Sutiono et al. 2009)

minimal lighting and less noise to avoid triggering spasms. Proper ventilation management by tracheotomy was also performed. All 35 patients received TIG between 500-4,000 international units (IU) and/or ATS 20,000 IU/day for 4 days. They also received antibiotics combination of oral/nasogastric tube and/or intravascular metronidazole and a third-generation cephalosporin. Of 35 patients, 16 had pneumonia, 1 had malaria, and 3 were diagnosed with pulmonary tuberculosis (TB) (Table 1). Sedation with diazepam and intravascular morphine were also used to reduce spasms and pain. Severe cases received magnesium infusions to reduce autonomic dysfunction. Patients with mild tetanus spent an average length of stay 6.8 days, whereas moderate tetanus patients spent 9.16 days, and severe tetanus patients spent 18.2 days in an average stay (Jeremijenko et al. 2007).

Fakinah Hospital Banda Aceh admitted 10 patients. They came with tetanus between 13-23 days post-tsunami. All patients received intravenous diazepam as sedation to control muscle contraction, plus intravenous TIG (4 received TIG 4,000 IU single-dose intravenous, 4 received intramuscular human IG 5,000-10,000 IU, 2 received horse serum anti-toxin intramuscular 40,000 IU daily for 2 days and 20,000 IU on day 3). Intravenous metronidazole was

administered for a week. Wounds were cleaned and debrided after the patient was stabilized. Fakinah Hospital also provided quiet and darkened rooms (Ritchie and Pearce 2005).

Out of 106 patients, death was mostly caused by continuous spasms and pain, hypoxia, and asphyxia together with comorbidities. Most death occurred within 17 days, except for one that occurred 28 days after the tsunami. In Zainal Abidin Hospital, four patients with aspiration pneumonia and two patients who had sputum retention because of suspected TB died (Jeremijenko et al. 2007). The mortality rate was highest in the late hospital admission and short incubation. Two patients in Fakinah Hospital died caused by severe spasms after surgical wound debridement. Immediate death occurred in one case soon after hospital admission (Ritchie and Pearce 2005).

Tetanus outbreak following earthquake in Yogyakarta Province

One and a half years after tsunami in Aceh Province, Indonesia faced another catastrophic natural disaster that occurred in Yogyakarta Province on Java Island. The Yogyakarta earthquake happened on the morning of May 27, 2006, with magnitude 6.4, classified as destructive type. The earthquake struck the southern coast of Java. It was also related with Mount Merapi activity. Although the impact was less than that of the earthquake and tsunami in Aceh Province, it caused a disproportionate number of casualties, with more than 5,700 deaths, 37,000 injuries, and many financial losses.

There was also an outbreak of tetanus in the aftermath of this disaster. Actually, MoH, WHO, and the International Federation of Red Cross (IFRC) reported jointly that a total of 71 cases of tetanus had emerged (IFRC 2006; WHO 2006a). IFRC (2006) reported that out of 71 patients, 26 died resulting in CFR 36.6% (Table 1). All other reports are cited in this report as the final number of tetanus occurrence. The average age for death cases was 74 years old. The average age of patients who survived was 55.6 years old.

Out of 71 patients, the details of 26 tetanus patients in Yogyakarta Province were analyzed further, including the distance from residence to hospital and the level of hospital. The patient ages were 20-89 years old, 15 of them were 60 years old or older. They were predominantly men (n = 20, 76.9%), not women (n = 6, 23.1%). Treatments for the 26 tetanus patients were conducted at eight hospitals in Yogyakarta Province: Sardjito General Hospital, Wates Hospital, Muhammadiyah Yogyakarta Hospital, Muhammadiyah Bantul Hospital, Harjo Lukito Hospital, Ludira Husada, Hospital, Panembahan Senopati Hospital, and Walubi Field Hospital. The Sardjito Hospital is the top academic referral hospital in Yogyakarta. It is categorized as a type B hospital. Six of the remaining hospitals were categorized as type C, with one (Walubi Field Hospital) as type D. The characteristics of those eight hospitals were collected from the Indonesian Hospital Association. Type A are the best hospitals based on the facilities, human resources, and management, whereas type D has the lowest quality of medical services. Treatment is given to patients as intravascular TIG (IFRC 2006), and ATT immunization. However other treatments such as sedation, administration of antibiotics, and oxygen therapy are not described. Death resulted from severe tetanus with continuous spasms.

The distance from the patient's place of residence to the admitted hospital and also the type of hospital, based on its health care facilities, were also regarded as significant predictors of mortality. For 26 cases, the mean distance from the dead patients' residence to the admitted hospital was 29.83 km. Most of the patients died in hospital types C and D. Late hospital admission was also considered as a death-related risk factor. Most patients had early stage tetanus (n = 17, 65.4%), whereas 9 patients who visited after 7 days already had severe symptoms (34.6%). Eight out of the nine patients with late hospitalization died within 4 days after admission. Recovered patients spent an average of 16.83 days in a hospital (Sutiono et al. 2009).

Diphtheria, tetanus, and pertussis (DTP) vaccination coverage and status

Although the current status of DTP vaccination in both Yogyakarta Province and Aceh Province are not available, the tetanus outbreak following the disaster probably resulted from low vaccination coverage on previous years. Considering that the most vulnerable patients were adults, it is expected that for the past decades, the DTP vaccination for children was not fully achieved. Neonatal tetanus vaccine was given to protect mothers and babies from tetanus risk. However, this vaccine coverage is still low (60% in 2004) in Aceh Province (Guha-Sapir and van Panhuis 2010).

Starting from 2001, MoH is promoting the Expanded Program of Immunization (EPI) supported by the Global Alliance for Vaccines and Immunization (GAVI), a global vaccine alliance established in 2000. The purpose of this EPI program is to improve the vaccine coverage among Indonesian residents, one vaccine target is the DTP vaccination. Since the EPI program started, all provinces are required to submit a vaccination report to monitor annual vaccination coverage and completeness. Although the completeness data obtained at the health center level and district/municipal level are not available, Aceh and Yogyakarta Provinces have not showed good performance at reporting vaccination status (Fig. 1). Therefore, no adequate data exist for the annual DTP vaccination coverage in these provinces. As of 2009, the effectiveness of EPI program for DTP3 (three doses of DTP vaccination) remains to be evaluated. The dropout of DTP vaccination was more than 5% in some provinces, including Aceh Province, although the situation in Yogyakarta Province is unknown (Fig. 2), which means, there are still many Indonesian citizens who did not receive 3 doses of DTP vaccine. This can decrease

Fig. 1. Reporting timeliness of Expanded Program of Immunization
Provinces (black) were unable to send the report on a timely basis, among which are Aceh Province and Yogyakarta Province. Provinces (white) sent timely reports (Directorate General for Disease Control and Environmental Health Ministry of Health Republic Indonesia 2010).

Fig. 2. Effectiveness of the vaccination program, based on number of dropouts from DTP-immunization coverage.
Black, Provinces with the dropout > 5% (not reached the target effectiveness of the program), among them Aceh Province; grey, Provinces with dropout < 5%; and white, Yogyakarta Province, with no data for the dropout rate or dropout incidence (Directorate General for Disease Control and Environmental Health Ministry of Health Republic Indonesia 2010).

the effectiveness of vaccines, and allow tetanus outbreaks at unexpected moments, such as after a disaster, when the human immune system is weakened (Directorate General for Disease Control and Environmental Health Ministry of Health Republic of Indonesia 2010).

Post-disaster surveillance system in Indonesia

Following the earthquake and tsunami in Aceh Province, extensive loss of life, property, and livelihood left a huge risk population with vulnerable conditions. During this acute phase of emergency, a temporary post-disaster surveillance, Early Warning, and Response (EWARN) system was implemented by the Aceh PHO, which was reinforced by MoH and the Communicable Diseases Department of the WHO and supported from Global Outbreak Alerts and Response Network (GOARN) (Jeremijenko et al. 2007).

EWARN was created to detect epidemic-prone diseases such as diarrhea, measles, dengue, malaria, as well as acute respiratory infections, and tetanus, to investigate outbreaks with confirmation of a potential pathogen, mode of transmission and individuals at risk, and to prepare for out-

break management and control measure of communicable diseases. The system involved fixed and mobile clinics, hospitals, and laboratories, which were operated at all the affected areas by government, volunteers, international teams, and Non-Governmental Organizations (NGOs) as sources of information. The participation included weekly reports, figures and daily alerts based on daily telephone calls, messages, and e-mail. The results were shared in twice-weekly health sector meeting with more than 50 participating agencies. A weekly epidemiological report was also released and published in both Bahasa Indonesia and English by PHO and MoH (WHO 2005). Since there was a cluster of tetanus cases was found during the month after the disaster, all hospitals agreed to notify all suspected case to the investigators using the EWARN surveillance system. Validation of reported cases was conducted by teams by visiting the hospital, resulting in 106 cases of tetanus in all with the peak occurred on mid-January and 18.9% CFR (Jeremijenko et al. 2007).

In Yogyakarta, a post-disaster surveillance system to monitor emerging infectious diseases was also established soon after the disaster. Health issues of the survivors immediately emerged because of poor sanitation. Palang Merah Indonesia (PMI-Indonesian Red Cross Society (IRCS)), along with the local government, NGOs, and volunteers conducted the highest emergency relief, coordination, and information sharing with stakeholders as well as the professional logistics, relief management, and volunteer commitment (IFRC 2006). WHO also helped to set up a disease post-disaster surveillance system to detect and control the outbreak of communicable diseases. According to the lessons from the Aceh disaster, WHO and the United States (US) Centers for Disease Control and Prevention (CDC) created 'The Outpatient Mortality and Morbidity Weekly Surveillance System' that collected information of communicable diseases from all actors such as MoH, local, and international NGOs and other agencies that were involved in activities in affected districts (US CDC and Yogyakarta Provincial Health Office 2006). Several infectious diseases were monitored to find descriptions that included key words such as acute watery diarrhea, bloody diarrhea, typhoid fever, malaria, dengue, acute respiratory infection, pneumonia, measles, jaundice syndrome, and tetanus. The WHO-MoH data compilation demonstrated that as of June 21, 2006, the number of tetanus cases in all had reached 71, with 26 deaths arising from this group, giving a case fatality rate of 36.6% (IFRC 2006; WHO 2006a).

Discussion

As a deadly wound-related infectious disease, tetanus must be a consideration in any natural disaster situation such as an earthquake and tsunami, as one of the few vaccine-preventable and not contagious disease (Waring and Brown 2005; Afshar et al. 2011). The rubble from collapsed structures and building, debris, and any kind of sharp material such as glass and nails contaminated with *C. tetani* in the environment can engender severe conditions.

This review has limitations related to available data about the vaccination status in Indonesia and limited publications about tetanus outbreak after the natural disasters in Indonesia. Therefore, the systematic literature review suggested the difficulty in the epidemic analysis of only one specific disease such as tetanus after a large-scale natural disaster. Of 16 papers, two papers presented details of the tetanus outbreak after the Aceh disaster (Ritchie and Pearce 2005; Jeremijenko et al. 2007). Only one original article described the Yogyakarta disaster (Sutiono et al. 2009). Reports from WHO and IFRC had useful information. All other reports referred to them as the total number of outbreaks.

Reasons for outbreaks

Outbreaks of tetanus follow a disaster in Aceh Province and Yogyakarta Province. In both disasters, the main cause of outbreak is explainable by the lack of prevention measures. Most patients had open contaminated wounds and injuries in the lower limbs because of debris. They received no immediate treatment or vaccination. Injured people must receive proper and prompt medical treatment and vaccination; otherwise the disease can develop quickly (Lim 2005). Wounds and injuries commonly occurred at the time of disaster or aftermath when survivors scavenged in the rubble, wandering around debris, hoping to find the corpses of relatives or to recover their property. The wound is considered as resulting from not wearing protection such as boots and gloves (Jeremijenko et al. 2007). Iodine, glutaraldehyde, or hydrogen peroxide is needed for effective antisepsis (Bleck and Brauner 2004). Many survivors left the wounds untreated, even for 2 weeks, increasing the severity of tetanus. Additional efforts have been undertaken to decrease the prevalence of general wound infections because a high prevalence of wound infections suggests poor disaster response achievement. In 2004, the Standard Emergency Health Kits endorsed by the WHO did not include penicillinase-resistant antibiotics (Brennan and Rimba 2005), but additional antibiotics were added to the kit in 2006 (WHO 2006b). Even *C. tetani* is known to be most sensitive to penicillin, which might have decreased the risk of other skin and wound infections among the survivors.

Tetanus occurred mostly in men because men do scavenging activities and undertook a higher intensity of outdoor activities during and after disasters than women do (Aceh Epidemiology Group 2006). Furthermore, men might have been more susceptible to tetanus infection because women receive maternal tetanus vaccinations when they are pregnant to avoid neonatal tetanus. The difference in susceptible gender is also regarded to derive from an immunization program conducted in the 1980s that targeted children and females before antenatal vaccination (Jeremijenko et al. 2007). In outbreaks in Aceh Province and Yogyakarta Province, tetanus occurred mostly among

elderly people, who are generally more susceptible because they might not have received vaccination at an earlier age in the 1950s-1970s. They are therefore not immune to *C. tetani* infection. Moreover, immune systems generally weaken along with age. Indonesia, as an economically developing country, also shows a higher frequency of tetanus in adolescents and younger adults. This might be true because of lower vaccine coverage and inadequate vaccination programs (Afshar et al. 2011). In Aceh and Yogyakarta, teenagers and children might have been affected as a result of drop out or prior non-vaccination. Tetanus vaccine should be given as three shots before children reach the age of 15. Aceh Province was among the lowest among provinces in Indonesia, as indicated by data provided in 2004: vaccination coverage of pregnant women reached only 60% of the female population (Guha-Sapir and van Panhuis 2010). Some individuals might be protected for life, but antitoxin antibody levels in most people reach a minimal protective level at 10 years after the prior dose. As patients were predominantly elderly people, their immune systems were in decline and a booster was extremely important to prevent tetanus infection (Afshar et al. 2011).

The CFR of tetanus in developing countries can be greater than 50% in adults and more than 80% in infants. However in Aceh and Yogyakarta, the CFR from tetanus outbreak is smaller than estimated because of post-disaster surveillance system. The lower frequency also reflects the capabilities of relief organizations working in disaster situations. Death incidence in both outbreaks was identified as resulting from continuous spasms and hypoxia, probably because of late admissions to hospital and short periods of incubation. A short period of incubation might lead to severe tetanus infection (Jeremijenko et al. 2007; Sutiono et al. 2009).

Several factors raise the difficultly of implementation and maintenance of EWARN systems in emergency situations: inconsistent weekly reporting by agencies, especially as a result of their short-term field presence; lack of an accurate population denominator data because of high mobility of the dislocated people; difficulty in reaching rural districts; lack of regular laboratory confirmation of suspected cases; and multiple reporting of individual patients because of multiple sources of medical services (WHO 2005). To overcome these challenges, we recommend the use of such a surveillance system as a fundamental instrument of public health to monitor infectious diseases regularly under normal circumstances.

A main concern is that tetanus might have occurred because of a lack of awareness in the community. Affected people might have limited knowledge about the risk of tetanus because they did not receive health education about the risks of tetanus following injury. This lack might be attributable to the condition that their community residence mostly located in remote area, with limited access to health education, difficulty of access to hospitals, and limited public health human resources (Guha-Sapir and van Panhuis 2010). Even after the disaster, awareness of tetanus will encourage people to visit health facilities as soon as possible.

Education, support, and vaccination

Vaccination programs are a long-term effort. Therefore, other factors play important roles in preventing tetanus outbreaks, including health education and disaster management following the national guidelines (Kouadio et al. 2012). To prevent tetanus outbreaks following a disaster, external support is necessary for an immediate response including aid and supplies and also post-disaster surveillance system. To treat injured people appropriately, surgical and medical care of contaminated open wounds and avoidance of late treatment are crucially important. Medical aid such as tissue debridement supplies, disinfectants, tetanus prophylaxis, and antibiotic treatment are expected to be available and be provided (WHO 2010). During emergencies, skilled health workers or staff members should be made available in primary-level health facilities to provide clinical management, wound care, and tetanus prevention (The Sphere Project 2011).

Lack of knowledge and understanding about the risk of tetanus infection make people less cautious of contaminated objects such as nails, glass, wood, or contaminated soil. It makes them likely to underestimate their wounds without knowing that they have a risk of tetanus. Health education assisted by media such as educational videos and brochures about tetanus risk for communities both during ordinary times and after disasters should be regarded as increasing their awareness of tetanus. Such efforts might include support such as the procurement of protective clothing, gloves, and closed shoes as preventive measures (The Sphere Project 2011).

One of key elements to humanitarian interventions in outbreaks is case management and surveillance (Burkle 2006). Both tetanus outbreaks in Aceh Province and Yogyakarta Province had already been monitored by a qualified system established by the Indonesia MoH, PHO, and WHO, using standard protocols on investigating and reporting cases. Rapid health assessments and an initial overview of immediate consequences and needs also had been done. The key to establishing a successful post-disaster surveillance system has been good cooperation among national and international NGOs, United Nations agencies and the MoH. With good coordination with health centers in district on a basic level, provincial hospitals, PHO, and MoH, consistency in reporting each case with details, and the post-disaster surveillance system will have better future performance. The MoH, with support from WHO, are also suggested to provide provincial offices technical support in the form of capacity-building and infrastructure-strengthening for a better post-disaster outbreak surveillance system (WHO 2005).

The Sphere Handbook is an internationally accepted

standard for disaster response. It uses a needs-based approach and relies upon a strong rights-based approach, which was not a predominant norm in many countries affected by the tsunami (Stratton 2009). For the earthquake and tsunami in Aceh Province, international humanitarian standards were not adapted to local contexts. Learning from this outbreak and as prevention for future events, the Indonesian MoH is promoting the Global Maternal and Neonatal Tetanus (MNT) Elimination Initiative to reduce death cases attributable to tetanus per 1,000 live birth by giving neonatal vaccination of TT. Based on the minimum standards in health action in humanitarian response, MoH arranged routine EPI for children aged 6 months to 15 years, especially in rural areas and disaster-prone areas with previous low coverage of DTP vaccine, to increase the coverage standard to 90% and improve the future outbreak response (The Sphere Project 2011). Along with this program, Indonesian MoH also adopted a three-pronged immunization approach to provide protection against tetanus infection for residents. It included short-term protection with TT dose for pregnant women and women who are engaged or recently married, long-term protection with three doses of DTP for infants through EPI program, one booster dose of DT to students in grade 1 of primary school, and TT booster doses for students in grades 2 and 3. It also included accelerated protection with three rounds of supplementary immunization activities (SIA) for women of reproductive age (15-39 y.o.) in areas where TT immunization and clean deliveries have low coverage (Directorate General for Disease Control and Environmental Health Ministry of Health Republic of Indonesia 2010).

Aside from these disasters in Indonesia, tetanus outbreaks also occurred following earthquakes in Haiti in 2010 (Afshar et al. 2011) and Pakistan in 2005 (Khurram and Mahmood 2007). However, only a few cases of tetanus with 0 CFR were reported after the Great East Japan Earthquake 2011 (Takahashi et al. 2012). Tetanus was endemic in Haiti even before the earthquake: 3-119 tetanus cases were reported annually during 2004-2009. Most were neonatal tetanus. It is considered that the outbreak resulted from low tetanus vaccination coverage. Only 50% of the Haiti's population received tetanus vaccination during the prior decade. The exact number of tetanus patients and CFR after the Haiti earthquake is unknown because of underreporting. Based on a recommendation from a surveillance report, The Haitian Ministry of Health with NGOs developed a post-disaster vaccination plan against tetanus, especially for children in affected areas (Afshar et al. 2011). There were at least 139 cases of tetanus with 41 deaths (CFR 29.5%) following an earthquake in Pakistan in 2005. The outbreak happened within 30 days post-disaster. Some patients received prophylactic vaccination after the earthquake, but developed the disease. The authors reported that the outbreak resulted from insufficient vaccination coverage, insufficient public health infrastructure, and lack of awareness among the public and health professionals (Khurram and Mahmood 2007). For these factors, similarly to Indonesia, public health promotion and education are presumably the best preventive measures.

In Japan, notification of tetanus cases became mandatory by the Communicable Diseases Prevention Law in 1947 (National Institute of Infectious Disease 2002). There were 10 tetanus patients after the Great East Japan Earthquake (GEJE) in 2011, in which more than 4,500 injuries were reported (as of April 12, 2012, http://idsc.nih.go.jp/earthquake2011/zensuu11img/20120413zensuu.html in Japanese). All patients were reportedly injured on the first day of the disaster. Most patients were elderly people (median 67 (56-82)). No one died because of tetanus, although they required intensive care. It is unlikely that the patients were injured after the disaster because of scavenging activities. Low frequency can also be the result of awareness of tetanus among healthcare providers in treating individuals with injuries from earthquakes and tsunami and law-enforced active surveillance and notification of new cases. General guidelines to prevent and detect the infectious, acute diseases and symptoms of anxiety among elderly people at shelters were established after GEJE. These measures are regarded as key factors for prevention of outbreaks after disasters (Takahashi et al. 2012).

Conclusion

Tetanus outbreaks following two major natural disasters that occurred in Aceh Province and Yogyakarta Province contributed important knowledge not only for the Indonesian government but also for the global community. Experiences show that, with good preparation, the outbreak severity can be minimized. Some efforts have been undertaken such as establishing a post-disaster surveillance system, immediate response in wound care treatment, and escalating vaccination coverage, although they still must be improved. Furthermore, health education, dissemination of information, and external support both in human and material supplies in the form of proper clothing, gloves, and proper shoes also play important roles for tetanus outbreak prevention.

Conflict of Interest

The authors declare no conflict of interest.

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