Medical response to the 2009 Sumatra earthquake: health needs in the post-disaster period

Tan CM[1], MBBS, MPH, Lee VJ[1], MBBS, MPH-MBA, Chang GH[1], MBBS, Ang HX[1], MBBS, Seet B[1], MMed, MPH

INTRODUCTION This paper provides an overview of cases seen by the Singapore Armed Forces (SAF) medical and surgical teams in the 2009 Sumatra earthquake and discusses the role of militaries in the acute phase of a disaster.
METHODS Two SAF primary healthcare clinics prospectively collected patient medical information for comparison. Descriptive analysis of the Emergency Department (ED) and surgical case records was performed.
RESULTS 1,015 patients were seen by the two primary healthcare clinics. In both Koto Bangko and Pariaman, respiratory-related conditions were the most common diagnoses (47.2% and 30.6%, respectively), followed by musculoskeletal/joint conditions (31.6% and 20.6%, respectively). In the ED, 55% and 27% of the 113 patients had trauma-related and infective-related diagnoses, respectively. Lacerations and contusions were the most common forms of trauma. Lung infection was the most common infective diagnosis seen at the ED. The number of ED cases was high during the first week and gradually declined in the second week. 56% of the 102 surgical procedures were performed on dirty or infective wounds. Fractures requiring fixation comprised 38% of surgical procedures.
CONCLUSION Medical aid remains an important component of the overall humanitarian response. Militaries could play an important role in disaster response due to their ability to respond in a timely fashion and logistic capabilities. Pre-launch research on the affected area and knowledge on disaster-specific injury patterns would impact the expertise, equipment and supplies required. The increasing evidence base for disaster preparedness and medical response allows for better planning and reduces the impact of disasters on affected populations.

Keywords: disaster, earthquake, health needs, Indonesia, military
Singapore Med J 2012; 53(2): 99–103

INTRODUCTION

A major challenge in post-disaster medical relief is its provision in affected regions where there is an intrinsic lack of healthcare facilities,[1-3] or where destruction of transport infrastructure limits the reach of medical aid and hinders the evacuation of casualties. While many countries have made some headway in disaster preparedness at the central level, the same level of preparedness may not be evident at the regional and community levels.[4] Militaries are able to provide timely response and can play an important role in the acute phase of disaster response by providing rapid and mobile medical resources.[5] The use of mobile medical clinics is also important in bringing healthcare to remote areas that are affected by the disasters.[6,7]

On September 30, 2009, an earthquake of magnitude 7.6 on the Richter Scale struck the Sumatra Barat province in Indonesia. The epicentre of the earthquake occurred just 60 km west-northwest of Padang, Sumatra, Indonesia.[8] The regency of Padang Pariaman was one of the worst hit areas, with 211 fatalities, 675 wounded, 3,245 missing and 10,191 homes damaged.[9] Koto Bangko, a village 20 km northeast of Pariaman within the regency sustained numerous casualties. Koto Bangko was served by a single doctor in a community clinic before the earthquake, and the facility was rendered structurally unstable and non-functional by the earthquake.

The Singapore Armed Forces (SAF) responded to the disaster and was in Pariaman within 48 hours of the earthquake. The Singapore Civil Defence Force Disaster Assistance and Rescue Team (SCDF DART) Team was flown in via military planes earlier to assist with search and rescue as well as to help with extrication of casualties. The SAF provided primary healthcare services, augmented the Emergency Department (ED) at one of Pariaman's public hospitals and deployed a surgical team with orthopaedic and general surgical capabilities from October 4–14, 2009. In addition, the SAF sent a mobile medical team to the village of Koto Bangko to reinforce the community clinic.

This paper provides an overview of the cases seen by the SAF medical and surgical teams in the Sumatra earthquake and discusses the role of militaries in augmenting rural health facilities in the acute phase of a disaster.

METHODS

The SAF was deployed on Day 5 of the earthquake and operated at four different locations from October 4–17, 2009 (Table I). The two SAF primary healthcare clinics prospectively collected patient medical information for comparison. The first clinic was set up in Pariaman, a suburban town, from October 4–7, 2009, and was located beside one of Pariaman's public hospitals, a secondary hospital with 140 beds. The second clinic was set up in Koto

[1]Singapore Armed Forces, Singapore
Correspondence: Dr Clive Tan, Registrar, Singapore Armed Forces Medical Corps, Headquarters Medical Corps, 701 Transit Road, #04-01, Singapore 778910. cmtan@jhsph.edu

Table I. Patient caseload at the SAF medical facilities.

Service	Date	Location	Caseload
Primary healthcare	4–7 Oct, 2009	Pariaman	253 patients
Mobile medical team	7–13 Oct, 2009	Koto Bangko	761 patients
Emergency department	7–13 Oct, 2009	Pariaman	113 patients; 30.1% earthquake-related
Surgery	4–14 Oct, 2009	Pariaman	102 surgical procedures performed

Note: Pariaman is a suburban town and Koto Bangko is a rural village.

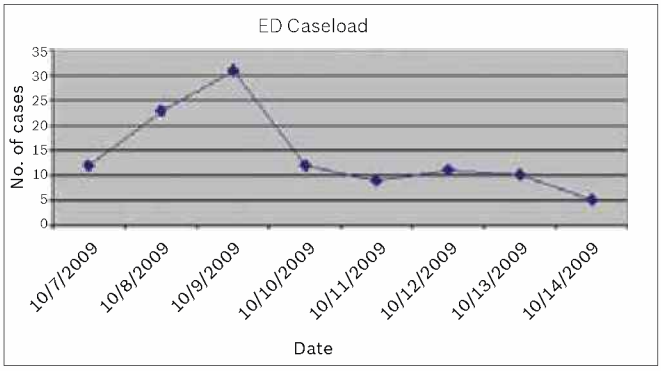

Fig. 1 Graph shows the time trend of the number of patients seen at the SAF emergency department.

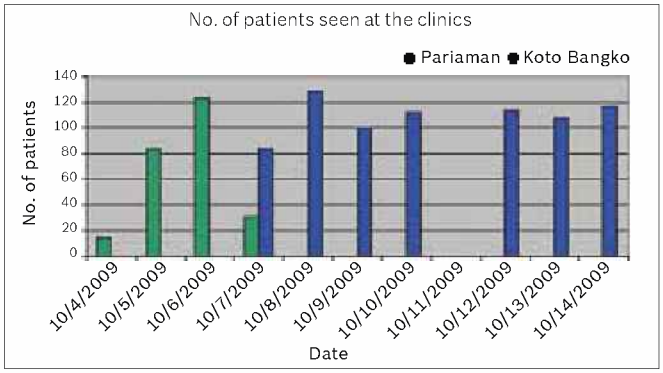

Fig. 2 Graph shows the time trend of patients seen at the two primary healthcare clinics.

Bangko, a village located about 20 km northwest of Pariaman. It has one community clinic that serves four other adjacent villages. The clinic operated from October 7–14, 2009. A group of five Singaporean and two Indonesian doctors attended to all the patients. Treatment protocols for common conditions were standardised. The registration form for each patient served as a documentation and prescription form, and captured all the key information.

We reviewed the clinical records of the patients and categorised the collected data, including the date of consultation, key demographic information, presenting symptoms and diagnosis, into various variables for analysis. Four age categories were constructed: age ≤ 5 years, 6–16 years, 17–64 years and ≥ 65 years. Clinical diagnosis was divided into ten categories, and patients were allowed to have more than one diagnosis at each consultation. The diagnosis categories were: trauma-related, respiratory conditions, joint- and musculoskeletal pain-related, headache and giddiness, skin conditions, gastrointestinal conditions, eye conditions, ear conditions, chronic disease and others.

In addition, descriptive analyses of the ED and surgical case records were performed. The ED saw 113 patients, and their diagnoses were broadly categorised into trauma, infective and non-infective, with further sub-classifications. The surgical team saw 47 patients and performed 102 procedures. The procedures were classified according to the type of procedure and the anatomical region operated on. Statistical analyses were performed using chi-square test in order to examine and compare the patient profile and disease patterns of patients from the two clinics. All statistical analyses were performed using STATA 10.0 (StataCorp LP, College Station, TX, USA), with the level of significance set at 0.05.

RESULTS

Among the ED patients, 55% had a trauma-related diagnosis and 27% had an infective diagnosis. Lacerations and contusions were the most common forms of trauma, followed by head and neck trauma. Lung infection was the most common infective diagnosis seen at the ED. The number of ED cases was high during the first week of the earthquake, and the numbers gradually declined in the second week (Fig. 1).

A total of 1,015 patients were seen at the two primary healthcare clinics. 763 consults were made at the Koto Bangko clinic, which operated for seven days. The Pariaman clinic operated for four days and saw 252 patients. Fig. 2 shows the highly variable patient load at the Pariaman clinic. This was due to the disruption of local primary healthcare and transport services by the earthquake. Services resumed on October 7, 2009, after which we ceased our primary healthcare clinic in Pariaman and shifted operations to Koto Bangko, and saw a steady stream of patients. Due to the time spent travelling to the village, consultation time was limited to only about five hours a day. This limited the number of patients that could be seen in a day, accounting for the relatively steady patient load in Koto Bangko.

Table II compares the patient demographics and diagnoses of patients seen at the two clinics. The mean age of the patients was 38.2 years and 44 years at Koto Bangko and Pariaman, respectively. Compared to Pariaman, Koto Bangko had more than twice as many patients who were < 5 years old (4.9% vs. 12.0%) and more patients aged 6–16 years (6.1% vs. 10.7%). More patients aged 17–64 years were seen at Pariaman than at Koto Bangko (71.4% vs. 61.4%), but there were more female patients seen at Koto Bangko than at Pariaman (56.9% vs. 43.7%). In both Koto Bangko and Pariaman, respiratory-related conditions were the most common diagnosis (47.2% and 30.6%, respectively), followed by

Table II. Comparison between user characteristics of Koto Bangko mobile clinic and Pariaman Hospital clinic in the post-acute phase of the 2009 earthquake.

Demographic Information	% (95% CI)		p-value
	Koto Bangko (n = 763)	Pariaman (n = 252)	
Age (yrs)			
≤ 5	12.0 (9.7–14.3)	4.9 (2.2–7.6)	< 0.01
6–16	10.7 (8.4–12.8)	6.1 (3.1–9.1)	0.04
17–64	61.4 (58.0–64.9)	71.4 (65.7–77.1)	< 0.01
> 64	15.9 (13.3–18.5)	17.6 (12.8–22.3)	0.55
Female gender	56.9 (53.4–60.4)	43.7 (37.5–49.8)	< 0.01
Diagnosis			
Trauma-related	3.1 (1.9–4.4)	9.9 (6.2–13.6)	< 0.01
Pneumonia/ lung-related/ URTI	47.2 (43.6–50.7)	30.6 (24.8–36.3)	< 0.01
MSK and joint-related pain	31.6 (28.3–34.9)	20.6 (15.6–25.7)	< 0.01
Headache/ giddiness	6.7 (4.9–8.5)	13.5 (9.2–17.7)	< 0.01
Skin-related	13.3 (10.9–15.8)	6.3 (3.3–9.9)	< 0.01
GI/dehydration	18.2 (15.5–21.0)	10.3 (6.5–14.1)	< 0.01
Eye-related	3.7 (2.3–5.0)	7.1 (3.9–10.3)	0.02
Ear-related	0.9 (0.2–1.6)	3.6 (1.3–5.9)	< 0.01
Chronic Dz*	2.5 (1.4–3.6)	6 (3.0–9.0)	< 0.01
Others	6.9 (5.1–8.7)	6.7 (3.6–9.9)	0.91

*Includes hypertension, diabetes mellitus, etc.
CI: confidence interval; URTI: upper respiratory tract infection; MSK: musculoskeletal; GI: gastrointestinal; Dz: diseases

musculoskeletal/joint conditions (31.6% and 20.6%, respectively). Koto Bangko saw more cases related to the following systems than Pariaman: respiratory (47.2% vs. 30.6%), musculoskeletal/joint (31.6% vs. 20.6%), skin (13.3% vs. 6.3%) and gastrointestinal (18.2% vs. 10.3%). Pariaman saw more cases related to the following systems than Koto Bangko: trauma (9.9% vs. 3.1%), headaches/giddiness (13.5% vs. 6.7%), eye (7.1% vs. 3.7%), ear (3.6% vs. 0.9%) and chronic diseases (6.0% vs. 2.5%).

Tables III and IV describe the surgical and ED patients seen by the SAF team. 56% of surgical procedures were performed on dirty or infective wounds that required surgical debridement. Fractures requiring fixation made up 39% of surgical procedures. 61% of all procedures were performed on the lower limbs and 37% on the upper limbs.

DISCUSSION

During the past decade, several major earthquakes have occurred in Asia: Taiwan in 1999, Turkey in 1999, India in 2001, Iran in 2003, the Indian Ocean in 2004, Pakistan in 2005 and Eastern Sichuan, China in 2008.[10] Natural disasters not only cause loss of life, but also result in destruction of infrastructure and damage of the economy.[11] When the Sumatra earthquake struck on September 30, 2009, a state of emergency was declared. Healthcare services were provided free by the state. This led to a surge in demand for healthcare services in addition to the added caseload of earthquake victims. In the SAF primary healthcare clinics, the most common presentation was routine respiratory illnesses that were not earthquake-related. Our experience was similar to that of

Table III. Descriptive analyses of surgical patients.

	No. (%)
Gender	
Male	48 (47)
Female	54 (53)
Age (yrs)	
≤ 16	0 (0)
17–64	47 (46)
≥ 65	55 (54)
Type of surgery	
Debridement	57 (56)
Open reduction internal fixation	20 (20)
K-wiring	11 (11)
External fixation	8 (8)
General surgery and others	6 (6)
Operated region	
Tibia/ankle/foot	46 (45)
Hand	20 (19)
Arm/forearm	18 (18)
Femur	16 (16)
Others	2 (2)

Total no. of patients: 47; Total no. of procedures: 102

Chan et al with post-earthquake primary healthcare clinics in Kashmir in 2005.[3] Our clinics also saw a high proportion of patients presenting with musculoskeletal disorders, gastrointestinal conditions, skin conditions and headaches. This showed that supplementing the primary healthcare capacity was necessary not only to deal with earthquake-related illness, but also to manage routine cases. The casemix and demographics of the patients would also impact the medications and resources required. A review of the existing literature on similar disasters with regard to patient profile and research on the local demographics would influence the type of supplies the response team should bring.

Earthquake-related trauma injuries are known to be primarily due to building collapse,[12] and occur more frequently in densely populated areas.[13] Orthopaedic conditions make up the majority of surgical caseloads in earthquakes.[14] Of the casualties operated on by the SAF surgical team, 98% of the patients had orthopaedic problems whereas only 2% were operated on for general surgery problems. This was evident from our experience, where trauma cases made up 7.1%–26.7% of the daily patient load in suburban Pariaman, compared to 0.9%–9.6% in rural Koto Bangko. However, there was a chronological bias to this observation, as the medical team was situated in Pariaman within the first week of the earthquake and shifted operations to Koto Bangko only in the second week of operations. It would be anticipated that trauma patients are seen in the initial 3–5 days after an earthquake. There would be an initial high load of casualties within 48 hours from the nearby area, followed by a second wave of casualties from the more distant areas as humanitarian operations reach those areas.[15]

The shift of operations to Koto Bangko was important, as these remote areas are typically lacking in healthcare services. The only community clinic in Koto Bangko, a village 20 km northwest of Pariaman, which serves four other adjacent villages, was

Table IV. Descriptive analyses of emergency department patients.

Characteristic	No. (%)
Gender	
Male	66 (58)
Female	47 (42)
Age (yrs)	
≤ 16	21 (19)
17–64	55 (49)
≥ 65	37 (33)
Trauma	65 (55)
Lacerations/contusions	23 (19)
Head and neck	14 (12)
Long bone fracture (i.e. humerus, femur)	9 (8)
Wrist/hand	7 (6)
Ankle/foot	7 (6)
Chest/abdomen/pelvis/spine	5 (4)
Infective	32 (27)
Lungs	15 (13)
Skin	6 (5)
Gastrointestinal	5 (4)
Others	6 (5)
Non-infective	22 (18)

Total no. of patients: 113; Total no. of diagnoses: 119

incapacitated by the earthquake. It also allowed us to reach out to trauma casualties who needed surgery and to evacuate them to a surgical facility. The medical team reached the less accessible Koto Bangko in the second week,[6,7,16] but it is possible that due to the time lag, the more severe casualties may have already sought help elsewhere.

In general, the austere environment posed several challenges. Due to the unreliability of electrical supply, there was a general preference for regional anaesthesia. Out of a total of 63 cases that required anaesthesia, 35 (55.5%) received general or regional anaesthesia and 28 (44.5%) were under conscious sedation. During the deployment, there were two episodes of power failure lasting about 20 minutes each. The team improvised and continued surgery with battery-operated LED lights and manual ventilation of the patients.

Militaries continue to play an important role in large-scale disasters,[5,17,18] but their disaster response has strengths and accompanying limitations. They can be mobilised at short notice and are able to respond in a timely manner to disasters as well as provide assistance in the immediate and acute phase of the response. Good logistics support and a history of bilateral relations between the host and foreign militaries facilitate disaster relief efforts. In addition, the presence of personnel in the team who speak the local language helps foster good relations, which facilitates the delivery of healthcare services. To prevent additional stress on the local food supply, the SAF brought food and water supply for its personnel. These ready-to-eat rations are nutritious and compact, and sufficient quantities were brought along to sustain our personnel for the period of deployment. Another essential commodity was electricity, and the SAF brought along six generators (each capable of generating 2,300 watts) and fuel in the form of diesel.

Responding in disasters necessitates working together with other local and international partners on the ground. Our experienced team leaders worked well with both the governmental agencies and local and overseas partners. In this situation, several non-governmental organisations (NGOs) (Red Cross, Red Cresent, Mercy Relief Singapore), disaster response teams (ISAR from Germany, Disaster Relief Team from Japan) and military medical teams (from the USA, Australia, Japan) were also in the vicinity. The deployment location is usually more coordinated for the national teams and slightly less so for NGOs. There was a local incident management system fronted by the Mayor-equivalent, involving the police, military and local medical staff. The SAF was represented at these local meetings and actively participated in exploring ways in which we could cooperate with the local authorities or other medical teams in the vicinity.

A wide range of medical services are required to respond to an earthquake-affected populace. There are different requirements for different response phases. The needs in the immediate phase would primarily be met by the local surge capacity, as foreign aid has a lag time for response. In the acute phase, primary healthcare, emergency medicine and surgical capabilities are essential, and this could be provided by NGOs or foreign aid. Primary healthcare caseload comprises a large proportion of respiratory illnesses, musculoskeletal disorders and gastrointestinal conditions. A surge in patients with chronic medical conditions seeking healthcare services may be expected;[19] however, they made up only a small proportion of cases in our experience. Emergency services would see a large proportion of trauma, with the majority of cases being lacerations and contusions. Surgical workload includes the management of dirty wounds and treatment of fractures. More trauma cases could be expected in densely populated urban areas.

In conclusion, foreign humanitarian aid would continue to play an important role in large-scale natural disasters. Medical aid remains an important component of the overall humanitarian response, and militaries will continue to play an important role in disaster response due to their ability to respond in a timely manner and their innate logistic capabilities. Based on the degree of urbanisation and the phase of disaster response, the disease epidemiology may change accordingly. Pre-launch research on the affected area and knowledge on disaster-specific injury patterns would impact the expertise, equipment and supplies required. The increasing evidence base for disaster-preparedness and medical response allows for better planning and reduces the impact of disasters on affected populations.

ACKNOWLEDGEMENTS

We would like to thank COL Steven Seng, the Mission Commander, and LTC (Dr) Rosman, the Mission Medical Commander, and the Tentara Nasional Indonesia for their assistance with the overall mission and for their collaboration to operate the clinic in Koto Bangko. We are also thankful to the directors and staff of RSUD

Pariaman and Dinas Kesehatan, Kab Padang Pariaman, as well as members of the SAF Medical Team who have contributed to this study.

REFERENCES

1. Woersching JC, Snyder AE. Earthquakes in El Salvador: a descriptive study of health concerns in a rural community and the clinical implications, part I. Disaster Manag Response 2003; 1:105-9.
2. Noji EK. Public health in aftermath of disasters. In: Reymond AD, Mahoney PF, Ryan JM, Macnab C, eds. ABC of Conflict and Disaster. Chichester: Wiley-Blackwell, 2006: 10-2.
3. Chan EY, Kim JJ. Remote mobile health service utilization post 2005 Kashmir Pakistan earthquake. Eur J Emerg Med 2010; 17:158-63.
4. Cheng MH. Natural disasters highlight gaps in preparedness. Lancet 2009; 374:1317-8.
5. Wiharta S, Ahmad H, Haine JY, Löfgren J, Randall T. Stockholm International Peace Research Institute (SIPRI): the effectiveness of foreign military assets in natural disaster response. Sweden: Elanders, 2008.
6. Krol DM, Redlener M, Shapiro A, Wajnberg A. A mobile medical care approach targeting underserved populations in post-Hurricane Katrina Mississippi. J Health Care Poor Underserved 2007; 18:331-40.
7. Késmárky-Kodak A, Borbély A, Oláh E, Fekete K. Organization and operation of mobile medical teams working in disaster areas. Internet J Rescue Disaster Med 2009; 1.
8. Magnitude 7.6 - Southern Sumatra, Indonesia. 2009 September 30. In: United States Geological Survey [online]. Available at: earthquake.usgs.gov/eqcenter/eqinthenews/2009/us2009mebz/. Accessed October 23, 2009.
9. Ministry of Health, Republic of Indonesia : As of 4 Oct 2009 0800H local time, West Sumatera quake victims reach 4,966. 5 Oct 2009. Available at: www.depkes.go.id/en/index.php?option=news&task=viewarticle&sid=580. Accessed October 23, 2009.
10. 2012 Significant Earthquakes and News Headlines Archive. In: United States Geological Survey [online]. Available at: earthquake.usgs.gov/earthquakes/eqinthenews. Accessed October 23, 2009.
11. Cuny FC. Disasters and Development. Texas: Oxford University Press, 1983.
12. Alexander D. The health effects of earthquakes in the mid-1990s. Disasters 1996; 20:231-47.
13. Pan American Health Organization. Natural Disasters: Protecting the Public's Health. No. 575. Washington, DC: Scientific Publication 2000:1-10.
14. Mohebbi HA, Mehrvarz S, Saghafinia M, et al. Earthquake related injuries: assessment of 854 victims of the 2003 Bam disaster transported to tertiary referral hospitals. Prehosp Disaster Med 2008; 23:510-5.
15. Noji EK. The Public Health Consequences of Disasters. New York: Oxford University Press, 1997.
16. Du Mortier S, Coninx R. Mobile health units in emergency operations – A methodological approach. Health Practice Network, 2007 [online]. Available at: reliefweb.int/node/23016/pdf. Accessed October 23, 2009.
17. Lee VJ, Low E, Ng YY, Teo C. Disaster relief and initial response to the earthquake and tsunami in Meulaboh, Indonesia. Ann Acad Med Singapore 2005; 34:586-90.
18. Fan SW. Clinical cases seen in tsunami hit Banda Aceh: from a primary health care perspective. Ann Acad Med Singapore 2006; 35:54-9.
19. Daniels A, Chapin E, Aspilcueta D, Doocy S, Instituto Peruano de Paternidad Responsable-John Hopkins Bloomberg School of Public Health-City University of New York Study Team. Access to health services and care-seeking behaviors after the 2007 Ica earthquake in Peru. Disaster Med Public Health Prep 2009; 3:97-103.