Role of the East Avenue Medical Center in Collaborative Local Disaster Response in Preparation for "The Big One"

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This article explores the response capacity of the East Avenue Medical Center (EAMC), in relation to the possibility of a major earthquake happening in Metro Manila, and in light of the current health governance situation in the Philippines. It employs a review of literature to analyze the present health and DRRM governance system, to draw a profile of the EAMC, and to explore possible solutions that can help improve trauma care delivery in the event of a major earthquake in Metro Manila. A cursory survey is also administered to 80 health professionals working in the EAMC to ascertain their perceived disaster preparedness and role in the DRRM in the said healthcare facility. Literature review reveals that, despite the existence of pertinent laws and policies on DRRM and universal health care, certain provisions in policy, such as multilevel, multi-agency coordination in DRRM and out-of-pocket financing for funding health care, may hamper the delivery of prompt disaster response and emergency trauma care. In terms of perceived disaster preparedness and role in the DRRM, health workers in the EAMC are at least aware of the DRRM protocols in health. However, the results also indicate the need for disaster management protocols to be operationalized through active engagement among health workers in the EAMC and other agencies working in DRRM.

Keywords**:** *disaster risk reduction and management, health care delivery, emergency response policy*

The World Risk Report of 2018 placed the Philippines third among the most vulnerable countries to natural sudden-onset disasters (SOD) (United Nations Office for Disaster Risk Reduction [UNDRR], 2019). The country lies in the Pacific Ring of Fire where 80% of earthquakes occur (UNDRR, 2019). Since the Philippines is frequented by various SODs, the probability of another major SOD in the Philippines is also not a matter of where, but when. The country's average annual multi-hazard loss is estimated at USD 7.9 million, which is equivalent to 69% of the country's total social expenditure (UNDRR, 2015). Moreover, due to high levels of poverty and inequality, many communities are unable to prepare,

cope with, and recover from natural SODs (Asian Development Bank [ADB], 2009).

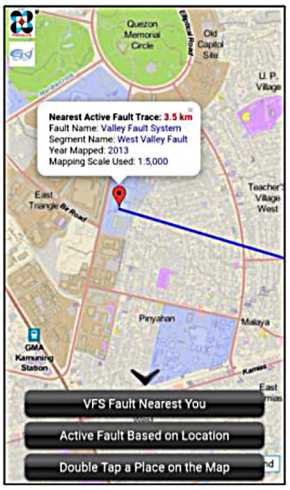
The Philippine Institute of Volcanology and Seismology (PHIVOLCS), in a joint study with the Metropolitan Manila Development Authority (MMDA) and the Japan International Cooperation Agency (JICA), selected three earthquake scenarios for detailed damage analysis: a 7.2-magnitude earthquake from the West Valley Fault, an offshore 7.9-magnitude earthquake from the Manila trench, and a 6.5-magnitude earthquake hitting Manila Bay. A major West Valley Fault movement, dubbed as "The Big One," which is believed to last at least 30 seconds based on a duration magnitude formula, is estimated to kill about 34,000 people and lead to the collapse of 170,000 residential houses (JICA et al., 2004).

The importance of pre-disaster activity has been reinforced by the International Federation of Red Cross in its first World Disaster Report, with success being largely determined by good disaster preparedness (Edwards, 2009). Therefore, all phases of emergency management begin with local jurisdictions. The collapse of structures brought on by earthquakes changes the nature of the demands for emergency medical technicians (EMTs) and local medical infrastructure is often damaged after an earthquake (Emami et al., 2005; Missair et al., 2013). Although the demand for more advanced, totally self-sufficient international types 2 and 3 EMTs[1] becomes greater when healthcare facilities are destroyed, building resilience into national health systems and strengthening response capacities of local EMTs in type 3 facilities during the pre-event status is an optimal strategy to protect populations.

Use of the FaultFinder version 9.0 developed by the PHIVOLCS locates the East Avenue Medical Center (EAMC), a type 3 hospital, 3.5 kilometers from the West Valley Fault, the nearest active fault trace (Figure 1). Therefore, when a major earthquake occurs, the EAMC would be one of the tertiary hospitals most likely to receive victims needing type 3 specialty care.

Many survivable injuries during an earthquake are orthopedic in nature (MacKenzie et al., 2017). Long bone fractures, major soft tissue injuries, and crush injuries to the extremities are predictably survivable with prompt and appropriate care (Missair et al., 2013). Development of an accurate threat analysis, which includes weighing the probabilities and consequences of various hazards, is the first step in effective emergency management at the local level (Edwards, 2009). Therefore, a review of the epidemiology of injuries after earthquakes in developing countries and evaluation of specialty care capabilities of the local community must factor in the degree of preparation by the society prior to natural SODs. International response is built upon these local efforts (Edwards, 2009).

Figure 1
Location of the East Avenue Medical Center 3.5 Kilometers from the West Valley Fault (from FaultFinder Version 9.0)



One of the key issues in addressing long-term challenges in anticipating a major earthquake in Metro Manila pertains to governance. Disaster response, which includes direct aid to earthquake victims, infrastructure reconstruction, relocation of victims displaced by the earthquake, healthcare response, and education, is mainly channeled through government bodies. Issues in governance and coordination of local disaster response and preparedness could potentially drain bureaucratic resources. Given the confusing situation on the ground in the immediate aftermath of a major earthquake, local bureaucrats may be overwhelmed by the task of delivering needed healthcare response. There is need for more studies that could help inform policy and disaster management decisions, including data on epidemiology of injuries resulting from major earthquakes and how these findings feed into disaster risk.

To determine how to best allocate resources for local healthcare response in preparation for "The Big One," this article: a) reviews the present healthcare system and bureaucratic conditions that affect disaster reduction, response, and management; b) reviews the epidemiology of injuries following earthquakes; c) proposes interventions to strengthen response capacities of local EMTs and ensure delivery of type 3 specialty care by the EAMC; and d) evaluates disaster preparedness among healthcare professionals of the EAMC. The article hopes to augment data-driven preparations by local bureaucrats tasked to deliver needed healthcare response in anticipation of a major earthquake in Metro Manila.

Review of Related Literature

Healthcare facilities are among the first to be affected after an SOD (Arbon et al., 2006). Because of the unanticipated and substantial load on hospital services in disaster situations, a well-documented and tested disaster management protocol needs to be put in place (Mehta, 2006). In a study among nurses in Hong Kong, majority of the respondents knew of the existing protocol in their workplace but only 61% reported to have read it (Fung et al., 2008). In another study, 58% of Jordanian nurses were not familiar with the disaster protocol in their workplace (Al Khalaileh et al., 2012), while in Australia, 87% of nurses knew that a disaster plan existed in their institution but 42% reported they had never read it (Duong, 2009).

When an SOD happens, healthcare professionals need to actively participate in giving immediate care to victims, assign on-site triage, and protect others from potential health hazards (Labrague et al., 2016). Some studies, however, indicate that health professionals also perform other roles such as educator, problem solver, logistical coordinator, clinician, commander, administrator, and psychosocial support provider (Yang et al., 2010; Ranse et al., 2010; Ranse & Lenson, 2012).

Given these challenges, health workers need to be equipped with knowledge and skills that allow them to alleviate disaster-related health impacts. Providing them training and capacity building during non-emergency periods may prove helpful in this regard (Labrague et al., 2016). Evidence suggests that holding mock disaster drills is one of the most preferred strategies for training healthcare workers to perform well in disaster relief (Chaput et al., 2007). First aid and basic cardiac life support training are equally essential for improving survival, limiting injury, and preventing further health complications (Labrague et al., 2016; Turale, 2014).

Institutional Mechanisms for Disaster Risk Reduction and Management

Reducing post-disaster health impacts is inextricably linked to the quality of governance. In the Philippines, disaster preparedness and response are institutionalized through the RA 10121 or the Philippine Disaster Risk Reduction and Management (DRRM) Act. The law replaced the National Disaster Coordinating Council (NDCC) with the National Disaster Risk Reduction Management Council (NDRRMC) and directed national government agencies to be more proactive in disaster risk management and disaster risk reduction. The NDRRMC is headed by the Secretary of the Department of National Defense, who is, in turn, aided by four vice chairpersons, namely, the Secretary of the Department of Science and Technology (DOST) for disaster prevention and mitigation; Secretary of the Department of the Interior and Local Government

(DILG) for disaster preparedness; Secretary of the Department of Social Welfare and Development (DSWD) for disaster response; and Director-General of the National Economic and Development Authority (NEDA) for disaster rehabilitation and recovery (Sec. 5., RA 10121).

The NDRRMC's membership also includes financial institutions, local government leagues, the private sector, and civil society organizations, to reflect a whole-of-society approach to disaster risk reduction (Sec. 2, RA 10121). The DRRM Act also mandated the establishment of local DRRM councils that replicate responsibilities of the NDRRMC (Sec. 11, RA 10121). The NDRRMC and these local councils support the local government units (LGUs) working in the front lines, and set the coordination mechanisms and policies for the private sector and civil society groups. However, most local councils are either understaffed or lacked professionalization, creating a mismatch between institutional responsibilities and LGU capacities. Difficulties of the NDRRMC to supervise all the local councils worsened these problems (Harkey, 2014). Moreover, the multi-sectoral, multi-level, and multi-agency approach to disaster response and mitigation may delay SOD response by the government (Commission on Audit [COA], 2013). Thus, the focus of capacity building on DRRM is at the local level, where actors and networks collaborate with communities to identify existing capacities as well as provide the opportunity to build infrastructure that could minimize impacts of natural SODs (Scriven, 2013).

The current health finance system in the Philippines compounds the challenges in reducing health impacts following disasters. Health expenditures are usually sourced from national and local governments, private insurance, out-of-pocket payments, and donors. The National Health Insurance Program (NHIP), managed by the Philippine Health Insurance Corporation (PhilHealth), was established in 1995 to provide the single-payer premium-based financing system for Filipinos. However, the current health care system places out-of-pocket payments as the dominant source of health expenditure. Although majority of patients confined in public and private hospitals pay for their health care expenses on their own account, out-of-pocket expenses are significantly higher among patients confined in public health facilities. In addition, amid safety nets like the NHIP, most Filipinos turn to donations from philanthropists and local or international charity organizations as major sources of health financing (Lavado, 2010).

These challenges in health governance and financing may possibly affect the capacities of health care facilities to render prompt and efficient service after major earthquakes. In particular, the collapse of health infrastructure changes the nature of demands for emergency medical personnel and other health resources (Emami et al., 2005; Missair et al., 2013). For instance, while the demand for more advanced, totally self-sufficient international type 2 and 3

emergency medical technicians (EMTs) may be greater after disasters, when most health facilities are heavily damaged, it is likewise important to build resilience of national health systems and strengthen response capacities of local EMTs in type 3 facilities early on to respond to disasters (International Committee of the Red Cross [ICRC], 2016).

A report by the Commission on Audit (COA) in 2013 found the national budget for DRRM inadequate amid the increasing costs of DRRM in the country (COA, 2013). The LGUs, in particular, have different disaster-related expenditure demands and revenue-raising capabilities, but these differences are not being considered in the allocation of resources for DRRM. Hence, the imbalance between available resources and risk exposure persists, making financial reserves and contingency mechanisms hardly available to majority of LGUs. Community participation and decentralization of responsibilities are guaranteed through the delegation of authority and resources to local levels, but present financial limitations continue to affect capacities of most LGUs for DRRM. Moreover, the occurrence of natural hazards puts a wide-ranging demand on healthcare response capacities and requires coordination, collaboration, and communication among major decisionmakers.

Burden of Injuries Following Earthquakes

Natural disasters have killed 760,000 people, injured two million, and affected more than two billion people in the last ten years (Bartholdson & von Schreeb, 2018). The Center for Research on the Epidemiology of Disasters (CRED) defines disaster as "a situation or event that overwhelms local capacity, necessitating requests to a national or international level for external assistance" (Guha-Sapir, et al., 2015, as cited in Bartholdson & von Schreeb, 2018, p. 103). Natural disasters are caused by natural phenomena, and the World Health Organization defines natural SODs, for which earthquake is an example, as disasters "for which there is little or no warning" (World Health Organization, n. d., as cited in Bartholdson & von Schreeb, 2018, p. 103).

Major earthquakes took more than 800,000 lives globally since 2000 (MacKenzie et al., 2017). In the last ten years, 350,000 people have died and more than one million people have been injured (Bartholdson & von Schreeb, 2018). As population density increases in the developing world, the chance of mass casualties caused by earthquakes are also likely to increase. Earthquakes have an estimated average death-injury ratio of 1:3-4 (Bartholdson & von Schreeb, 2018). Building damage is found to be a major cause of death and injury, especially where concrete is used and buildings are not adapted to withstand ground motion (Ramirez & Peek-Asa, 2005). Severe trauma from head injury, asphyxiation, and shock is reportedly the most common cause of mortality (Liang et al., 2001).

MacKenzie et al. (2017), who studied types and locations of injuries following earthquakes, found that 87% of the injuries requiring treatment were orthopedic in nature. Fractures accounted for 65% of the total injuries, with 60% affecting the lower extremities (MacKenzie et al., 2017). Bortolin et al. (2017) also reported that the lower extremity (42%) is the most common fracture location, followed by the spine (17%) and the pelvis (10%). Missair et al. (2013) found a global limb injury incidence of 54% in earthquake survivors, with lower extremity injuries being the most common. A study in Haiti found that children had higher surgery rate and higher percentage of femoral fractures than adults (Bar-on et al., 2013).

Orthopedics in Major Earthquakes

One outcome of major earthquakes is the shortage of resources. However, some studies highlighted that the essential surgical interventions are cost-effective even in such settings (Grimes et al., 2014; Chao et al., 2014). In any case, treatment facilities need to focus on the main burden of the disease. Disability-adjusted life years (DALYs) have been suggested as a feasible metric to estimate the burden of surgical disease (Bickler et al., 2010), and DALYs averted by surgery have been used by authors to estimate the averted burden of surgical diseases (Gosselin & Heitto, 2008).

Rodriguez-Llanes et al. (2018) analyzed systematically collected data by a tertiary care facility close to the epicenter of the 2008 Wenchuan earthquake in Sichuan, China that received injured patients within hours of the earthquake, to provide estimates of DALYs produced by earthquakes and assess how much of the burden may be averted by surgical procedures. They found the burden of surgical injuries corresponded to 10,397 DALYs. Lower leg and femur fractures, which, are the second- and eighth-most common injuries, accounted for 30% of the DALYs. Surgical management averted 42% of the burden of injury (4,379 DALYs), and corresponding percentages for lower leg and femur fractures were 48% and 69%, respectively. Comparing crush injuries with femur fractures, the two groups were relatively similar in number but surgical treatment of femur fractures averted 4.3 times more DALYs than surgery for crush injuries (Rodriguez-Llanes et al., 2018).

In the review by MacKenzie et al. (2017), 1,260 orthopedic procedures during earthquakes were reported with the following frequencies: 33% debridement, 24% closed reduction/casting, 24% open reduction and internal fixation, 12% external fixation, and 7.5% amputation. Bar-on et al. (2011) reported use of external fixation in 31% of fractures, whereas Phalkey et al. (2011) found use of external fixators in fewer than 2% of cases.

Role of the East Avenue Medical Center (EAMC)

The East Avenue Medical Center (EAMC) is a 600-bed, tertiary referral health care facility under the DOH. The EAMC is located in Quezon City, Philippines. Due to its capacity to deliver advanced trauma care, it is designated as the national trauma center. Being a public general hospital, it provides medical services to a majority of patients from various regions in the country and from different socioeconomic backgrounds. Its in-patient admissions, at present, exceeds up to 150% of the hospital's bed capacity (EAMC, 2019a). In 2014, the EAMC was certified by the International Organization for Standardization (ISO) for the delivery of medical services and training of healthcare professionals (EAMC, 2019b).

The Department of Orthopedics (DO) in the EAMC is engaged in training orthopedic surgeons who conduct relevant research, provide specialized orthopedic services, and deliver advanced trauma care. All service units are complemented with medical specialists trained in the various orthopedic subspecialties. Moreover, in line with the EAMC's designation by the DOH as training and teaching center, the DO has continually trained specialists with the ability to provide coordinated and comprehensive orthopedic care.

The DO works with the anesthesiology, internal medicine, and rehabilitation medicine departments of the EAMC. The Department of Anesthesiology has upgraded its facilities to offer sophisticated services, including ambulatory anesthesia for various diagnostic and surgical procedures and pain and emergency airway management. Likewise, the Department of Internal Medicine has housed internists of various subspecialties. It also operates the EAMC's intensive care units and provides diagnostic and quality medical care. The Department of Rehabilitation Medicine, through its modernized physical and occupational therapy programs, provides inpatient, outpatient, and teleconsultation services for patients suffering from a wide range of medical or surgical conditions.

Problems with Implant Procurement

Orthopedic implants are fixation devices applied on fractured bones to restore stability, and thereby allow early mobilization and return to pre-injury functional status. These implants come in the form of plates and screws, intramedullary nails, joint prostheses, external fixators, or spinal pedicular screw systems, to name a few. Depending on the status of the soft tissue, as with open fractures, or neurological deficits, such as unstable spinal fractures, reduction and fixation procedures using these implants may need to be performed on either elective or an emergent basis.

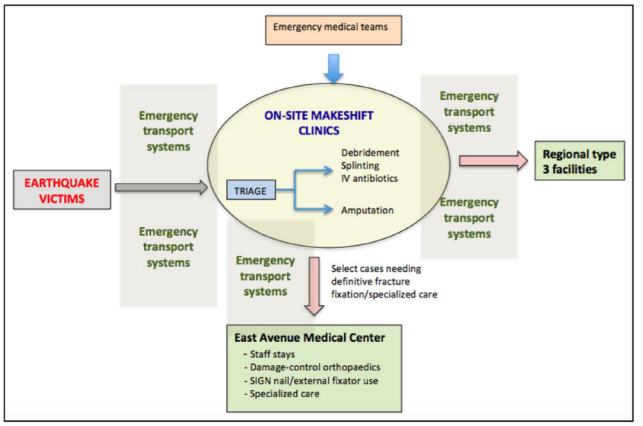
At present, the DO of the EAMC affiliates with five implant companies, offering the complete assortment of essential implants and prostheses the department needs for its trauma service delivery. While the surgeon prefers an implant company to provide the implant for a private case, all five companies follow a strict rotational decking for the charity cases. While some implant companies specialize in a particular set of surgical instruments, such as that for spine and joint replacement, most of these companies provide for the complete array of trauma surgery instruments. As implant costs are presently not covered by the NHIP, implants are provided by either out-of-pocket or public financial assistance through the Philippine Charity Sweepstakes Office (PCSO), with some being given by local companies and international organizations as donations.

The cost of an implant, considering out-of-pocket as the primary source of health financing in the country, in addition to the lack of coverage by the NHIP, is one significant obstacle to fracture care delivery by the EAMC. A commercial intramedullary (IM) nail, on the average, costs USD 650 each. SIGN Fracture Care International, a nonprofit organization based in Richland, Washington, has developed and donated an interlocked, IM prosthesis known as the SIGN nail, allowing low-cost fracture care in resource-limited settings (Carsen et al., 2015). The SIGN nails have been approved by the US Food and Drug Administration (FDA) and have shown good clinical results in small clinical series (Carsen et al., 2015). These nails are donated to affiliated hospitals like the EAMC where SIGN-trained surgeons can thereby treat fractures using intramedullary prostheses without much concern for implant-related costs (Carsen et al., 2015).

Exploring Solutions

Delivery of sound orthopedic care to most patients sustaining injuries after a major earthquake must consider the resulting lack of resources and blockade of major transport arteries within the metro. This scenario must greatly affect delivery of decisive care by medical specialists in a tertiary facility like the EAMC. In addition to strengthening response capacities of local EMTs in type 3 facilities like the EAMC during the pre-event phase, there is a need to rapidly build functional transport systems immediately post-event to facilitate bringing of victims to the nearest makeshift clinics for proper triage. The need for EMTs coming from various type 3 facilities both from abroad and other parts of the archipelago may be accommodated to ensure prompt delivery of first-line medical or surgical care as needed in the makeshift clinics, in addition to performing closed reduction, splinting, or casting of fractures.

Figure 2
Model Showing the EAMC's Plan of Delivering Prompt Orthopedic Care



Source: Author's own construction

With proper triage, cases requiring damage-control orthopedics (DCO) must receive emergency surgical treatment and administration of intravenous (IV) antibiotics in makeshift clinics adequately staffed with nurses, medical specialists, anesthesiologists, and surgeons. Through provisional emergency transport systems, patients in these cases shall be transferred to the EAMC, hopefully within a two-week period, for definitive fracture care.

Building Efficient Emergency Transport Systems

Time is a key determinant of survival in natural disasters (Ryan, 2005), as shown by data (Kaw, 2001) describing the likelihood of earthquake survivors depending on time of rescue (Table 1). Epidemiological figures from past earthquakes indicate that mortality rate depends on the total number of collapsed structures and the extent of damage, number of occupants, time of day or night, the proportion of occupants trapped in the buildings, the proportion killed outright, and the continuing deaths of trapped survivors (Ryan, 2005). Therefore, one key to reducing mortality is timely extrication.

Table 1
Time of Rescue and Likelihood for Earthquake Survivors

Time before rescue (hr)	No. of survivors	Cumulative %
Less than 1	197	84
1 to 12	26	95
12 to 24	7	98
12 to 48	3	99
More than 48	2	100
Total	235	

Source: Kaw (2001)

From a surgical perspective, late preventable deaths occur due to prolonged entrapment causing crush syndrome or sepsis developing from neglected wound contamination (Ryan, 2005). Data from the Marmara earthquake in 1999 (Sever et al., 2002) and the Bam earthquake in 2003 (Naghi et al., 2005) illustrate the enormity of the surgical challenge. The Marmara earthquake resulted in more than 17,000 dead and 43,000 injured. Among the latter, 639 (12%) presented with renal failure, while 790 victims had limb fractures. On the other hand, the Bam earthquake resulted in about 40,000 people dead and 30,000 victims injured. Injury patterns mirror findings from the Marmara earthquake, except that renal failure rate was lower in the Bam earthquake report (2.9%). This could be attributed to the shorter time period under the rubble, as 12,000 injured victims of the Bam earthquake had been airlifted on time to regional tertiary care centers (Naghi et al., 2005).

Strong earthquakes can result in many instances of flooding due to ground liquefaction and burst pipes, and many roads can become uneven due to ground movements and, in some cases, damage by major cracks. Structures may also rise relative to the road surface, creating additional solid obstacles to passage. Similarly, bridges can end up at a different level from the adjacent roads, or they may be closed immediately following a major earthquake while being checked for structural damages. Damage from the Great Hanshin-Awaji Earthquake in 1995 devastated the transportation network in Kobe, Japan, leaving the city's transportation system at less than five percent of its normal capacity (Iida et al., 2000). Such a situation alone clearly demonstrates the severity of a major earthquake's impact on traffic conditions. However, Iida et al. (2000) highlighted the use of the automobiles in both rescue and emergency aid activities right after the earthquake, despite the nearly total confusion following closures of major road arteries.

Time is of the essence in establishing emergency systems for extricating and bringing victims to nearest makeshift clinics or referral centers. Because of the importance of emergency rescue and relief activities during the period of

confusion directly after an earthquake, emergency vehicles traveling along roads that have been designated for emergency use must be given priority of passage, and the passage of ordinary passenger vehicles must be fundamentally limited even along routes not specifically designated for emergency travel. Approximately a week after the earthquake, traffic from vehicles involved in emergency relief and restoration activities may increase and, as the overall traffic conditions settle, traffic regulations that ensure the use of roads for emergency recovery traffic must be given priority (Iida et al., 2000). Even so, the anticipated volume of injured victims can overwhelm response capacities of the EAMC. Therefore, emergency air transport systems should help in prompt delivery of decisive care by nearby regional type 3 facilities.

Holding Efficient On-site Triage Systems

Earthquakes carry a low injury-to-death ratio, with approximately one death for every three injuries (ICRC, 2016). Hence, surgical response following a major earthquake can result in decreased morbidity and mortality by promptly treating wounds and fractures. Victims may also present with crush-type injuries, which can progress to crush syndrome, a clinical scenario that may require ICU care or even dialysis. With the collapse of most healthcare facilities after a major earthquake, the increase in demand for advanced, totally self-sufficient type 2 EMTs to handle on-site triage systems must hopefully be met to expedite delivery of proper care and, more importantly, reserve resources in type 3 facilities. Type 2 EMTs concentrating on surgical triage must identify those with life-threatening medical conditions, especially crush syndrome. Moreover, the EMT should be able to properly triage at least 200 cases daily and arrange referrals to type 3 facilities such as the EAMC (ICRC, 2016). Using common language in surgical triage is important for documentation and communication, particularly when arranging transfers. The categories shown in Table 2 make up a widely accepted system for triage (ICRC, 2016).

Table 2
Categories Commonly Used in Emergency Triage Systems

Category 1	Immediate medical or surgical management
Category 2	Patients who are able to wait
Category 3	Patients awaiting ambulatory care
Category 4	Patients with little to no hope of survival regardless of care delivered

Source: ICRC (2016)

Victims presenting with closed fractures uncomplicated by serious medical condition or additional injuries can be surgically triaged as category 2 and managed initially with splinting. However, closed fractures suspicious for developing acute compartment syndrome are category 1 cases and should

be managed immediately with surgical fasciotomy. Cases of infected wounds and open fractures, similarly under category 1, need to be treated with prompt administration of IV antibiotics and on-site surgical care. Patients presenting with crush syndrome must be hurriedly transferred to nearest type 3 facilities by land or air to improve survival.

Delivering Needed On-site Primary Care

Given the austere conditions following an earthquake, type 2 EMTs must be able to deliver sound—in lieu of ideal—orthopedic care. Bertol et al. (2014) reviewed orthopedic surgical activities performed in the aftermath of the 2010 Haiti earthquake and found 81% of open fracture cases were treated by amputation. They subsequently analyzed data from surgical programs by the *Médecins Sans Frontières* (Doctors Without Borders) in local hospitals in Congo, Haiti, and Afghanistan, and concluded that introduction of and training on the proper use of external fixators can increase limb salvage rates, particularly in humanitarian contexts where surgical care must be provided. In Malawi, an emergency treatment protocol for open fractures that emphasized the use of primary external fixation with other low-cost techniques was established. This protocol resulted in outcomes similar to data reported from high-income countries (HICs), such as the recovery of normal function in about 80% of patients (Bach et al., 2004). It seems that if biological principles guiding modern treatment of open fractures in HICs are respected, results from low-resource settings should not differ as much as the difference in resources might suggest.

Response teams arriving early to earthquake sites must bring a higher proportion of external fixators in their cargo and be prepared to reduce as much as 25% of open fractures by external fixation. Several authors have proven the value of external fixation following major earthquakes (Awais et al., 2014; Bertol et al., 2014; Bar-on et al., 2011). Compared with internal fixation, external fixation reduces the risk of operative infection, minimizes operative time, and is technically easier to perform when intraoperative imaging is absent (Awais et al., 2014). Moreover, in the immediate aftermath of a massive earthquake, it may be impractical to pursue definitive internal fixation, and DCO is a sound approach until definitive fixation is performed in a type 3 facility like the EAMC. Hence, type 2 EMTs providing surgical care in makeshift clinics must focus on hemorrhage management, wound debridement, infection control, and soft tissue stabilization. External fixation, in addition to surgical debridement and irrigation, is key to proper management of open fractures and soft tissue stabilization in the acute austere setting, such as earthquake disaster situations (Awais et al., 2014). In addition, Lebel et al. (2011) found that the use of external fixation and, when necessary, amputation, as strategy for DCO allowed fractures to be definitively addressed later by more sufficiently staffed and supplied treatment teams. The strategy also allowed patients to be transported to better-equipped type 3 facilities.

Enhancing Capacity for Tertiary Care

In the Haiti earthquake of 2010, the Israeli Defense Force reported that it took approximately two weeks for an adequate number of treatment centers to be established to allow definitive internal fixation (Lebel et al., 2011). In the interest of sparing earthquake victims of excessive financial burden, there must be prompt response by the EAMC to allow definitive internal fixation at the soonest time possible. Implant procurement becomes a rate-limiting step in low-resource settings like the Philippines, but timely definitive internal fixation is possible and sustainable for cases of femoral and tibial fractures, with implant donations such as the SIGN nails (Carsen et al., 2015).

Most orthopedic injuries following a major earthquake are fractures in the diaphyseal region of the femur and tibia (Ramirez & Peek-Asa, 2005). Therefore, approximately twice as many femoral and tibial orthopedic implants must be supplied to type 3 facilities near earthquake disaster zones to be able to perform secondary internal fixation of fractures treated by DCO. In particular, tibial orthopedic implants are most needed, since the tibia is the most commonly fractured bone in earthquake victims (Emami et al., 2005; Phalkey et al., 2011). Bozkurt et al. (2007) noted that 84% of tibial fractures incurred after the 2005 Pakistan earthquake involved the middle and distal shaft, as opposed to the proximal third or tibial plateau. Hence, type 3 facilities may be faced with peak volumes of tibial fracture cases in the aftermath of a major earthquake. Most of these cases may be amenable to intramedullar (IM) nailing. Keeping partnership with the SIGN Fracture Care International may ensure supply of the lower-cost SIGN nails at the EAMC and guarantee definitive secondary IM nailing of fractures referred by type 2 EMTs performing DCO in various disaster zones. However, it may be prudent to consider primary external fixation or amputation for cases in which SIGN nails are inapplicable, if only to provide timely and affordable care to poor earthquake victims as needed.

Lastly, the EAMC and other type 3 facilities must encourage its staff to stay at work to protect the patients (Edwards, 2009). To do so, administrators of tertiary care facilities must provide the staff with guidance on family preparedness and self-sufficiency. In the post-Katrina New Orleans, people left work to care for their own family members first (Cooper & Block, 2006), and there is reason to believe that such reaction is not unique. A 2003 survey on Hawaiian medical personnel showed only 25% of them planned to stay at, or return to, work amid a catastrophic disaster (Lanzalotti, 2003).

Perceived Disaster Preparedness at the EAMC

Despite benefiting from facility upgrades and obtaining national and international accreditation, the EAMC has yet to ascertain whether it is truly

prepared for SODs, such as the "Big One." This section presents the highlights of a cursory survey on disaster preparedness conducted in the said hospital from 12 April to 7 June 2021. Descriptive, cross-sectional research design was used for the survey. The questionnaire administered to the respondents was adapted from the disaster preparedness questionnaire prepared by Fung et al. (2008), later modified and validated by Labrague et al. (2016). Respondents of the study were mainly medical doctors, nurses, and rehabilitation medicine therapists working in the EAMC. They were selected through convenience sampling.

A total of 94 healthcare professionals were invited to participate in the survey. The healthcare professionals were personally approached in their workplaces and asked if they are willing to participate in the study. To be eligible to participate, healthcare professionals needed to be (a) regular or full-time employees, (b) working at the EAMC, and (c) sufficiently informed about the study, having signed a consent form. The questionnaires were dispersed at the respective sites and collected in a sealed envelope upon completion. Code numbers instead of names were used to maintain confidentiality and anonymity of the respondents. Of those invited to participate in the survey, 80 (85%) responded.

Data were collected over a period of two months (12 April to 7 June 2021) and analyzed using SPSS version 21.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were obtained to analyze the participants' responses.

The participants' baseline characteristics are described in Table 3. Majority of the respondents were medical doctors (n=42, 52.5%), while the rest were nurses (n=22, 27.5%) and rehabilitation medicine therapists (n=16, 20%). More than half (51.2%) were female (n=41, 51.2%), while 67.5% were not married. Majority belonged to the 26- to 35-year-old age group (n=57, 71.3%), and more than half of the participants have been working at the EAMC for 1-5 years (n=45, 56.3%). More than half were doctors, while around a quarter were nurses. Some (20%) were physical/occupational therapists.

Table 3
Respondents' Characteristics

Variable	N	%
Age in years		
18-25	2	2.5
26-35	57	71.3
36-45	15	18.8
46-50	6	7.5
Sex		
Male	39	48.8

Female	41	51.2
Marital Status		
Not Married	54	67.5
Married	26	32.5
Years of experience in healthcare profession		
1-5	45	56.3
6-10	18	22.5
11-15	9	11.3
>15	8	10
Current profession		
Doctor	42	52.5
Nurse	22	27.5
Physical/occupational therapist	16	20

**Note.* Respondents answered more than once.

Disaster Preparedness at the Organizational Level

The respondents were generally aware that the EAMC had disaster management protocols in place (77.5%). However, only more than half of them actually participated in disaster management initiatives (56.3%).

Meanwhile, most of the respondents point to the DOH (76.3%), the NDRRMC (71.3%), and the Philippine Red Cross (63.7%) as most involved in disaster situations. These perceptions support the observations of Arbon et al. (2006) regarding healthcare institutions being at the front line during disasters.

Table 4
Perceived Own Disaster Preparedness

	N	%
*Organizations most involved in disastrous situations**		
Department of Social Welfare and Development	29	36.3
Philippine Army	15	18.8
Philippine Red Cross	51	63.7
DOH	61	76.3
NDRRMC	57	71.3
Philippine National Police	27	33.8
Bureau of Fire Protection	43	53.8
City Government Disaster Unit	44	55
Philippine Navy	17	21.3

Philippine Coast Guard	15	18.8
Awareness of available protocol for disaster management at workplace		
Yes	62	77.5
No	1	1.2
Don't know	17	21.3
Participation in a disaster management activity at workplace		
Yes	45	56.3
No	27	33.8

**Note.* Respondents answered more than once.

Individual Preparedness and Role in Disaster Preparedness

Majority (56.3%) of the respondents claimed they are "somewhat prepared" when an SOD occurs. However, a considerable number (36.3%) felt they were "somewhat unprepared" (Table 5). Interestingly, only one (1.2%) respondent claimed to be "fully prepared" when an SOD happens. These findings agree with that of other studies (Al Khalaileh et al., 2012; Fung et al., 2008; Jiang et al., 2015).

Table 5

Perceived Own Preparedness and Role in Disaster Preparedness

	N	%
Perception of own preparedness		
Totally unprepared	5	63
Somewhat unprepared	29	36.3
Somewhat prepared	45	56.3
Fully prepared	1	1.2
*Perception of role in disaster preparedness**		
Educator	66	82.5
Researcher	29	36.3
Caregiver	52	65
Coordinator	36	45
Manager	24	30
Counselor	29	36.3

**Note.* Respondents answered more than once.

Most (65%) of the respondents believed that they are caregivers in the event of disasters, corroborating the findings of Labrague et al. (2016) and confirming the main role of health care workers in disaster situations. However, more (82.5%) perceived that they are mainly educators, especially in pre-disaster situations.

Learning Needs for Disaster Preparedness

Most of the participants believe that a disaster management protocol (n=72, 90%) by the hospital must be developed, publicized, and well-implemented to improve disaster preparedness among the hospital staff (Table 6). Majority also cited specific practice drills (n=69, 86.3%), completion of a disaster management course (n=59, 73.8%), and informational pamphlets (n=48, 60%) as important learning needs for disaster preparedness.

Table 6
Learning Needs in Relation to Disaster Preparedness

	N	%
*Materials needed for disaster preparedness**		
Drills	69	86.3
Disaster management protocol	72	90
Disaster management course	59	73.8
Informational pamphlets	48	60
Informational website	35	43.8
Onsite visit	26	62.5
*Educational courses that should be taken**		
First aid	71	88.8
Field triage	67	83.8
Basic life support	70	87.5
Advanced cardiovascular life support	61	76.3
Prehospital trauma life support	61	76.3
Advanced trauma care for nurses	63	78.8
Advanced trauma life support	61	76.3
Infection control	50	62.5
Peritrauma counseling	59	73.8
Post-traumatic psychological care	65	81.3

**Note.* Respondents answered more than once.

When asked about what educational courses should be taken to prepare for SODs, first aid (n=71, 88.8%), basic life support (n=70, 87.5%), field triage (n=67, 83.8%), and post-traumatic psychological care (n=65, 81.3%) were deemed the most essential (Table 6).

Based on the survey findings, it is implied that the health professionals in the EAMC are aware of the role of the health facility and other agencies in responding to disasters and managing disaster risks. The findings also show

that the health workers are aware of their own role in DRRM. However, granted a disaster management protocol is in place in the EAMC, practical application needs to be improved among the staff.

DRRM readiness is most crucial in the EAMC departments mandated to deliver healthcare in the aftermath of major disasters. These departments need to consider the resulting lack in resources and structural impediments in delivering prompt trauma care. In addition to strengthening response capacities of local EMTs in type 3 facilities like the EAMC during the pre-event phase, there is a need to rapidly build functional transport systems during the immediate post-event to facilitate bringing of victims to the nearest makeshift clinics for proper triage. The need for EMTs coming from various type 3 facilities from within the country and abroad may be accommodated to ensure prompt delivery of first-line medical or surgical care as needed in the makeshift clinics. Proper triage of medical emergencies will facilitate immediate response and treatment of injuries after SODs before transport to the nearest health facility for definitive treatment.

Study Limitations

While the results of the present investigation are important, the study is not without limitations. First, the use of convenience sampling may have weakened the generalization of results. Second, the investigation could be duplicated in other tertiary healthcare institutions to recruit more representative samples. Finally, data were collected from only one country (Philippines). Thus, caution must be observed when comparing present results with those of other countries.

Conclusion

This study assessed the current DRRM and health governance situation in the Philippines and disaster preparedness among healthcare professionals working at the EAMC. The current DRRM governance structure in the Philippines acknowledges the predominant role of key players from the academe and civil society organizations. However, medical institutions like the EAMC can complement knowledge on post-earthquake activities by the national and local DRRM councils with their technical expertise. By putting up on-site makeshift clinics, delivery of prompt and decisive care to earthquake victims presenting with major musculoskeletal injuries at the EAMC can be facilitated. Building functional transport systems during the immediate post-event can ensure timely extrication and transfer of victims to the nearest makeshift clinics. Moreover, by proper triage, it is possible for victims of SODs requiring damage-control orthopedics (DCO) to receive emergency surgical treatment and administration of IV antibiotics on-site at these makeshift clinics. Some patients can be

transferred to the EAMC following initial treatment in the disaster zones for definitive specialized care.

Key governance issues, such as coordination between multiple agencies working in DRRM and health, as well as response capacities of key agencies working in the front line especially in times of SODs, need to be addressed through policy. A possible centralization of disaster response and relief efforts under a single agency, i.e., the NDRRMC, may be explored vis-à-vis devolution of DRRM efforts to LGUs. Meanwhile, policymakers working on public health funding systems may explore alternatives to the out-of-pocket funding that will alleviate the burden on the patients needing emergency care, particularly those in the marginalized sector. Meanwhile, the EAMC needs to ensure the applicability of its disaster management plan. In particular, the protocol needs to delineate definite areas for involving the management and staff, as well as other agencies working in DRRM.

Endnote

[1] Type 2 EMTs identify those with life-threatening medical and obstetric presentations, and arrange referrals to higher levels of care. Type 3 EMTs stay in type 3 hospitals and reserve resources for referral from other facilities (ICRC, 2016).

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