RESPONSE IN MASS CASUALTY INCIDENTS: SURVIVAL OF SELECTED TERTIARY LEVEL HOSPITAL IN BANGLADESH

A Dissertation for the Degree of Masters in Disaster Management

By

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Finally, I am deeply indebted to my beloved wife Dr. Abida Sultana (Mila) for her immense moral supports towards me, and my sons Abyaz Abid and Ashahab Munif who have brought good luck for me from the Almighty.

Abstract

An effective and immediate response from hospital personnel is critical to meet the needs of affected populations at the time of an disaster. Hospitals need to develop, practice and continuously update an effective disaster/emergency medical response plan. Communities and impacted regions cannot depend on immediate medical and humanitarian aid from other outside sources to meet medical care needs during the first three to five days following a mass casualty incident. How hospitals in disaster-prone countries like Bangladesh can improve their medical response is discussed.

To find out the resilience of a tertiary level hospital in Bangladesh to combat mass casualty incidents, Kurmitola General Hospital was selected and study was carried out. This study was a cross-sectional questionnaire survey. The administrator, engineers and in charge of the Emergency & Casualty department were interviewed. The hospital was visited to verify the selected questionnaire response by a checklist. Among all the tertiary level hospitals "Kurmitola General Hospital" was selected. It is the most recently constructed tertiary level general hospital in Bangladesh. So it is expected that disaster survival and disaster support elements and structures are well formulated in this hospital. This study was conducted from January 2017 to September 2017. The WHO guideline was followed to find out resilience of Kurmitola General Hospital.

Hospital Safety Index (HSI) for this hospital was included with 162 items, which included structural, non-structural and functional capacity. Hospital safety was classified to three safety classes: low (≤34.0), average (34.01–66.0) and high (>66.0). Structural safety of this hospital was 100%, nonstructural safety was rated as 78%. But functional safety which included the managerial aspects was 37% only. Which demands more emphasis to be given on hospital disaster planning, training of personnel and coordination with other stakeholders.

Same type of survey for all the tertiary level hospitals of Bangladesh and forwarding a consolidated report to the competent authority for further planning is recommended.

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Chapter 1

Introduction

1.1 Background

The World is exposed to adverse phenomena. These are cyclone, floods, earthquakes, wildfires, volcanic eruptions, chemical incidents, terrorist attacks, violence against health workers patients and health facilities, and outbreak of disease. Disaster cause proportionately more damage to developing countries and the poorest communities because of different levels of vulnerability and capacities in the two communities (WHO, 2015-b).

No one discuss the aftermath of a disaster. It's almost as if, once the disaster is over, everything goes right back to normal. Anyone who has ever been involved in a major mass casualty event knows that's not true. Sure, the worst is over. The hospital has survived the onslaught of the patient influx surge. There are so many things to do, and so many obstacles to overcome. It is more a question of long-term survival than it is of bracing for the impact (Goldschmitt, 2009).

Health facilities, especially hospitals, are critical assets for any community. Those are especially important in response to emergencies, disasters and other crises. Hospitals and health workers are often among the major casualties of emergencies. As a result health services cannot be provided to the affected communities when they are most needed (WHO, 2005-a). Destruction of or damage to a hospital may result in a loss of trust in local authorities as well as exposing patients and health workers to further vulnerabilities. Acts of violence, including direct attacks, have increased the threats to the security of hospitals, health workers, patients and health services.

The scale of damage to health facilities ranges from a single critical hospital to many health facilities. In September 2009, floods caused the evacuation of patients and shutdown of

critical services in Burkina Faso's main hospital in the capital Ouagadougou. Health services for millions of people have been affected by damage to and destruction of thousands of health facilities in Gujarat, India 2001 (Bemer, 2003), in Indonesia's northern Aceh province (2004), in Pakistan 2005 (Smith et al., xxxx and Chapin et al., 2009) and in Myanmar (2008). More than 11 000 health facilities were damaged or destroyed by the earthquake that struck China on 12 May 2008. Typhoon Haiyan in the Philippines damaged some 432-health facilities in 2013. During the three-week Gaza Strip emergency in 2008-2009, 16-health staff was killed and 25 injured while on duty, and 15 hospitals, 41 primary health centers and 29 ambulances were damaged.

It was Friday, Nov 13, 2015. At 2130 h, Assistance Publique-Hôpitaux de Paris (APHP) was alerted for an explosion just outside Paris. Within 20 min, there were shootings at four sites and three bloody explosions in the capital. At 2140 h, a massacre took place and hundreds of people were held hostage for 3 h in Bataclan concert hall. The APHP crisis unit was able to coordinate 40 hospitals, the biggest entity in Europe with a total of 100000 health professionals, a capacity of 22000 beds. The activation of the "White Plan" (by the APHP Director General), mobilization of all hospitals, recalling staff, and releasing beds was confirmed by 2234 h. The concept of the "White Plan" was developed 20 years ago, but this is the first time that the plan has been activated (Hirsch et al., 2015).

After that terrorist attack in Paris, France was hit again by terrorism in the city of Nice on July 14, 2016. At 2233 h, a 19-ton cargo truck crashed into crowds gathered along the waterfront to celebrate Bastille Day. Soon after that, on-site incident command officers coordinated. The prehospital triage process categorized victims into four categories and directed patients towards hospitals depending on age and severity. This process was properly achieved with only 3% of the first 234 patients requiring a secondary transfer. The first patient arrived at Pasteur Adult Hospital (PAH) at 2313 h. After the Paris attacks they did exercises including an emergency event simulation involving more than 60 actors (May, 2016). That helped to prepare them for the night of July 14 (Carles et al., 2016).

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February 26, 1993 brought the initial attack on World Trade Center of USA and marked the beginning of a new era of terrorism of mass killing the civilians for the purpose of a fundamentalist religious military strategy. Terrorists were able to load 1,500 pounds of explosive along with three tanks of compressed hydrogen gas hidden in the center of containers of nitroglycerine. Twin tower were the work place of some 50,000 people. The explosion blew a hole of five stories high. Six people were killed. The attackers were disappointed in the outcome. Eight years later, they kept their promise with a tragic consequence (Bonvino, 2009). September 11, 2001, was a cool, crisp morning. 9/12/16 within few minutes two plane had hit the World Trade Center (WTC) of New York. Nearly 1200 to 1500 patients came in waves to NYU Downtown Hospital. The field Emergency Medical Services (EMS) Command had informed the hospital that they felt a 50% mortality rate would be. The entire hospital is only 146 beds, a tiny place and there was not a plethora of staff. The ED received 40 times of regular patient flow. The hospital lost gas, stream for sterilization, communication and was covered in a dust of the destroyed twin tower. Despite all those odds, the mortality rate was 8%, not the 50% expected. The success was unprecedented. This major accomplishment was due to the training the hospital had received in Incident Command and Disaster management (Privitera, 2009 and Goldschmitt, 2009). Believe it or not, within ten minutes they got all the supplies that they asked. They were waiting for the first ambulance to come. After all they had a lot of practice at this kind of thing. Immediately after the terrorist attack, a huge cloud of grayish-white dust cascaded toward the hospital. But, was the cloud toxic? Were they risking the entire hospital? Then who would treat the patients? (Privitera, 2009).

Disaster medical response is a historically necessary function in any society. These range from response to natural disasters, to the ravages of warfare, and most recently, to medical response after terrorist acts. Our current disaster response systems are largely predicated on military models derived over the last 200 yrs. Their hallmark is a structured and graded response system based on numbers of casualties (Dara et al., 2005).

When Hospital Itself is in Disaster: An effective and immediate response from hospital personnel is critical to meet the needs of affected populations at the time of MCI. Role of local hospitals is very crucial during the first three to five days following a disaster (Smith et al., xxxx).

It was Saturday, February 15, 2003. CBC news broadcasted that, a mysterious illness, an atypical pneumonia, had afflicted over 300 people in Asia (CBC, 2003). Soon the illness had a name: Severe Acute Respiratory Syndrome (SARS). On February 23, 2003, an airliner touched Toronto. Onboard was a 78-year-old women, came after a visit from Hong Kong. The lady was admitted to a hospital and died on March 5. Her 44-year-old son started feeling unwell and passed away after six days. Over the next few days, the illness spread to other patients and health care workers with in the Scarborough Grace Hospital. The illness spread to other hospitals in the greater Toronto area (Booth et al., 2003). SARS was a tragedy. The only thing that saved North America from a worse disaster was the courage and sacrifice and personal initiative of the nurses, the doctors and the paramedics. They made a protocol at their own. Triage the patient into three groups. Nurses lived with a fear that they would die or infect their families with a fatal disease (Jakubowski, 2009). The majority (93.5%) of the patient in that cohort survived (Booth et al., 2003).

The Spanish Flu outbreak of 1918-19 was the worst pandemic in modern times. An estimated 17 million people died in India, about 5% of India's population of that time. Almost 22% of troops of Indian Army died. It is estimated that about 2 to 5 percent of the global population died (McGlown and Robinson, 2009).

During the worldwide pandemic influenza attack, the schools were closed, universities instructed to run the online academic classes and markets were restricted by government order in many countries. But if it would be equally applicable for the hospitals, what would be scenario (McGlown and Robinson, 2009).

Chapin et al., 2009 cited in (Smith et al., xxxx) stated, the 2005 Pakistan earthquake (7.6 magnitude) left only 32% of the health facilities functioning. The Marmara region of Turkey in 1999, the damage was devastating to 26% of the hospitals. In Bam, Iran, during 2003 nearly all health facilities in the surrounding area were destroyed. Approximately half of the local health staff were died or missing.

An unprecedented public health response was critical when an earthquake struck Haiti on 12 January 2010. Most common medical problems were traumatic injuries from earthquake and exacerbation of chronic disease due to lack of access to healthcare (APHA, 2010). The injury toll was 310,928 in Haiti. (CNN, 30 March 2010).

Scenario: December 11, 2016: Just two days before I started writing the research proposal. On December 11, 2016, I received following news notification from BBC.

a. A suicide car bomber has killed at least 16 people and dozens of others were injured in the Somali Capital Mogadishu (BBC-a, 2016).

b. A bombing near the Coptic cathedral in the Egyptian capital Cairo has killed at least 25 people. Dozens of others were injured (BBC-b, 2016).

c. A twin bomb attack on police officers outside a football stadium in Turkey's largest city, Istanbul, has killed 38 people and injured many more (BBC-c, 2016).

d. At least 60 bodies have been recovered from a church that collapsed in the southeastern Nigerian city of Uyo (BBC-d, 2016).

These all were manmade mass casualty incidents that occurred with a difference of few hours around the Globe. In addition to these, natural disasters also exist. Like the natural disasters we cannot stop the terrorist attacks. But what we can do, that is effort to reduce damage by timely effective measures.

There is a growing concern about possible terrorist use of chemical or biological weapons against civilian populations. The need for concern is illustrated graphically by the sarin nerve gas attack in a Tokyo subway in 1995 (Wetter et al., 2001). The 1984 incidence in Oregon where a deliberately contaminated salad bars with *Salmonella typhimurium, causing 751* cases of gastroenteritis (Torok et al., 1997). Although such incidence have not occurred in our country. The more emphasis to be drawn in light of grenade attack of 21 August 2002, the Holi-Artisun attack in 2016 and so many terrorist attack including incidental chemical leakage and accidental biological poisoning.

1.2 Statement of the Research Problem

Continuous improvement of medical responses by health care facilities and government agencies across the world is critical to reduce the impact of mass casualty events on citizens. This paper will focus on the present status and capabilities of selected tertiary level hospital in Bangladesh in respond to mass casualty events. In describing mass casualty events the author elected to focus on both natural and manmade hazards.

1.3 Research Question

What is the present state of Kurmitola General Hospital in combating the mass casualty from any type of natural or manmade incidents as well as its own survival capacity?

1.4 Objectives

1.4.1 Overall Objective: To assess the existing administrative, infrastructural, physical, training and medication resources at tertiary level hospital in selected area of Bangladesh for managing the victims of mass casualty incidences.

1.4.2 Specific Objectives: The present study was conducted in order to achieve the following specific objectives.

1) To make an initial assessment of Kurmitola General Hospital about whether or not the hospital will be able to function in the immediate aftermath of emergencies and disaster.
2) To make a standard criteria which will be a common basis for reviewing the safety and needs of other tertiary hospitals in Bangladesh.
3) To find out the strength and weakness of Kurmitola General Hospital regarding

its capacity to manage emergencies and disaster.

4) Recommend to improve hospital safety and preparedness.

1.4.3 Ultimate Objective: It is expected that the findings of the study will help enhancing understanding the present state of the referral hospitals of Bangladesh to manage mass casualty incidences. Thereby guide disaster planners and medical administrators in effective hospital incidence management.

1.5 List of Variables

There is a clear need for information about current hospital preparedness for natural disasters and terrorist attacks, to provide a foundation for systemic planning, relative costs, probable effectiveness and over all societal priorities (Wetter et al., 2001). Considering this the list of the variables are stated below. It is worthwhile to mention that lot of other variables are included in these broad headings.

1. Hazards affecting the safety of the hospital and the role of the hospital in emergency and disaster management
    - 1.1 Geological hazards
    - 1.2 Meteorological hazard
    - 1.3 Hydrological hazards
    - 1.4 Climatological hazards
    - 1.5 Biological hazard
    - 1.6 Human made hazards
    - 1.7 Societal hazards
    - 1.8 Biological hazard
    - 1.9 Properties of hospital soil
2. Structural Safety
    - 2.1 Prior events affecting hospital safety
    - 2.2 Building integrity
3. Nonstructural Safety
    - 3.1 Architectural safety
    - 3.2 Infrastructure protection, access and physical security

3.3 Electrical systems

3.4 Telecommunications systems

3.5 Water supply system

3.6 Fire protection system

3.7 Fuel storage systems (e.g. gas, gasoline and diesel)

3.8 Medical gases systems

3.9 Heating, ventilation, and air-conditioning (HVAC) systems

3.10 Office and storeroom furnishings and equipment (fixed and movable)

3.11 Medical and laboratory equipment and supplies used for diagnosis and treatment

3.12 Equipment and supplies

4. Emergency and disaster management

4.1 Coordination of emergency and DM activities

4.2 Hospital emergency and disaster response and recovery planning

4.3 Communication and information management

4.4 Human resources

4.5 Logistics and finance

4.6 Patient care and support services

4.6 Patient care and support services-cont.

4.7 Evacuation, decontamination and security

5. Emergency management of Chemical and Biological Incidents

5.1 Availability of PPE (personal protective equipment)

5.2 Availability for Nerve agents

5.3 Availability of medicine for Biological agents

1.6 Operational Definitions

Mass Casualty

A mass casualty is any event in which the number of victims is large enough to overwhelm available resources, disrupting normal emergency and health care services. This is based on other possible components: Number of ambulances minus the number of ambulances out of service or on other duties. Number of available qualified personnel. Personnel

efficiency. Number of appropriate hospital beds, minus the number of beds occupied by patients. Communications system capacity (DGHS, 2010).

Tertiary Level Hospital

(i) All government and private medical college hospitals, centers and institutes.

(ii) All CMH of respective area.

(iii) Few specialized hospitals in Dhaka city.

Survival

It is hospital disaster resilience. Which can be defined as "the ability of hospitals to resist, absorb, and respond to the shock of disasters while maintaining and surging essential health services, and then to recover to its original state (Zhong et al., 2014).

1.7 The Importance of the Study

Bangladesh is a disaster prone country. By and large terrorist attack is an emerging issue. More over manmade incidents like building fire, building collapse, chemical leakage, road rail and water craft accidents are very common. All these creates a huge burden on health services specially emphasizing on the hospitals. More particularly the tertiary level hospitals. WHO has given a tabulated format to evaluate all hospitals. But so far no complete evaluation has been conducted in any of the hospitals in Bangladesh. With this survey we can assess the present status of one of the newly constructed tertiary level hospital. That will help our health planners as well as the hospital administrators to manage future mass casualty incidents in an efficient way.

Chapter-2

Literature Review

2.1 Hospitals and the community

In view of disaster perspective WHO recommends the following objectives for hospitals (WHO, 2005):

a. to continue function before, during and following disaster.

b. to protect health workers, patients and families.

c. to protect the physical integrity of hospital buildings, equipment and critical hospital system.

d. to make the hospitals safe and resilient to future risks including climate change.

The role of hospitals can be seen in three perspectives:

a. To provide health services to their surrounding communities and catchment populations.
b. Acting as referral centers.
c. In the wider social system as critical assets in disaster risk management to promoting health and preventing actions.

For achieving all these, hospitals need wide support system from community and governments.

2.2 Hidden Cry of Hospitals

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2.3 Discussion on disaster:

MCIs may be the result of a natural disaster, such as those caused by weather and the environment, or they may be man-made including unintentional and intentional events (Table 2.1).

Table 2.1. Types of disasters (VandenBerg and Davidson, 2015)

Natural	Man-Made Unintentional	Man-Made Intentional
Cyclones	Plane crash	Biologic agents
Floods	Train crash	Chemical agents
Tornadoes	Multicar crash	Explosions/bombs
Landslides	Gas leak/explosion	Active shooter
Volcanoes	Water craft crash	Radioactive agents
Earthquakes	Building collapse	Human migration due to political or ethnical issues
Tsunamis	Building fire	
Severe weather		
River bank erosion		
Disease outbreak		

Intentional disasters are considered terrorism and may involve weapons or bombs that have the ability to produce large numbers of casualties that can easily challenge a health care system (VandenBerg and Davidson, 2015).

2.4 Discussion on Terrorist attack:

Terrorism is the war of the present for human species. By and large we recognized that most terrorist attacks in recent years have been perpetrated with conventional weapons, such as car bombs, guns, explosive devices etc (Alonso and Fuentes, 2009 and Niska and Burt, 2005). The MCI may be localized but its impact is global. Hospitals must be prepared to treat an influx of trauma cases. It also be prepared to diagnose and treat diseases caused by bioterrorism agents (small pox, anthrax, plague, botulism, tularemia and hemorrhagic fever).

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The Moving Terror, Now in Turkey:

BBC reports on 01 January 2017, at least 39 people, including 16 foreigners, have died in an attack on a nightclub in Istanbul. Another 69 people were being treated in hospital. A terrorist with a long-range weapon brutally and savagely carried out this incident by firing bullets. There were reportedly as many as 700 people in the nightclub at the time of the attack (BBC, 2017-a).

Deadly attacks in Turkey in 2016 (BBC, 2017-a and CNN, 2016):

20 December: The Russian ambassador, Andrei Karlov, was shot dead by off-duty Turkish policeman.
10 December: Twin bomb attack outside a football stadium in Istanbul kills 44 people.
20 August: Bomb attack on wedding party in Gaziantep kills at least 30 people
30 July: 35 Kurdish fighters try to storm a military base and are killed by the Turkish arm
28 June: A gun and bomb attack on Ataturk airport in Istanbul kills 41 people.
13 March: 37 people are killed in a suicide car bombing in Ankara.
17 February**:** 28 people die in an attack on a military convoy in Ankara.

Fig 1: Emergency services at Istanbul nightclub attack (Source:BBC, 2017-a).

The terrorist attacks are moving from one point of the world to another. After Pakistan, Iraq, Libya, Yemen and Syria, it is now in Turkey. No place in the world is safe now. We cannot stop the terrifying thoughts. But we can reduce the casualty by planning and preparedness.

2.5 Biological and chemical hazards

There is a growing concern about possible terrorist's use of chemical or biological weapons against civilian populations. The need for concern is illustrated graphically by the sarin nerve gas attack in a Tokyo subway in 1995 (Wetter et al., 2001). The 1984 incidence in Oregon where a deliberately contaminated salad bars with *Salmonella typhimurium, causing 751* cases of gastroenteritis (Torok et al., 1997). Though such incident did not occur in our country, more emphasis to be drawn in light of grenade attack on 21 August and heinous attack of Holly Artisum.

On Monday morning 1995, St Luke's International Hospital, a private teaching hospital in Tokyo, suddenly announced emergency call. ED overwhelmed with a sheer number of walk-in patients from a Sarin gas attack. That was the real hell on earth. More than 640 voictims sought care at St Luke's International Hospital. More than 5,500 people in entire

Tokyo area required emergency medical care (Taneda, 2009 and Okumura et al., 1998). Sarin is a powerful neurotoxic agent. “Cult group” conducted the attack. This group had cultured and experimented with botulinum toxin, anthrax, cholera and Q-fever (Taneda, 2009). This was completely a new experience to the hospital staffs. Immediately after the assumption, the hospital administration distributed the handwritten handout to all staff, about the modalities of treatment.

Planning for chemical attacks is similar to that for biological attacks and ahead of nuclear-radiological exposures (Niska and Burt, 2005).

2.6 Role of hospitals in MCI

Planning, practice, and debriefing are essential to meet the demands an MCI places on a health care facility and community. Because of the frequency in which they respond to MCIs, the US military has developed standardized response protocols as has Israel, which relies on national standard templates (VandenBerg and Davidson, 2015).

Any Hospital can experience a severe occurrence that can prevent it from continuing its normal operations. This can range from a Flood, Earthquake, Tsunami, and Tornado, Cyclone to fire. The management of the hospital has a responsibility to recover from such incidents in the minimum amount of time, with minimum disruption and at minimum cost. This requires careful preparation and planning.

2.7 Hospital preparedness and planning

Hospital resilience is a comprehensive concept derived from existing disaster resilience frameworks. It has four key domains: hospital safety; disaster preparedness and resources; continuity of essential medical services; recovery and adaptation (Zhong et al., 2014-a). US department of Health and Human Services indicates three key components of emergency preparedness for hospitals. The priorities were improving surge capacity, providing supplies for hospitals and related education and training (Smith et al., 2016).

2.8 Survival of hospitals on MCI

Managing the catastrophic mass casualty, hospitals to be prepared with 72 hours of in-

house capabilities (Suner, 2015, Smith et al., 2016 and Knotts et al., 2006) identified the factors that determine the survivals of a hospital are:

a. Surge capacity
b. Simple Triage and Rapid treatment (START)
c. Transport of victims
d. Link with resources outside of its own.
e. Supplement the medical and support staff.
f. Pre-planning.
g. Adequate supply of medical consumables.
h. Early warning system
i. Response time
j. Community empowerment and participation
k. Number of trained and dedicated clinician.

2.9 Hospital surge capacity

Hospitals should incorporate "surge" capacity in their planning (Smith et al 2016) states that a relatively small number of injured persons can create a surge and overwhelm the normal capacity of a hospital even if the facility is not damaged by hazards like earthquake or terrorist attack.

2.10 When Hospital Itself is in disaster

An effective and immediate response from hospital personnel is critical to meet the needs of affected populations at the time of MCI. Role of local hospitals is very crucial during the first three to five days following a disaster (Smith et al., 2016).

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Chapin et al. 2009 cited in Smith et al., 2016 stated, the 2005 Pakistan earthquake (7.6 magnitude) left only 32% of the health facilities functioning. The Marmara region of Turkey in 1999 (7.4 Richter), the damage was devastating to 26% of the hospitals. In Bam, Iran (6.6 Richter), during 2003 nearly all health facilities in the surrounding area were destroyed. Approximately half of the local health staff were died or missing. Compared to the above, Peru fared relatively well after the 2007 Ica earthquake (7.9 Richter). Sixty percent of the health facilities reported some damage. But nearly all (97%) facilities provided service within 48 hours following earthquake. Chapin et al. 2009 found that "Response plan" were an important factor in the ability to provide service immediately. Their findings also suggested that health facilities in disaster- prone areas should invest in developing and implementing disaster response plans in order to improve health service provision capacity during disasters.

An unprecedented public health response was critical when an earthquake struck Haiti on 12 January 2010. Most common medical problems were traumatic injuries from earthquake

and exacerbation of chronic disease due to lack of access to healthcare (APHA, 2010). The injury toll was 310,928 in Haiti. (CNN, 30 March 2010).

2.11 Hospital contingency plan: Why and when required

Contingency plan is an alternative action plan for emergency through which any organization can combat with the emergency effectively to reduce the impact of hazards. (DGHS, 2010). A plan for backup procedures, emergency response, and post-disaster recovery.

A good disaster management plan should have some characteristics as follows:

1. Compliant with the goal & objectives of the organization.
2. Specific, realistic & information based.
3. Flexible
4. Ensuring optimum utilization of local resources.
5. Need based
6. Continuation & relevance in different steps of planning.
7. Self-evaluating
8. Relevant to implementation capacity of the organization.

It is essential that all related personnel of every department of the hospital participate and go through a thorough discussion before developing any contingency plan for the hospital. The kinds of disaster in a particular area and its probable impacts, the vulnerability of the hospital building, number of hospital beds, and availability of other resources like water, electricity and gas supply during a disaster must be kept in consideration while developing the plan. The plan should be finalized after consulting with the related institutions like the fire service and civil defense, gas supply authority, water supply authority, blood donation center, police, scouts, girl's guides, etc. (DGHS, 2010. DGHS-a, 2010. Smith et al., 2016. VandenBerg and Davidson, 2015).

2.12 Triage system

The development of triage in the 1790's, by Baron Dominique Jean Larrey, Surgeon in Chief to Napoleon's Imperial Guard 10, for rapid evacuation and field surgical care which

started in WW-II and was further refined in the Vietnam and Korean wars are important links in Disaster Medical Management (Suner, 2015).

2.13 Weapons of mass destruction (WMD)

The Defense against Weapons of Mass Destruction Act of 1996 in USA (created by senators Nunn, Luger and Domenici), which established first responders training for WMD. It was an important turning point in disaster medicine after the use of Sarin by terrorists in the Tokyo subway system in 1995 (Suner, 2015 and Goldschmitt, 2009). Hospitals would be among the first institutions affected after deployment of a weapon of mass destruction (Niska and Burt, 2005).

2.14 Historical importance of hospitals in mass casualty management

Disaster medical response is a historically necessary function in any society. These range from response to natural disasters, to the ravages of warfare, and most recently, to medical response after terrorist acts. Our current disaster response systems are largely predicated on military models derived over the last 200 yrs. Their hallmark is a structured and graded response system based on numbers of casualties (Dara et al., 2005)

a. Iranian earthquake,

b. Haiti earthquake.

c. Fukushima tsunami

d. Southeast Asian tsunami

2.15 Necessity of hospital preparedness for mass casualty management

Increasing urbanization world-wide and the shift of populations to coastal areas, coupled with the anticipated rise in severe weather related events secondary to climate change, there will undoubtedly be an increase in the human impact of large scale disasters in the decades to come (Suner, 2015).

The three World Conferences on Disaster Risk Reduction (DRR), held in Yokohama (IDNDR, 1994), Kobe (UNISDR, 2005) and Sendai (UNISDR, 2015), Japan, identified capacity development for DRR as one of the primary means of substantially reducing disaster losses.

We have seen with the recent Ebola epidemic in western Africa that ineffective response in one part of the world can have rippling effects throughout the world (Suner, 2015).

2.16 Pre hospital mass casualty management

Federal Emergency Management Agency (FEMA), Civilian Military Contingency Hospital System, National Disaster Medical System (NDMS), Disaster Medical Assistance Teams (DMAT) are not only the systems for disaster response for mass casualty management in United States. There are local organizations and city and state assets devoted to response as well (Suner, 2015).

To manage the mass casualty from catastrophic incidences, deployment must be swift and rapid and there must be a designated agency with authorities and capabilities to coordinate (Suner, 2015).

Arziman, 2015 stated that a safe location with easy access to the disaster zone should be chosen as Casualty Collecting Point (CCP). Proper organization of CCP is also essential for rapid flow of wounded. He also emphasized for the completion of rapid needs assessment survey and implementation of emergency action plan.

As per the manual of CDC on Blast injuries (CDC, Blast injury): the quality of pre-hospital care will affect the subsequent clinical care activities and outcome. Addressing the following issues are important:

a. Recognition of specific hazards
b. Identification patients with significant injuries
c. Effective communication
d. Expedient patient triage

2.17 Hospitals capacity development initiatives

To meet the DRR hospitals should continue capacity development programs. Capacity development is understood as, “a locally driven change process through which individuals, organizations and institutions obtain, strengthen, maintain and adapt their ca- pacities to set and achieve their own development objectives (Hagelsteen et al., 2016). The priority of patient transportation should be based on triage level and hospital capacity (Whittaker,

2015).

2.18 Mass casualty management and role of military hospitals

Throughout the history, management of large disasters was conducted by military. Indeed, the military still plays a large role in disaster response in many countries (Suner, 2015). An important unit in any country is the military. Basically, the medical personnel in military medical team have to play several roles including treatment of the patients (both at disaster site and hospital), evacuation, referring of the cases, prevention of outbreak of diseases, disease surveillance, rehabilitation, and communication linkage and infrastructure reconstruction of the disaster area. (Joob and Wiwanitkit, 2014).

2.19 Incidence command system (ICS) and its role on hospitals

ICS was first introduced in the 1970's in USA for the firefighters in the forest service (Bradt, 2003) ICS consists of effective command and control, safety, information processing and public information, liaison and operation elements (Arziman, 2015).

Incidence Command System (ICS) is the total system needed to care for a casualty from the site of an accident or incident to definitive care (WHO, 2011). It includes:

1. On-site care

2. Triage

3. Initial treatment

4. Transport

5. Referral to a definitive care center

The system is comprised of a number of elements including:

a. Transport: They are usually ambulances varying from Basic Life Support (BLS) vehicles to mobile intensive care units (MICU), through to Advanced Life Support (ALS) vehicles. It may also include air transport: either fixed wing or rotary aircraft which is yet not applicable for our country.

b. Personnel: It Includes Medical First Responders (MFR), Emergency Medical Technicians (EMT), Paramedics, Ambulance Nurses, and ambulance driver trained in emergencies.

c. Communications System: This should be a two-way system to enable information about an emergency to be transmitted and received.

d. Medical Control: This is the use of both on-line communications with a licensed and specialized physician or through off-line protocols of care to be followed when emergency personnel respond to emergency situations.

e. Equipment and Supplies: They include all the necessary tools which an Emergency Medical Technicians or emergency personnel may need during a response.

f. Legislation and advocacy.

2.20 Hospital communications network

An effective communication network is one of the key points of a successful disaster management plan (World Disasters Report 2014).

Disaster medical response is a historically necessary function in any society. These range from response to natural disasters, to the ravages of warfare, and most recently, to medical response after terrorist acts. Our current disaster response systems are largely predicated on military models derived over the last 200 yrs. Their hallmark is a structured and graded response system based on numbers of casualties (Dara et al., 2005).

2.21 Coordination among the health facilities

Hospitals should have provisions in their response plans for cooperation with appropriate outside entities (Niska and Burt, 2005). Bremer (2003) and Nanda (2008) recommended that effective disaster planning and coordination between facilities and organizations would have improved the Gujarat earthquake post-disaster medical response. On the other hand Chapin et al. (2009) noticed that after Peru earthquake in 2007, response plan helped

the hospital staff to appropriately arrange referral when care could not be provided at their facility.

2.22 Hospital accreditation and mass casualty management

In USA hospitals are required to have disaster response plans to be accredited by the Joint Commission on Accreditation of Healthcare Organizations (Niska and Burt, 2005).

2.23 Decontamination at hospitals after mass casualty incidents

After a chemical or biological attack, patients might require decontamination at the hospital if they have bypassed the firefighter or emergency medical team at the exposure site (Niska and Burt, 2005).

2.24 Hospitals and mass casualty drill

Mass Casualty Management Drill is a training exercise focusing on post disaster management and response. It is carried out in the hospital ground following an imaginary post disaster scenario to train the hospital staffs. The purpose of the drill is to strengthen the capacity of the hospital authority and its staffs to deal with post disaster management and thereby reducing casualties (DGHS-a, 2010).

Stakeholder of Hospital Based Mass Casualty Management Drill: The following is a list of the prime participants in the Drill exercise:

i. Hospital authority.
ii. Fire service and civil Defence.
iii. Scouts/Girls Guide/Community Volunteer.
iv. Power Supply Authority.
v. Police/ Traffic Police.
vi. Telephone Authority
vii. Non-Govt. Organization

There would be a team of Observers from the following departments:

i. Ministry of Food and Disaster/Disaster Management Bureau.
ii. Zilla/Upazila Administrator.
iii. Zilla/Upazila/City Corporation Health Department.
iv. Armed Forces Division

In USA since September 11, 2001, 88.4% of hospitals participated in mass casualty drill **(**Niska and Burt, 2005).

2.25 Hospital's mass casualty resources

Every hospital must be available with resources that would be useful in a MCI **(**Niska and Burt, 2005). Those may be mentioned as follows:

a. Personal protective equipment or suits
b. Critical care bed
c. Decontamination showers
d. Mechanical ventilators
e. Negative pressure isolation room
f. Antidotes

2.26 Safety of hospital's health care personnel

Incident sites specially the blast sites are dangerous (CDC, Blast injury). Especially mentionable are secondary device explosion, fire, environmental exposure or structural collapse.

2.27 Safe hospital initiative

Countries and communities need to prioritize the protection of hospitals and other health facilities from identified hazards and should ensure the physical integrity of buildings, equipment and critical hospital systems. They should ensure that hospitals are able to continue to function and provide life saving services during emergency and in their aftermath. Hospitals can be made more resilient and functional through actions. World wide over 3500 health facilities have been assessed and action has been taken to implement the recommendations (WHO, 2005). The Hyogo Framework for Action 2005-2015 (UNISDR, 2005) and Sendai Framework for Disaster Risk Reduction 2015–2030 (UNISDR, 2015) makes specific references to promote the goal "hospitals safe from disaster" by:

a. All the new hospitals are built with a level of resilience so that they can remain functional in disastrous situations.

b. Implement mitigation measures to reinforce existing health facilities.

2.28 Medico legal issues in mass casualty incidents

Medico-legal aspects of mass casualty incident management basically deal with recognizing the needs and mechanism for dealing with disaster victims and deceased in a particular situation, identifying the need of legal and ethical operational issues and the patho-physiological and security issues relating to emergency/ disaster response. The recovery of the remains of deceased after a disaster is an unpopular but unavoidable task. It is required for proper identification of the victims so that death certificates can be issued and families can continue to process through their grief. Safety Issues, psychological issue and legal issues to be considered in all phases of responses (DGHS, 2010, and DGHS-a, 2010).

2.29 Bangladesh perspective

The first responders during a disaster typically are the survivors, and local health facilities assume the primary responsibility for the health of the affected population (Chapin et al., 2009).

2.29.1 Natural Disaster: The Asia-Pacific region where Bangladesh is located has experienced 60% of the world's natural disaster (Smith et al., 2016) The earthquake may cause catastrophic damage to a majority of medical facilities, housing and road system. Like a moderate earthquake (5.7 Richter) in Sikkim of 14 February 2006 (Kaushik et al., 2006) health care facilities of Bangladesh may face real problem. Bangladesh is not experienced with earthquake like Sikkim, Iran, Pakistan, Gujarat, Peru and Turkey (Smith et al., 2016. Kaushik et al., 2006. Chapin et al., 2009).

2.29.2 Terrorist Attack: Since catastrophic events and terrorist attacks has increased across the world, particularly in areas with dense population, all health care facilities need to create, practice and implement efficient and effective disaster response planning to provide an adequate disaster response (Dara et al., 2005 and Chapin et al.,2009). In Bangladesh, healthcare is primarily a state function. While there is formal private sector medical care facilities and informal sector practitioners. That is level of care varies. Thus, attention to

mass casualty preparedness in Bangladesh needs to include military, public and private sector hospitals.

2.29.3 Common Natural and Man Made Hazards in Bangladesh:

2.22.1 Man made:

a. Fire: Nimtoli, Tampaco, Slam, Bashundhara, NTV building,

b. Building Collapse:

c. Terrorist Attack:

d. Land Slide:

e. RTA:

f. Boat Collapse:

2.22.2 Natural Hazards:

a. Cyclone

b. Tornado-

c. Flood-

d. Earthquake-

e. Epidemic out break

2.30 Integration of hospitals with national or community-wide disaster plan

In the developed countries like the USA, UK, Europe, Australia and Japan, they already have a system that integrates the pre-hospital and inter-hospital facilities. In the developing countries, we don't even have a Pre Hospital Emergency Service and our resources are minimal. But if we can integrate all available pre-hospital and hospital resources, we can make an Integrated Emergency Medical Service System (IEMSS) which will be able to manage the daily Emergencies and Disasters in an organized way. An integrated EMS system may assist in delivering good quality medical care and help manage daily emergencies and disasters in an organized way. Such a system should have the same organizational structure at national, district and local level so that there is uniformity even if the resources may vary (DGHS, 2010). On 2005, in USA 76.4% of the hospitals were integrated into community wide disaster plans (Niska and Burt, 2005).

2.31 Implementation status of international and national guideline

WHO has formulated and revised a guideline for all hospitals (WHO, 2015-b). Accordingly Directorate General of Health Services of Bangladesh has published two guide line (DGHS, 2010, and DGHS-a, 2010). But unfortunately very few hospitals use to practice the drill. The few hospitals who occasionally do the practice but do not follow the full requirement.

2.32 Hospital Safety Index (HSI)

Iran's health system has developed a Farsi edition of the Hospital Safety Index (HSI) and has integrated the related assessment program into the health information system (Ardalan et al., 2016). HSI includes 145 items categorized in three components including, structural, non-structural and functional capacity. For each item, safety status was categorized into three levels: not safe (0), average safety (1) and high safety (2). A normalized scoring scheme on a 100-point scale was developed. Hospitals were classified to three safety classes according to their normalized total score: low (≤34.0), average (34.01–66.0) and high (>66.0). The index was originated from Pan American Health Organization (PAHO) and the Latin America countries. Accordingly, following the global campaign of hospitals safe from disasters, it was extensively applied in other regions including Europe (Radović et al., 2012. Rockenschaub and Harbou, 2013).

Chapter 3

Research Methodology

To find out the resilience of a tertiary level hospital in Bangladesh in case of mass casualty incidents Kurmitola General Hospital was selected and study was carried out as per the following methodology.

3.1 Study Design

This study was a cross-sectional questionnaire survey of a selected tertiary level hospital. The administrator and the in charge of the Emergency & Casualty department were interviewed. The hospital was visited to verify the selected questionnaire response by a checklist.

3.2 Selection of the Study area

DGHS (Directorate General Health Services) web site was used to identify the location of tertiary hospitals in different areas of Bangladesh. Following has included as tertiary hospitals:

(i) All government and private medical college hospitals, centers and institutes.

(ii) All CMH of respective area.

(iii) Few specialized hospitals in Dhaka city.

Among the all tertiary level hospitals "Kurmitola General Hospital" was selected for the following reasons.

(i) It is the most recently constructed tertiary level general hospital in Bangladesh. So it is expected that disaster survival and disaster support elements and structures are well formulated in this hospital.

(ii) If the "hospital risk index" of this hospital is not up to the standard, then it is well assumed that rest of the tertiary hospitals in Bangladesh need further attention to improve.

(iii) This hospital is affiliated with Armed Forces Medical College.

(iv) There are important installations with in its catchment area including the international airport of the country, few high rated hotels, diplomatic zone and big number of population.

(v)

3.3 Study Period

The study was conducted from January 2017 to September 2017.

3.4 Study Population

As per the WHO guideline to find out sustainability of Kurmitola General Hospital the following aspects were studied: General information about the hospital, Hazards affecting the safety of the hospital and the role of the hospital in emergency and disaster management, Structural safety, Nonstructural safety, Emergency and disaster management facilities of the hospital and Emergency management of chemical and biological incidents. For that purpose following individuals were interviewed and a checklist was filled up: Director and assistant director, Hospital engineer, Officer in Charge of Emergency and Casualty department, Pharmacist and OT in charge of the hospital.

3.5 Inclusion Criteria

The persons who were working in the relevant sectors of Kurmitola General Hospital were included.

3.6 Exclusion Criteria

The persons who were unwilling to participate were excluded.

3.7 Sample Size

The study was conducted on Kurmitola General Hospital with 162 questions.

3.8 Sampling Technique

After taking prior permission the respondents were interviewed. Physicians were selected purposively and conveniently.

3.9 Research Instrument

Questionnaire and checklist

3.10 Research Tools

a. iPhone 6 plus.

b. Scientific calculator-Casio fx-500MS.

c. Clip board and necessary stationary.

d. Laptop-Asus.

3.11 Research approach

Research proposal was presented and approved by honorable faculty members of BRAC University. Identity of the researcher and purpose of data collection were explained to the respondents. At the same time verbal consent was taken.

3.12 Data Collection Procedures and Technique

The purpose of the study was explained in details to the respondents. After that verbal consent as per selection criteria of the study, data from the respondents were collected through face-to-face interview. Questions were asked in Bangla and English where applicable. Rewording was hardly necessary. Both the questionnaires were pretested. It was made clear to the respondents that they were at liberty to answer or not to answer any question. The respondents were given full assurance on some ethical point of view that under no circumstances any part of the interview will be disclosed to any unauthorized person.

3.13 Data processing and analysis

At the end of the day of data collection, individual questionnaire was edited through checking and rechecking to see whether it was filled completely and consistently. Then the data were entered into the computer, with the help of software SPSS program version 20 by the researcher himself. An analysis plan was developed keeping in view with the objective of the study. Frequency distributions and normal distribution of all continuous variables were checked. In most of continuous variable asymmetrical or skewed

distributions were found. For analysis of the study results mean, percentage and standard deviation was used. Cross tabulation was prepared.

3.14 Limitations of the Study

a. Time constraints due to military profession and appointment.

b. No previous evaluation of any tertiary level hospitals of Bangladesh.

3.15 Ethical consideration

The respondents were briefed properly and motivated to participate. No interventions were given; no personal questions were asked. The respondents were neither harmed physically nor mentally.

Chapter 4

Results

To find out the resilience of a tertiary level hospital in Bangladesh to combat mass casualty incidents, Kurmitola General Hospital was selected and study was carried out. This study was a cross-sectional questionnaire survey. The administrator, engineers and in charge of the Emergency & Casualty department were interviewed. The hospital was visited to verify the selected questionnaire response by a checklist. Among all the tertiary level hospitals "Kurmitola General Hospital" was selected. It is the most recently constructed tertiary level general hospital in Bangladesh. It started functioning since 2014. So it is expected that disaster survival and disaster support elements and structures are well formulated in this hospital. We can get an overall idea about the health services of Bangladesh in response to disaster. The study was conducted from January 2017 to September 2017. The survey was conducted as per the WHO guideline to find out resilience of Kurmitola General Hospital. Results and findings are presented below.

Hospital Safety Index (HIS) for this hospital was included with 162 items, categorized in three components including, structural, non-structural and functional capacity. For each item, safety status was categorized into three levels: not safe (0), average safety (1) and high safety (2). A normalized scoring scheme on a 100-point scale was developed. Safety margin of the hospital was classified to three safety classes according to their normalized total score: low (≤34.0), average (34.01–66.0) and high (>66.0).

4.1 State of hospital treatment and operating capacity:

a. Internal medicine

Department of service	Routine bed capacity	Maximum bed capacity in disaster	Observation
General medicine	100	150	
Pediatrics	30	40	

Cardiology	-	-	
Pulmonology	-	-	
Neurology	-	-	
Endocrinology	-	-	
Hematology	-	-	
Gastroenterology	-	-	
Dermatology	-	-	
Burn unit	5	10	
Physiotherapy	10	10	
Psychiatry	10	15	

b. Surgery

Department of service	Routine bed capacity	Maximum bed capacity in disaster	Authorized number of staff	Available number of staff	Observation
General surgery	100	125			
Gynae & Obs	100	125			
Orthopedics	30	40			
Urology	-	-			
Otolaryngology	10	10			
Ophthalmology	10	10			
Neurosurgery	-	-			
Plastic surgery	5	5			
Cardiovascular surgery	-	-			

c. Intensive Care Unit (ICU)

Department of service	Routine bed capacity	Maximum bed capacity in disaster	Authorized number of staff	Available number of staff	Observation
General ICU	10	10	Nil	Nil	ICU service not started yet.
Gen Intermediate care	Nil	Nil	Nil	Nil	
Cardiovascular ICU	Nil	Nil	Nil	Nil	
Pediatric ICU	Nil	Nil	Nil	Nil	
Burns ICU	Nil	Nil	Nil	Nil	

d. Operating theatres

Department of service	Number of OT-routine	Maximum number of OT for emergency/disaster	Observation
Septic surgery/ Aseptic surgery	12	12	No separate OT for septic and aseptic surgery
Pediatric surgery	Nil	Nil	
Gynae & Obs surgery	02	02	
Emergency surgery	02	02	
Eye	02	02	

e. Clinical and non-clinical support services

Department of service	Authorized number of staff	Available number of staff	Observation
Diagnostic services	18	18	
Blood bank services	3	3	
Pharmacy	4	9	
Medical Engineering & maintenance	4	8	
Decontamination	60	76	
Security	10	50	40xAnser are attached

f. Emergency and disaster operations

Department of service	Authorized number of staff	Available number of staff	Observation
Incident management (command, control, coordination)	Nil	Nil	
Logisticians	1	Nil	
Communication & information	4	4	
Administration(HRM& finance)	3	3	
Media spokes persons	Nil	Nil	
Ambulance staff	6	6	
Advance medical post/dispatch team	Nil	Nil	

4.2 Results on hazards affecting the safety of the hospital and the role of the hospital in emergency and disaster management

Hazards	**Hazard level**				Should hospital be prepared? If yes, mark	Evaluator's comments & observations
	No hazard	Hazard level				
		Low	Ave rage	High		
1.1 Geological hazards						
Earthquakes			yes		yes	
Volcanic eruption	Yes				No	
Landslide	Yes				No	
Tsunamis	Yes				No	
Mudflows/rock falls etc.	Yes				No	
1.2 Meteorological hazard						
Cyclone		Yes			Yes	
Tornadoes		Yes			Yes	
Local storms			Yes		Yes	
Sand storms etc.	Yes				No	
1.3 Hydrological hazards						
River flood		Yes			No	
Flash flood	Yes				No	
Storm surge	Yes				No	
Land slides	Yes				No	
Costal floods/high tides etc.	Yes				No	
1.4 Climatological hazards						
Heat wave			Yes		No	
Wild fire	Yes				No	
Drought		Yes			No	
Sea level rise	Yes				No	
1.5 Biological hazard						
Epidemic disease				Yes	Yes	
Pandemic disease				Yes	Yes	
Emerging disease				Yes	Yes	
Foodborne outbreak (other than food poisoning)				Yes	Yes	
Infestations				Yes	Yes	
1.6 Human made hazards						
Industrial Chemical hazards				Yes	Yes	
Radiological hazards		Yes			Yes	
Building fires				Yes	Yes	

Hazards	**Hazard level**				Should hospital be prepared? If yes, mark	Evaluator's comments & observations
	No hazard	Hazard level				
		Low	Ave rage	High		
Human made hazards-cont			Yes		Yes	
Biological attack			Yes		Yes	
Chemical attack						
Radiological attack		Yes			Yes	
Power outage of hospital (if any previous incidents)				Yes	Yes	
Water supply disruption				Yes	Yes	
Road accidents				Yes	Yes	
Rail accidents				Yes	Yes	
Water transport accidents			Yes		Yes	
Air accidents				Yes	Yes	
Building collapse				Yes	Yes	
Food contamination				Yes	Yes	
Water contamination				Yes	Yes	
Air pollution				Yes	Yes	
				Yes	Yes	
1.7 Societal hazards						
Security threats to hospital and staff		Yes			yes	
Armed conflicts	Yes				Yes	
Civil unrest/demonstration				Yes	Yes	
Mass gathering				Yes	Yes	
Displaced population (due to conflict)			Yes		No	
Bomb explosion				Yes	Yes	
Terrorist attack (any past incidents, mention)				Yes	Yes	
1.8 Biological hazard						
Epidemic disease				Yes	Yes	
Pandemic disease				Yes	Yes	
Emerging disease				Yes	Yes	
Foodborne outbreak/poisoning				Yes	Yes	
Infestations				Yes	Yes	
1.9 Properties of hospital soil						
liquefaction				Yes	Yes	
Clay soil	Yes				No	
Unstable slopes	Yes				No	

4.3 Results of Structural Safety of the hospital

2.1 Prior events affecting hospital safety	**Safety level**			**Observations (evaluator's comments)**
	Low	Average	High	
1. Prior structural damage of the hospital building			Yes	
2. Hospital built or repaired using current safety standard			Yes	
3. Effect of modification on structural behavior of hospital			yes	
2.2 Building integrity	**Safety level**			**Observations** (evaluator's comments)
	Low	Average	High	
4. Structural system design			yes	
5. Condition of the building			yes	
6. Condition of the constructional materials			yes	
7. Interaction of nonstructural elements with the structure			yes	
8. Proximity of buildings for earthquake			yes	
9. Proximity of buildings for wind tunnel effect			yes	
10. Structural redundancy			yes	
11. Structural detailing			yes	
12. Ratio of column strength to beam strength			yes	
13. Safety foundation			yes	
14. Irregularities to building structure plan	low			
15. Irregularities in elevation of building	low			
16. Irregularities in height of stairs	low			
17. Structural integrity of rods			yes	
18. Structural resilience to hazard other than earthquake & wind			yes	

4.4 Results on nonstructural safety

Module 3, Nonstructural Safety **3.1 Architectural safety**	**Safety level**			**Observations (evaluator's comments)**
	Low	Average	High	
19. Major damage and repair of nonstructural elements			Yes	
20. Condition and safety of doors, exits and entrance			Yes	
21. Condition and safety of windows and shutters			Yes	
22. Condition and safety of elements of building envelope			Yes	
23. Condition and safety of roofing			Yes	
24. Condition and safety of railing and parapets			Yes	
25. Condition and safety of perimeter walls and fencing			Yes	
26. Condition and safety of architectural elements			Yes	
27. Safe conditions for movement outside the hospital			Yes	
28. Safe conditions for movement inside the building			Yes	
29. Conditions and safety of internal walls & partitions			Yes	
30. Conditions and safety of false or suspended ceilings			Yes	
31. Conditions and safety of elevator system			Yes	
32. Conditions and safety of stairways and ramps			Yes	
33. Conditions and safety of floor coverings			Yes	

Module 3, Nonstructural Safety **3.2 Infrastructure protection, access and physical security**	**Safety level**			**Observations (evaluator's comments)**
	Low	Average	High	
34. Location of hospital's critical services and equipment in the hospital in relation to local hazards			Yes	
35. Hospital access routes			Yes	
36. Emergency exits and evacuation routes			Yes	2xexit route
37. Physical security of building, equipment, staff and patients			Yes	
Critical systems	**Safety level**			**Observations (evaluator's comments)**
	Low	Average	High	
3.3 Electrical systems				
38. Capacity of alternate sources of electricity (e.g. generators)			Yes	1x1000KV for hospital 2x250kv for CT & MRI 4xsmall
39. Regular tests of alternate sources of electricity in critical areas			Yes	
40. Condition and safety of alternate source(s) of electricity			Yes	
41. Condition and safety of electrical equipment, cables and cable ducts			Yes	
42. Redundant system for the local electric power supply			Yes	Substation from PDB
43. Condition and safety of control panels, overload breaker switches and cables			Yes	Automatic circuit breaker available
44. Lighting system for critical areas of the hospital			Yes	
45. Condition and safety of internal and external lighting systems			Yes	

Module 3, Nonstructural Safety **Continued Critical systems (3.3 Electrical systems)**	**Safety level**			**Observations (evaluator's comments)**
	Low	Average	High	
46. External electrical systems installed for hospital usage			Yes	
47. Emergency maintenance and restoration of electric power supply and alternate source			Yes	
3.4 Telecommunications systems				
48. Condition and safety of antennas cable ducts			Yes	
49. Condition and safety of low- and extra-low-voltage systems (internet and telephone)			Yes	
50. Alternate communication systems			Yes	
51. Condition and safety of telecommunications equipment and cables			Yes	
52. Effect of external telecommunications systems on hospital communication			Yes	
53. Safety of sites for telecommunication systems			Yes	
54. Condition and safety of internal communications systems			Yes	
55. Emergency maintenance and restoration of standard and alternate communications systems			Yes	
3.5 Water supply system				
56. Water reserves for hospital services and functions			Yes	
57. Location of water storage tanks			Yes	
58. Safety of the water distribution system			Yes	
Module 3, Nonstructural Safety	**Safety level**			**Observations**

Continued Critical systems (3.5 Water supply system)	Low	Average	High	**(evaluator's comments)**
59. Alternate water supply to the regular water supply	Yes			
60. Supplementary pumping system			yes	
61. Emergency maintenance and restoration of water supply system		Yes		
3.6 Fire protection system				
62. Condition and safety of the fire protection (passive) system			Yes	
63. Fire/smoke detection systems		Yes		
64. Fire suppression systems (automatic and manual)			Yes	
65. Water supply for fire suppression			Yes	
66. Emergency maintenance and restoration of the fire protection system			Yes	
67. Safety of nonhazardous wastewater systems	Yes			
68. Safety of hazardous wastewater and liquid waste	Yes			
69. Safety of nonhazardous solid waste system		Yes		
70. Safety of hazardous solid waste system		Yes		
71. Emergency maintenance and restoration of all types of hospital waste management systems			Yes	

Module 3, Nonstructural Safety **Continued Critical systems**	**Safety level**			**Observations (evaluator's comments)**
	Low	Average	High	
3.7 Fuel storage systems (e.g. gas, gasoline and diesel)				
72. Fuel reserves	Yes			
73. Condition and safety of above - round fuel tanks and/or cylinders	Yes			
74. Safe location of fuel storage away from hospital buildings	Yes			
75. Condition and safety of the fuel distribution system (valves, hoses, connections	Yes			
76. Emergency maintenance and restoration of fuel reserves	Yes			
3.8 Medical gases systems				
77. Location of storage areas for medical gases			Yes	
78. Safety of storage areas for medical gas tanks and/or cylinders			Yes	
79. Condition and safety of medical gas distribution system (e.g. valves, pipes, connections)			Yes	
80. Condition and safety of medical gas cylinders and related equipment in the hospital			Yes	
81. Availability of alternative sources of medical gases	Yes			
82. Emergency maintenance and restoration of medical gas systems			Yes	
3.9 Heating, ventilation, and air-conditioning (HVAC) systems				
83. Adequate location of enclosures for HVAC equipment			Yes	
84. Safety of enclosures for HVAC equipment			Yes	
85. Safety and operating condition of HVAC equipment (e.g. boiler, exhaust)			Yes	

86. Adequate supports for ducts and review of flexibility of ducts and piping that cross expansion joints			Yes	
87. Condition and safety of pipes, connections and valves			Yes	
88. Condition and safety of air-conditioning equipment			Yes	
89. Operation of air-conditioning system (including negative pressure areas)			Yes	
90. Emergency maintenance and restoration of HVAC systems	Yes			
3.10 Equipment and supplies Module 3, Nonstructural Safety Continued - Critical systems	**Safety level**			**Observations (evaluator's comments)**
	Low	Average	High	
3.10.1 Office and storeroom furnishings and equipment (fixed and movable)				
91. Safety of shelving and shelf contents		Yes		
92. Safety of computers and printers		Yes		
3.10.2 Medical and laboratory equipment and supplies used for diagnosis and treatment				
93. Safety of medical equipment in operating theatres and recovery rooms			Yes	
94. Condition and safety of radiology and imaging equipment			Yes	
95. Condition and safety of laboratory equipment and supplies		Yes		
96. Condition and safety of medical equipment in emergency care services unit		Yes		
97. Condition and safety of medical equipment in ICU	Yes			

Module 3, Nonstructural Safety Continued Critical systems **3.10 Equipment and supplies**	**Safety level**			**Observations (evaluator's comments)**
	Low	Average	High	
98. Condition and safety of equipment and furnishings in the pharmacy			Yes	
99. Condition and safety of equipment and supplies in the sterilization services		Yes		
100. Condition and safety of medical equipment for obstetric emergencies and neonatal care		Yes		
101. Condition and safety of medical equipment and supplies for emergency care for burns		Yes		
102. Condition and safety of medical equipment for nuclear medicine and radiation therapy			Yes	
103. Condition and safety of medical equipment in other services		Yes		
104. Medicines and supplies		Yes		
105. Sterilized instruments and other materials		Yes		
106. Medical equipment specifically used in emergencies and disasters	Yes			
107. Supply of medical gases			Yes	
108. Mechanical volume ventilators			Yes	
109. Electro medical equipment			Yes	
110. Life-support equipment		Yes		
111. Supplies, equipment or crash carts for cardiopulmonary arrest		Yes		

4.5 Results of variables of emergency and disaster management

Module 4, Emergency and disaster management **4.1 Coordination of emergency and DM activities**	**Safety level**			**Observations (evaluator's comments)**
	Low	Average	High	
112. Hospital Emergency/Disaster Committee	Yes			
113. Committee member responsibilities and training	Yes			
114. Designated emergency and DM coordinator		Yes		
115. Preparedness program for strengthening emergency and disaster response and recovery		Yes		
116. Hospital incident management system	Yes			
117. Emergency Operations Centre (EOC)	Yes			
118. Coordination mechanisms and cooperative arrangements with local emergency/disaster management agencies		Yes		
119. Coordination mechanisms and cooperative arrangements with the health-care network	Yes			
4.2 Hospital emergency and disaster response and recovery planning				
120. Hospital emergency or disaster response plan		Yes		
121. Hospital hazard-specific sub plans	Yes			
122. Procedures to activate and deactivate plans	Yes			
123. Hospital emergency and disaster response plan exercises, evaluation and corrective actions	Yes			

Module 4, Emergency and disaster management **4.2 Hospital emergency and disaster response and recovery planning-cont.**	**Safety level**			**Observations (evaluator's comments)**
	Low	Average	High	
124. Hospital recovery plan	Yes			
4.3 Communication and information management				
125. Emergency internal and external communication			Yes	
126. External stakeholder directory		Yes		
127. Procedures for communicating with the public and media		Yes		
128. Management of patient information	Yes			No set procedure
4.4 Human resources				
129. Staff contact list			Yes	
130. Staff availability			Yes	
131. Mobilization and recruitment of personnel during an emergency or disaster		Yes		
132. Duties assigned to personnel for emergency or disaster response and recovery		Yes		
133. Well-being of hospital personnel during an emergency or disaster		Yes		
4.5 Logistics and finance				
134. Agreements with local suppliers and vendors for emergencies and disasters	Yes			
135. Transportation during an emergency	Yes			
136. Food and drinking-water during an emergency		Yes		No alternative source
137. Financial resources for emergencies and disasters	Yes			
4.6 Patient care and support services				
138. Continuity of emergency and critical care services		Yes		

139. Continuity of essential clinical support services			Yes	
140. Expansion of usable space for mass casualty incidents		Yes		Outside space is less
Module 4, Emergency and disaster management **4.6 Patient care and support services-cont.**	**Safety level**			**Observations (evaluator's comments)**
	Low	Average	High	
141. Triage for major emergencies and disasters		Yes		
142. Triage tags and other logistical supplies for mass casualty incidents	Yes			
143. System for referral, transfer and reception of patients			Yes	
144. Infection surveillance, prevention and control procedures	Yes			
145. Psychosocial services			Yes	
146. Post-mortem procedures in a mass fatality incident			Yes	
4.7 Evacuation, decontamination and security				
147. Evacuation plan	Yes			
148. Decontamination for chemical and radiological hazards	Yes			
149. Personal protection equipment and isolation for infectious diseases and epidemics		Yes		
150. Emergency security procedures		Yes		
151. Computer system network security		Yes		

4.6 Results of Emergency management of Chemical and Biological Incidents

Module 5, Emergency management of Chemical and Biological Incidents	**Safety level**			**Observations (evaluator's comments)**
	Low	Average	High	
152. Availability of PPE (personal protective equipment) Low- PPE is less than staff number. Average- Equal to ICU bed number. High- More than ICU bed number		Yes		Not adequate
153. Inventory for MCI management. Low- No inventory. Average- Have but not up to date. High- Regular reviewed and up to date.		Yes		
154. Written protocol for chemical and biological incident management. Low- Not available. Average- Available but not up to date. High- Regular reviewed and up to date	Yes			
155. Decontamination facilities Low- Nil, Low- Facility is not isolated and not separate from hospital building. High- Separate and isolated and having ventilation facilities		Yes		
156. Shower facilities for decontamination. Low- Not available. Average- Available but communicate with common drainage line. High- Separate line	Yes			
157. Conducts regular decontamination drill	Yes			
Availability for Nerve agents				
159 Atropine. Low-no stock. Average- capable to manage five		Yes		

casualties. High- Can manage more than five.				
160. Paralidoxime. Low-no stock. Average- capable to manage five casualties. High- Can manage more than five.		Yes		
Availability of medicine for Biological agents				
161. Ciprofluxacin. Low-no stock. Average- capable to manage five casualties. High- Can manage more than five.		Yes		
162. Doxicycline. Low-no stock. Average - capable to manage five casualties. High- Can manage more than five.		Yes		

Chapter 5

Discussion Recommendation and Conclusion

Discussion

5.1 State of hospital treatment and operating capacity

The authorized hospital beds for Internal Medicine and Surgery departments are adequately distributed (para 4.1a and 4.1b). But it is alarming that ICU facilities are not established yet (para 4.1c). These are the most urgently required for any tertiary level hospitals. It is also important to mention that septic and aseptic OT is not segregated (para 4.1d). This may affect treatment outcome.

The Clinical and non-clinical support services are well equipped and manpower is adequately distributed (para 4.1e). But arrangements for emergency and disaster operations are not well established. Incident command system and advance medical team is not formed (para 4.1f).

5.2 Hazards affecting the safety of the hospital and the role of the hospital in emergency and disaster management

Kurmitola General Hospital is likely to face the challenges of the following hazardous incidents: Earthquakes, Cyclone, Tornadoes, Local storms, River flood, Epidemic disease, Pandemic disease, Emerging disease, Foodborne outbreak, Infestations, Industrial Chemical hazards, Radiological hazards, Building fires, Biological attack, Chemical attack, Power outage of hospital, Water supply disruption, Road accidents, Rail accidents, Water transport accidents, Air accidents, Building collapse, Food contamination, Water contamination, Air pollution, Mass gathering, Bomb explosion and Terrorist attack. At the same time this hospital is developed comparatively is a newly formed soil which has made this hospital vulnerable for Liquefaction (para 4.2).

5.3 Structural safety of the hospital

Structural safety of this hospital was found high (para 4.3). Structural "Hospital Safety Index" (HSI) of this hospital is 100%. The engineering plan of this hospital is well appreciated. But one important dimension was missed in the planning. There is no ramp as an alternative of lift system. This may create huge problem while managing patient surge or electricity failure. Ardalan et al., 2016 conducted a study in Iran where no hospital was rated high in HSI.

5.4 Nonstructural safety

Nonstructural safety of this hospital was found high (para 4.4). Nonstructural "Hospital Safety Index" (HSI) of this hospital is 78%. The engineering plan of this hospital is good. In case of Kurmitola General Hospital emphasis to be given in the following systems (para 4.4):

1. Alternate water supply.
2. Emergency maintenance and restoration of water supply system.
3. Fire/smoke detection systems.
4. Safety of hazardous wastewater and liquid waste.
5. Safety of hazardous solid waste system.
6. Hospital should plan for fuel reserves and its safety, alternative source of medical gas system.
7. Emergency maintenance and restoration of heating, ventilation, air condition and circulation (HVAC) systems.

5.4 Emergency and disaster management

Every hospital should have Safety, and emergency management protocols for today and the future (Price and Forrest, 2016). Various committees and systems for emergency and mass casualty management in this hospital is not well developed (para 4.5). HSI on emergency and mass casualty management of this hospital is merely average (37%). Whereas our range for average rating is 34.01% to 66%. That means there are lot of scopes for development in this respect. Following are the dimensions where emphasis may be given.

a. There is no hospital emergency/disaster committee in this hospital. Almost in all the countries this is mandatory for hospital accreditation. Such as China (Zhong et al., 2014), USA (Smith et al., 2016. Jacobs et al., 2013), India (Nanda, 2008), Iran (Ardalan et al., 2016) and Japan (Okumura and Tokuno, 2015. Harada et al., 2015). But in Bangladesh, for national health services this is not made mandatory (DGHS, 2010. DGHS-a, 2010).

b. The hospital staffs and doctors are not receiving regular training as well as drill on emergency and mass casualty management. But this should be conducted on regular basis (Haverkort et al., 2016).

c. Hospital incident management system and emergency operations center (EOC) are not existing in this hospital. It is a recognize system all over the world and also recommended by WHO.

d. Coordination mechanisms and cooperative arrangements with the health-care network is not well maintained by this hospital. During crisis this is very much required where every second is counted.

e. This hospital does not have any hospital recovery plan. When hospital itself will be in disaster it needs to recover as early as possible to maintain the normal flow of patient surge. An effective and immediate response from hospital personnel is critical to meet the needs of affected populations at the time of MCI. Role of local hospitals is very crucial during the first three to five days following a disaster (Smith et al., 2016. VandenBerg and Davidson, 2015. DGHS, 2010).

f. Management of patient information is crucial during MCI. Failure to comply this will create a social crisis. There should be a set procedure to maintain the patient information which is not properly functioning in this hospital.

g. Mobilization and recruitment of personnel during an emergency or disaster is sometimes required. For this a central policy and plan is required and every hospital should be a part of this plan. This is lacking here in Kurmitola General Hospital.

h. Well-being of hospital personnel during an emergency or disaster is the responsibility of the hospital. it includes the family members of the hospital employee. The facility is not available in Kurmitola General Hospital.

j. During disaster it is usual that all the population will be affected. It includes the venders and suppliers of the hospital. On the other hand extra demand of medical stores

will be required. So agreements with local suppliers and vendors for emergencies and disasters is essential for effective hospital management. This type of agreement was not available in this hospital.

k. Kurmitola General Hospital has only five ambulances. There is no probation of extra transportation during an emergency. An alternative probation is required.

l. There is extra fund for hospital disaster management. Financial resources for emergencies and disasters is required.

m. Triage tags and other logistical supplies for mass casualty incidents should be adequately kept in reserve. This was not efficiently managed in this hospital.

5.5 Emergency management of chemical and biological incidents

a. There is a growing concern about possible terrorist's use of chemical or biological weapons against civilian populations (Wetter et al., 2001. Torok et al., 1997. Taneda, 2009. Okumura et al., 1998. Niska and Burt, 2005). So every hospital should have a plan of decontamination for chemical and radiological hazards. But there was no such plan available in Kurmitola General Hospital. Written protocol for chemical and biological incident management was also not available.

b. Personal protective equipment (PPE) and isolation for infectious diseases and epidemics was found inadequate in Kurmitola General Hospital. This may create a sense of insecurity among the employees.

c. Decontamination facilities specially mentioning the shower facilities was not found. This is a clear cut threat for the hospital as well as for the community to unchecked disease transmission by chemical and biological agents.

d. Regarding the availability of nerve agents like Atropine, Paralidoxime, Ciprofluxacin and Doxicycline was inadequate in emergency department of Kurmitola General Hospital. These all demanded urgent attention.

Recommendation

1. It is recommended that this type of details survey may be conducted for all the tertiary level hospitals and a consolidated report may be submitted to the competent authority for further planning and management.

Conclusion

Emergency preparedness is a universal global need. Large scale disaster, whether from natural or deliberate cause, result in mass illness or unchecked disease transmission (epidemic or pandemic). The National Incident Management System and its incident command system (ICS) are used by many countries. Every hospital of Bangladesh need to be prepared 24/7 for any mass casualty events. The comprehensive framework mentioned in this research paper may provide a way to conceptualize hospital resilience, and a foundation for developing a user-friendly instrument for measuring it. A five-factor structure of hospital resilience was identified. Although additional work is still needed, the findings provide a basic framework and foundation for future research.

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