

Review Article

Safe Hospital: Lessons Learned from Past Disasters

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Abstract

Preparedness is the key to ensure the proper functionality of a hospital during and the aftermath of a disaster situation. Therefore, it is important to study past cases to identify the good practices and weaknesses of preparedness. The main objective of this paper is to draw some lessons from past disasters to improve the preparedness of hospitals in order to face future crisis successfully. Examination of different case studies from different countries highlighted that proper planning, regular drills and exercises, and networking with regional hospitals and emergency services are paramount important to respond to any disaster situation adequately.

Keywords: Preparedness, Disaster, Hospitals, Drills, Exercises

Introduction

This paper focuses on disaster cases at hospitals in different parts of the world to better illustrate what may occur to hospitals under heavy disaster situations and what safe hospitals may look like under these conditions. It first discusses a case study of the Memorial Medical Center in New Orleans, USA, during Hurricane Katrina in 2005. It attempts to illustrate how a hospital could fail during a disaster due to its inadequate preparedness. This paper then discusses two success stories. One demonstrates a mass casualty incident management in Jerusalem; and the other discusses actions Ishinomaki Red Cross Hospital in Japan took to prepare for disasters. As it turned out, this Hospital played important roles in responding to the Great East Japan Earthquake and Tsunami (GEJET) in 2005.

The Memorial Medical Center during the Hurricane Katrina

Five Days at Memorial: Life and Death in a Storm-Ravaged Hospital is a non-fiction book written by Dr. Sheri Fink. It describes in details the aftermath of Hurricane Katrina when it struck New Orleans. Fink, a journalist, medical doctor and former relief worker in disaster and conflict zones, won the Pulitzer Prize for this investigative reporting in 2010. The book dramatically describes how the patients, doctors and nurses experienced the five days and made the hardest choices. Also it examines the legal, political and ethical issues surrounding euthanasia [1].

On Sunday, August 28, 2005, the weather forecast warned about the arrival of the imminent powerful hurricane. The mayor of New Orleans ordered residents to leave the City, but many residents who went out already got stuck in the traffic. The Superdome, a giant stadium, was designated as a “shelter of last resort.” The mayor exempted hospitals and their workers from the mandatory evacuation. All staff assigned to work in the hospital packed their cars with provisions for three days. They were accompanied by their family members and pets in kennels. They parked their cars in a multistory garage above the flood prone street. There were 2,000 people inside the Memorial hospital, including 240 patients, health workers, their family members and their pets [1].

In the early morning of the following day, Hurricane Katrina, a category five storm, struck New Orleans. The Memorial Medical Center lost its power supply. When the backup generator came on, it supplied only emergency lights, certain critical equipment, and a

handful of outlets on each floor. The air-conditioning system was shut down, and sweltering heat began to swallow the Hospital and its patients. The basement began to flood. Pets and food brought in by staff were moved upstairs from the ground floor. The flooding had subsided by the evening. Not much damage had resulted by the hurricane itself except those on roof and windows of the hospital buildings. Pets and food were moved back downstairs. The hospital remained functional [1].

On the third day (August 30) the hospital received a stab-victim at the emergency room, where she underwent surgical interventions and was mechanically ventilated. The staff heard on the radio news that the martial law had been declared in the disaster zone. Also, they heard gunfire outside the Hospital as hungry people were getting restless and violent. The security system was found to be inadequate to protect the patients. The staff was getting anxious about safety as New Orleans was one of the highest crime rates in the USA [1].

Then levees failed and flooded 80% of the city. The Memorial Hospital soon faced the second flooding. The Memorial was situated three feet below sea level and the flood was expected to rise by 15 feet. The Hospital incident command system announced to operate in “survival mode,” in which all staff and their family members were instructed to stay indoors. All elective surgeries and procedures were cancelled. All medically stable patients were discharged but they had to wait for rescue. Now it became necessary to evacuate the Hospital. The staff had to determine immediately priority for evacuation. A group consisting of a few doctors decided quickly to categorize the patients according to the severity of their conditions. Relatively healthy people were category one. Typical hospital patients were category two. Critically ill patients were category three. The third category patients were put on “Do not resuscitate” order (DNR) and they were to be the last to be evacuated. Some of the ambulatory patients were evacuated by boats [1].

However, the evacuation itself posed formidable challenges. The helipad was situated above the 8th floor of the Hospital building.

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Received: July 29, 2019; **Accepted:** August 08, 2019; **Published:** August 12, 2019.

It was found difficult to bring critically ill patients there as the lifts did not work. The Hospital was without electricity, running water or air conditioning. The temperature rose up to 110 °F and everybody suffered from heat. The health workers had to fan the patients with cardboard and give sips of water to those who were lying on the parking garage waiting for rescue helicopters. Even though the emergency coordinator communicated with “Tenet,” they failed to supply transportation or any other supplies needed. They relied on government resources to respond to the emergency. Rescue helicopters took a long time to respond as they had prioritized those civilians stranded on rooftops [1].

In the early morning of day four (August 31), the last backup generator failed resulting in the complete power loss at the Hospital but mechanical ventilators were still working with battery backups.

In the fifth day, the staff was becoming helpless and anxious. Helicopters evacuated only a limited number of patients, and refused to take bed-bound patients and babies in incubators. Volunteers and health workers had to lift patients upstairs even in the dark. Sometimes they were soaked with patient’s urine and feces as toilets were foul and overflowing. Patients waited for a rescue helicopter for hours under the burning sun, and some died there from dehydration. Critically ill and obese patients could not reach the helipad. Nurses had to manually adjust the drop rates of IV infusions and ventilators. One patient died choking on his secretions because medical workers could not effectively suction his airways as vacuum lines in the entire hospital had failed with the power failure. Patients who were on DNR order were struggling to breathe. Some veteran doctors believed that these patients were not going to survive and decided to give them morphine and a sedative known as midazolam to hasten their death without further suffering. There were arguments among doctors and nurses regarding this action [1]. By the end of the day five adequate rescue forces arrived and the entire Hospital was evacuated. An obese patient, weighing more than 300 pounds was the last living patient to be evacuated from the Hospital.

Ten days later, when relief workers entered the empty hospital, they discovered 45 corpses. Among them 20 had high concentrations of morphine and midazolam. Considering the ethical issues of euthanasia, one doctor and two nurses were arrested for the alleged second degree murder (for hastening the death of the patients).

Identified Gaps in the Memorial’s Preparedness

After examining this case, I found a number of conditions that exacerbated survival conditions at the Memorial Center. One is the shortcomings of the administration’s actions. Tanet, the company that owned this Hospital, could not help evacuate the patients because it did not have a preexisting contract with medical transportation companies, and the corporate headquarters did not have an incident command system in place [1]. Like many modern hospitals, Memorial did not maintain a large stock of medicines because it had adopted a “just in time” delivery system. It was also found that the medical suppliers left their local warehouse ahead of the storm and there was no way to get medicines [1].

Despite repeated warnings by disaster experts about the possibility of a devastating hurricane and flood combination, the Hospital administration did not identify its vulnerabilities. One year before Katrina, the engineers of the US Army Corps of Engineers applied the “government storm surge model” and found that 15 feet of water could rise around Memorial if a storm beyond category four hits the city, as the Hospital sat three feet below the sea level. The Hospital administration believed that only up to four feet of flooding would possibly affect it according to its own estimates, and placed generators on the second floor and some critical parts of the emergency power distribution system below ground level. Emergency power transfer

switches and pumps that supplied medical air and vacuum suction were in the ground level [1].

There were many shortcomings in the preparedness plans at this Hospital. Even though Memorial had 20 separate preparedness plans to manage hurricanes, flooding, electricity outage and evacuations, it was not prepared to deal with them all at once when Katrina struck. Its preparedness plan for hurricanes did not anticipate flooding, and the flooding plan did not anticipate the need to evacuate. The evacuation plan did not anticipate the loss of power and communications. The hurricane plan assumed that generators would function for at least 72 hours although they had never been tested to run that long. Also, there was no plan for emergency evacuation by helicopters. The Hospital helipad had not been used for 10 years [1].

The government focused narrowly on “bioterrorism preparedness” in hospitals. Billions of dollars were spent on this after the infamous September 11 attack and subsequent mailing of anthrax-laced letters. Memorial also had a counter-bioterrorism manual of 101 pages while only 11 pages were devoted to hurricane measures [1].

Memorial was highly dependent on electricity-based technology. The patient records were electronically stored and the staff could not access them without power. None of the Memorial electricians or engineers on-site was a generator mechanic [1]. Therefore, attempted repair was unsuccessful. They had many difficulties while transferring patients to other hospitals without patient histories because the electronic medical record system became useless [1].

Also, when electronic instruments were not functioning, modern health professionals found it difficult to practice medicine in the traditional way. Many of them were not familiar with manually ventilating patients or adjusting drop-rates accurately in IV drips. However, when systems fail, creative ideas of individuals could make a real difference. For example, when babies were not allowed into helicopters with incubators to save more space, one doctor kept a fragile baby inside his gown providing his body-warmth while ventilating the baby with the other hand. This baby survived due to this doctor’s creative thinking [1] (Fink, 2013: 93-94). Another example was using teenage family members as “Runners” who carried messages throughout the Hospital. It was an effective means of communication when all high-tech communication devices failed [2].

Finally, Hospital staff faced ethical issues while working exhaustively with limited resources for five consecutive days without adequate rest. This means that there is the need for standard guidelines on ethical issues arising in disaster situations. To save more lives effectively, all hospitals need to be prepared for disasters so that euthanasia is not the only option doctors and nurses have during disasters.

A Successful Mass Casualty Management in Israel

Another useful case study that helps us better understand the possible scenario at hospitals during disasters is the so-called Versailles Disaster of 2001 in Israel. Michel et al. discusses the Versailles Disaster as an example of a terrifying civil mass casualty situation in recent history. This case exemplifies Israel’s on-site disaster management by paramedics, well-coordinated mass casualty management at hospitals, and social worker’s assistance appeared to work excellently.

It occurred in Jerusalem on May 24, 2001 during a wedding ceremony held at night. The whole dancing floor of the Versailles banquet hall on the third floor collapsed to the ground floor, killing 23 and injuring 310 people. The health authorities put an alert immediately and allocated four hospitals for emergency response. These four received and treated more than 300 patients within two hours after the collapse [3]. These hospitals could manage these patients effectively. This mass casualty event occurred during the

period of repeated terrorist attacks in Israel, therefore, health care providers already had had experience in handling such events [4].

During this Versailles incident, four hospitals worked under an effective and well-rehearsed information sharing system. Emergency departments in these hospitals coordinated well with the ambulance staff, constantly informing about the current capacity of their hospitals to on-site triage teams. The correct initial onsite triage by well-trained paramedics prioritized patients. Due to this arrangement highly experienced surgeons at the emergency receptions of the hospitals saved much time and many lives. Their training experience allowed them to use critical resources of the hospitals effectively.

Those hospitals had established a quick assessment and discharge procedure for minor physical and mentally traumatized patients. This system prevented the hospitals from unnecessarily being overcrowded. The hospitals established a telephone hotline for three days to get psychiatric support for affected people. Also, Jerusalem had well-trained social workers who could be mobilized to hospital receptions, accident and emergency departments, and mass casualty sites [3].

In Israel, the police are responsible for overall command of a mass casualty event. Almost all out-of-hospital care is provided by the Magen David Adom emergency medical services system. This service employed about 600 ambulances stationed across the country, enabling them to be dispatched to any site within minutes. About a tenth of the ambulances are equipped with mobile intensive care units with a physician and a paramedic or with two paramedics. The on-site senior paramedic assumes command of all medical teams and is responsible for triage and resuscitation. The distribution of casualties to hospitals is controlled by the medical commander on-site and coordinated by the area dispatch center. All general hospitals are connected to this out-of-hospital system and the Home Front Command under the Israeli Defense Forces [4].

Jerusalem had an automated SMS system to private mobile phones of designated emergency response personnel, who would then rush to the allocated emergency response centers. To quickly mobilize a large number of ambulances in Jerusalem, the vehicles were parked at the respective on-call ambulance driver's homes [4].

Success factors of Jerusalem's Disaster Preparedness

The number of dead and seriously injured people could have been worse in an event of this nature. Emergency response personnel used "the scoop and run principle" to triage many patients. This enabled them to quickly stabilize the spines and airways of the injured before transporting them to hospitals. Only seven patients needed immediate help with breathing. As the transport distances were short, it was best to drive the injured immediately to hospital with minimum triage.

It is important also to have a coordinated traffic management system to prevent other vehicles from blocking access routes for ambulances. Also, it was an advantage that there were designated dividing lines and transport routes, which helped the police and hospital security staff to manage the traffic and the crowd efficiently.

I observe that Israel's disaster management system worked excellently. It had well-trained paramedics on-site, who subsequently transported the casualties to specially-trained senior doctors. There were mobile teams of consultants from various fields ready to attend arriving patients in the accident and emergency departments in Jerusalem. This relieved the workload on surgeons who had the primary responsibility for examinations. I believe that the correct initial prioritization of injured patients according to the severity saved time and lead to the effective use of available critical resources. Continuous sharing of information between responding hospitals and onsite triage teams enabled to avoid overloading hospital capacities.

Israel had set up a telephone hot line to offer psychiatric support

to those in need. In this case, the line was kept open for three days. Psychological trauma is one of the most common disorders seen after a disaster, therefore, this type of easy access for psychiatric care is very helpful to the victims.

Identified weaknesses

This case illustrates how errors in building construction could severely jeopardize safety and lead to accidents and loss of life. The floors of the hall were built by the Pal-Kal method that use lightweight concrete. The method had been banned even before the wedding hall was built as it was proven to be unsafe. The Pal-Kal method reduced the amount of other building materials, such as concrete supporting columns [5]. Also, the third floor, where the wedding ceremony took place, was added later, placing more strains on supporting columns [5].

The owners of this wedding hall were convicted in 2004 of negligence and wrongful death. Finally, they were sentenced to three and a half years of imprisonment [6]. This tragic event was a bitter lesson that reminded us about the importance of safe hospital construction. It is important that safety measures and proper building codes should be followed during construction with careful supervision of engineers and architects.

In this Versailles case, management at the hospitals exposed some weaknesses in preparedness. The emergency treatments were disturbed as these hospitals were overcrowded with patients' relatives and media who wanted to get more information about treatment conditions. A designated responsible person to deal with the media and relatives could have alleviated these problems. Confidentiality of the injured was breached by the television and photographers [3].

Ishinomaki Red Cross Hospital during the Great East Japan Earthquake

On March 11, 2011, northeastern Honshu Island in Japan experienced one of the worst natural disasters in history, the Great East Japan Earthquake and Tsunami (GEJET). This was a triple disaster with a magnitude nine earthquake, a subsequent tsunami and a nuclear power plant accident, which affected 15 prefectures in all [7]. It claimed nearly 16,000 lives and destroyed some 128,000 homes and buildings. More than 3,200 people are still missing [8].

Ishinomaki Red Cross Hospital played a central role as a disaster base hospital at the time. It was the only designated disaster hospital in the Ishinomaki medical zone of Miyagi Prefecture. In May 2006, this hospital moved from its original tsunami prone coastal location to a safer inland location. The new facility was constructed to withstand large earthquakes. Heliports were installed both on the ground and the top of the building. The main entrance was made wide enough to allow access by many patients at once. Wall oxygen supplies were enhanced. The administration revised its hospital's disaster manual and disaster drills. Tabletop exercises were conducted regularly. A helicopter training exercise was performed in collaboration with Miyagi Prefecture to simulate receiving and transporting patients during a major disaster in the area [9].

Also, the Hospital established a network council to coordinate with relevant institutions such as fire, public health, police, self-defense forces, medical associations and nearby hospitals to carry out effective responses during disasters. It entered into agreements with telecommunication companies to receive emergency supplies of satellite-based mobile equipment. Hospital restaurants would receive food and water. A construction company would provide tents in case of any emergency or disaster [10].

When the GEJET struck, the revised hospital manual instructed to establish a hospital disaster task force immediately. Then it

declared a Level 3 emergency, which cancelled all routine works and commenced mass casualty responses. The task force checked vital infrastructures for functionality. Several seconds after the city power supply failure, the Hospital switched to its own backup power. All the patients and employees in the Hospital remained unharmed. Physical damage was minimal. It had a three-day water supply, including general service water. There was also a three-day food supply for patients. A triage area was set up quickly within an hour after the earthquake struck. The company responsible for setting up tents arrived at the scene immediately and erected tents in front of the Hospital entrance. The telecommunication company provided ten mobile telephones with priority connections and two satellite-based mobile telephones in accordance with the agreement [10].

Due to the critical shortage of medical facilities in the Ishinomaki area, doctors and nurses were sent to reinforce Ishinomaki Red Cross Hospital as it was the only functional hospital that survived in the region (Japanese Red Cross Society, 2013). The Hospital treated 3,938 patients within the first seven days. Most of the patients suffered from hypothermia due to the cold winter weather [10].

The Hospital successfully coordinated medical activities and supported emergency shelters with help from other medical institutions, Tohoku University, prefectural and municipal governments, the self-defense force, the fire department, the police department, and private businesses. There was a significant private-public partnerships during disaster management. Also, Google supplied software for easy handing of patient data [10].

Disaster Medical Assistance Teams (DMATs) are specially trained mobile medical-aid teams, which operate during the acute phase of large-scale disasters. DMATs were established in Japan in 2005 after learning lessons from the Great Hanshin-Awaji Earthquake in 1995. Soon after the news of the GEJET spread, DMATs quickly deployed medical rescue teams to disaster areas within 48 hours. Altogether 15,000 professionals were dispatched to the Tohoku area within two days of the earthquake and treated victims. They also assisted in transferring victims to safe medical facilities [11,12].

Ishinomaki Red Cross Hospital's management learned a great deal from the 2011 tsunami. It now has a disaster-emergency unit, consisting of five permanent medical staff. This unit collaborates with university experts and related agencies. It is not stationed in the hospital to treat patients, but mainly gathers information to formulate efficient disaster management procedures for the Hospital. The Hospital annual conducts two major drills, fully rehearsing disaster mitigation and patient evacuation. Some divisions of the Hospital also hold their own weekly drills to check their disaster readiness. During the disaster, hospital's available beds and rooms are not sufficient to treat a large number of injured patients. However, it can use its lobby area to temporarily treat the injured. The Hospital administration realized the need for extra space and they constructed a new building with 50 additional wards to carry out operations successfully in future disaster situations [13].

Conclusion

These three cases discussed above demonstrate the paramount importance of proper hospital preparedness in order to face a disaster situation adequately. Any hospital in the world could face similar scenarios at any time. If governments or organizations fail

to plan adequately, health workers and patients may get trapped in very difficult situations. The above cases emphasize the importance of preparedness in three levels: infrastructure, organization and personnel. Infrastructure should be thoroughly inspected periodically and retrofitted if necessary to withstand any possible disaster situations. Preparedness at organizational level includes good leadership, conducting regular drills and exercises, as well as networking with other organizations. It is also important that hospitals have prior arrangements on emergency supplies such as adequate water, and food as part of evacuation procedures. At a personal level creative thinking and responsible decision making are of paramount importance in a disaster management process. A set of standard-emergency-procedures need to be in place and health workers should practice those plans with regular drills and exercises. Written plans alone are inadequate, and everybody should be a partner in the response. National level guidelines or standards are necessary, especially, for triage criteria in order to protect health workers from unnecessary legal issues. Hospitals situated in known vulnerable locations could learn many lessons from the past cases.

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