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Resilience of hospital in disaster

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Abstract

Disasters and crisis situations are unforeseen events. When a disaster occurs, the most critical step after the intervention at the scene is the health and treatment services provided in hospitals. Since it is of vital importance that hospitals, where health services are provided, are accessible and operational when faced with natural and man-made disasters such as earthquakes, fires, epidemics, CBRN events, wars, and crises such as cyber-attacks, economic problems, hospitals must protect themselves against a disaster hazard and plan what to do during and after the disaster. This review was written to emphasize the importance of hospitals and their resilience in times of crisis and disaster.Hospitals can enhance their resilience by strengthening both their physical and social aspects. It is essential to create resistance in hospitals not against specific dangers such as fire and earthquake, but against all crises that may occur in the system. A hospital must first identify its structural and non-structural risks to enhance its physical resilience. To enhance social resilience, a hospital should plan its organisations and human resources, establish accurate information communication, and engage in logistics and financial planning. It is crucial to guarantee uninterrupted patient care and all supportive services. Measures should be taken for decontamination and evacuation of patients when necessary while also ensuring the overall security of the hospital. As a result, hospital resilience plays a critical role in maintaining healthcare services, effectively managing emergencies, and generally protecting public health. Further studies are needed to strengthen this resistance.

Keywords: resilience, crisis, disaster, hospital

1. Introduction

Resilience can be interpreted with different essential components in different disciplines. However, it can be defined in common in all sectors as the ability of a system to adapt, change, recover and reorganise to a more desirable state after a disruptive event, a stressful event or a shock (Walker, 2020; Wulff, Donato, & Lurie, 2015). It is vital to build resilience not only against specific threats but also against crises of all kinds in all parts of the system (Walker, 2020).

Resilience holds critical importance in healthcare services. The healthcare system is required to deliver high-quality and safe patient care consistently. Simultaneously, it is expected to adapt during crisis situations, maintaining its functions and emerging from crises through self-improvement (Wiig et al., 2020). Although fundamentally similar, healthcare settings (nursing homes, home care services, hospitals, pre-hospital care) vary, so resilience should be increased by making different preparations for each environment in crisis situations.

The Regulation on the Functioning of Inpatient Treatment Institutions by the Ministry of Health defines hospitals as places where the observation, examination, diagnosis, treatment, and rehabilitation of patients, the injured, those suspecting illness, and those wishing to have their health conditions checked are conducted either on an outpatient or inpatient basis and where births are also performed (Sağlık Bakanlığı, 1983).

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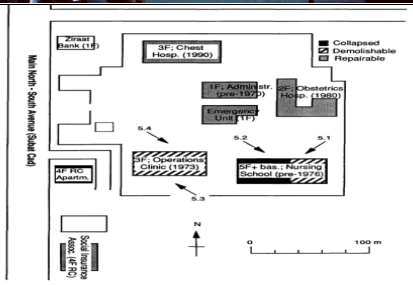
Hospitals are complex organisations where health services, hotel management, support services, and administrative services are provided. These institutions utilise many technological devices and hazardous substances, consist of diverse human communities, and operate 24/7 to provide health services. The processes in these organisations are dynamic, not static (Khalil et al., 2022).

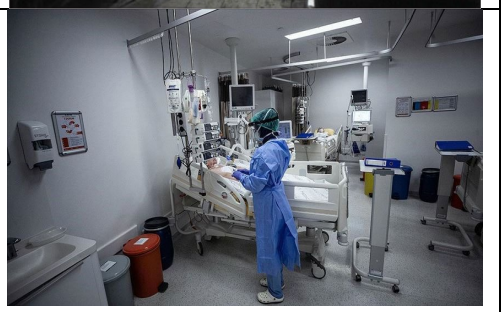
Disasters and crises are unexpected situations. Hospitals must be equipped to be ready and resilient to various disaster and crisis scenarios. The most crucial aspect of hospital resilience is ensuring the quality and continuity of patient care during all kinds of disasters and crises, along with the uninterrupted continuation of education and research activities (Khalil et al., 2022).

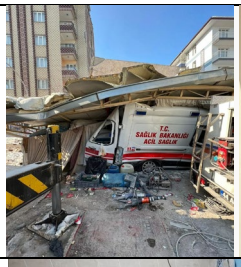
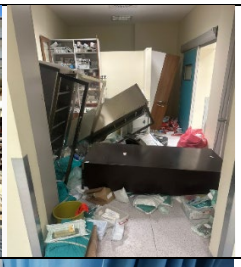
Disasters and crisis situations that affect hospitals can include natural and man-made events such as earthquakes, fires, floods, epidemics, terrorist attacks, CBRN events, technological problems, cyberattacks, financial problems, interruptions or deficiencies in the supply chain, infrastructure damages, human resources problems, etc.

Numerous scientific studies and media reports present the effects of disasters and crisis situations on hospitals (Table 1).

Table 1 Effect of Disasters and Crisis situations on hospitals

Date	Place	Impact	
1971	San Fernando California Earthquake (World.Bank, 2010)	San Fernando Veterans Hospital completely collapsed, 50 people receiving treatment at the hospital died	
1972	Managua-Nicaragua Earthquake (World.Health.Organization, 1973)	Most hospitals were destroyed, and 1250 patient beds were damaged.	
1985	Mexico City Earthquake (Villazon-Sahagun, 1986)	5090 patient beds were damaged. Due to the collapse of 2 hospitals, approximately 1000 people, including medical school students, patients and healthcare workers, died.	
1992	Erzincan Earthquake (Birand & Ergünay; Williams, Pomonis, Booth, Vaciago, & Ring, 1992)	Most of the hospitals in the center were severely damaged, the nursing school was completely destroyed and the victims were sent to hospitals in neighboring provinces.	 Layout of buildings at the Erzincan state hospital

1999	Marmara Earthquake,	One of the 10 public hospitals in Izmit was destroyed and four were partially damaged.	
2003	Iran Bam Earthquake (Eshghi & Naserasadi, 2005)	Due to structural, non-structural and mechanical damages in the buildings, all hospitals stopped working and the injured were transferred.	
2004	Indonesia tsunami (Morrow & Llewellyn, 2006; Redwood-Campbell & Riddez, 2006)	80% of the hospitals in the region were destroyed and the rest became unusable. Ship hospitals were used.	
2011	Van Earthquake	A hospital became unusable. Health services in Erciş were provided through field hospitals.	
2013	Philippines Super Typhoon Haiyan (Barmania, 2014)	Health system health information management system collapsed	
2019	Whole world Covid-19 (Anadolu.ajansı, 2023a; Blumenthal, Fowler, Abrams, & Collins, 2020; Iyengar, Mabrouk, Jain, Venkatesan, & Vaishya, 2020)	Telemedicine applications have been developed in hospitals around the world where the healthcare system has been affected, routine patient care has been restricted and medical equipment and consumables have been in short supply.	
2021	All over the world Cyber Attacks (Kolouch, Zahradnický, & Kučínský, 2021)	Following cyber-attacks on hospitals all over the world, disruptions have occurred in the services of many hospitals.	

2023	Kahramanmaraş Earthquake	Kahramanmaraş destroyed and damaged hospitals in 11 provinces. Field hospitals were established in these provinces.	 
2023	Gaza War Genocide (Anadolu.Ajansı, 2023b; Cumhurbaşkanlığı, 2023)	471 people died as a result of the bombing of the hospital.	

The initial effects of the event that caused the crisis can be overcome in a certain period for society and many institutions. However, especially in disaster situations, hospitals are among the institutions that have to sustain crisis management for a long time.

When disasters and crises occur, endangering the continuity of medical services and the hospital itself, the hospital must first secure basic emergency coverage and, secondly, recover from the crisis situations(Bai, 2023).

Upon examining the literature, it is evident that information on the general characteristics of resilient hospitals is limited. There are difficulties in defining the elements or dimensions of resilient hospitals, and inconsistencies exist in language and terminology.

However, in general, the literature on hospital resilience is discussed within the framework of physical and social resilience (Ali et al., 2021; Khalil et al., 2022).

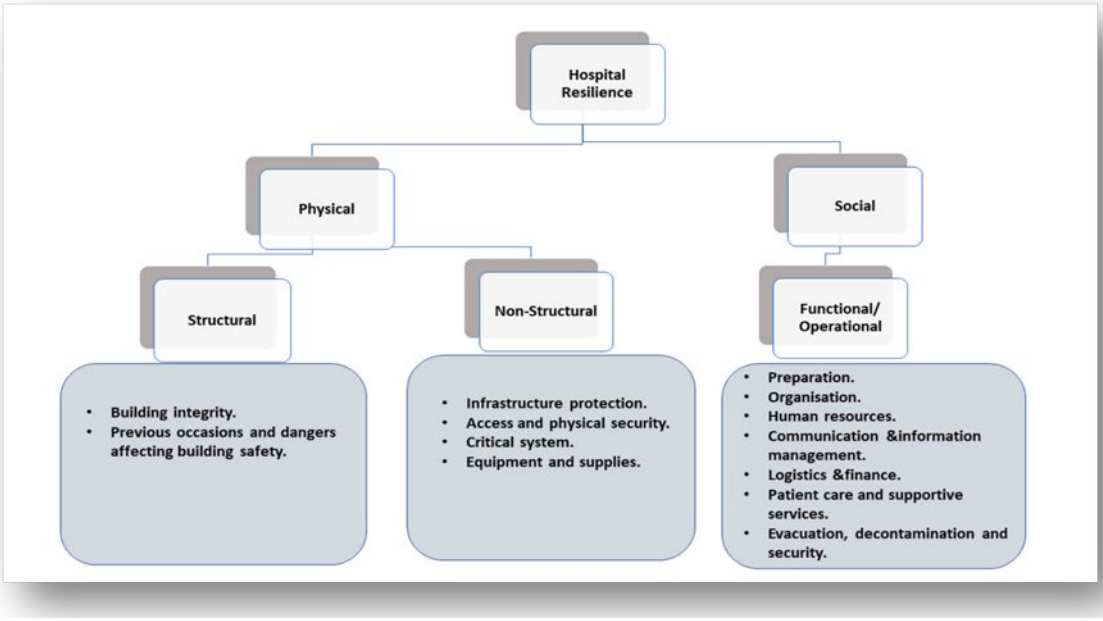


Figure 1 Factors contributing to hospital resilience (Ali et al., 2021)

"In this article, the resilience of hospitals in disaster situations will be assessed through the lenses of physical and social resilience. Additionally, the discussion will be framed within the context of prevention/risk assessment, mitigation, preparedness, response, and recovery phases in the disaster management cycle."

2. Prevention/Risk Assessment, Mitigation

All activities within healthcare institutions involve risks. Reducing risks in disaster and crisis situations is a vital responsibility for hospital management to mitigate risks and damages, a thorough risk analysis must be conducted. Since the most immediate and primary outcome of resilient hospitals is to maintain their functions, and ensure the continuity of high-quality basic and critical services to vulnerable groups, three main security objectives should be taken as basis; protection of life, protection of investment and uninterrupted continuity of activities (Khalil et al., 2022; Sağlık.Bakanlığı, 2021).

Headings taken into consideration during the hazard and risk analysis of hospitals include:

1. Determining the hazards that may be affected by the location of the hospital,
2. Safety of structural elements,
3. Safety of non-structural elements,
4. Ensuring its capacity and business continuity.(Sağlık.Bakanlığı, 2021)

Hospital projects are crucial in potential emergency situations. Hospital structures are designed within the framework of relevant regulations and quality standards, and they are supervised during construction. The vulnerability levels of healthcare institutions to disasters impact the trust and preferences of the community. Additionally, hospital resilience minimizes the impact on the community by absorbing the shock of disasters or emergencies (Khalil et al., 2022) The resilience of healthcare institutions ensures the safety of patients, healthcare professionals, and every individual who may be affected by the situation in the region. It guarantees the uninterrupted provision of health services during emergency and disaster situations

Mitigation of Structural Risks - Structural Resilience

When it comes to mitigating structural risks, it is crucial that hospitals are designed in compliance with the necessary legislation, inspected during the construction phase, and used in accordance with the project.

In this context, the Istanbul Project Coordination Unit (IPCU) of the Governorship of Istanbul has earthquake-proofed the buildings of hospitals, out-patient clinics, and health centers, particularly for earthquakes and various disasters and crises that may occur concurrently with earthquakes. Notably, important hospitals in Istanbul have been demolished and reconstructed using the seismic isolator system. This project is considered an exemplary case of good practice within the realm of hospital risk reduction(World.Bank, 2010).

Figure 2 Göztepe Training and Research Hospital Construction Seismic Isolator Usage (İPKB, 2023)

Mitigation of Non-Structural Risks - Non-Structural Resilience

All building elements other than the structural system can be categorized as non-structural risks. Mitigating non-structural risks is a crucial step in minimizing vulnerability during disasters and emergencies. Reducing non-structural risks in critical facilities like hospitals, which are exposed to multiple hazards, ensures the continuity of business operations in unusual situations, protects life and health, and prevents property loss.

Actions to be taken against non-structural risks in hospitals:

- ✓ Securing all medical devices to prevent displacement or damage.
- ✓ Securing cabinets, lighting fixtures, decorative objects, and other items prone to falling or shaking.
- ✓ Proper placement of oxygen tanks, stretchers, and other equipment to ensure open escape routes.
- ✓ Locking drawers and cabinets, using devices to prevent contents from spilling, especially during events like earthquakes.
- ✓ Implementing emergency lighting and signage for critical areas.
- ✓ Regular maintenance of firefighting equipment and conducting evacuation drills periodically.
- ✓ Adopting suitable storage methods for construction materials, especially for sensitive equipment and medications, to prevent falling or damage.
- ✓ Regular inspection of electrical installations and implementation of safety measures.
- ✓ Providing regular training to staff on disaster and emergency procedures to enhance awareness and preparedness.
- ✓ Reviewing and updating emergency plans on a regular basis.

Figure 3 Precautions taken against non-structural risks in hospitals(parkzon, 2023)

The occurrence of fatalities in the intensive care unit of Hatay Training and Research Hospital during the Kahramanmaraş earthquake on February 6, 2023, due to the failure to activate the generator following a power outage serves as a stark illustration, underscoring the importance of resilience in the face of disasters (Artıgerçek, 2023).

3. Preparedness

The preparation phase is when plans are formulated based on potential scenarios identified after conducting risk analyses and mitigation studies. In this phase, response plans for disaster and emergency scenarios, logistics plans for crisis moments, and evacuation plans are developed. At this stage, the standard operating procedures and workflow instructions must detail how each task will be executed (Sağlık.Bakanlığı, 2021). These guidelines serve as a reference for employees to carry out their duties in a sequential and accurate manner during times of crisis.

As a result of disasters and emergencies, mandatory or precautionary evacuations may be carried out. In cases requiring evacuation within the hospital, evacuation triage is required. Evacuation triage patients are grouped according to whether they can be evacuated on their own or with assistance. (T0,T1,T2,T3)(Sağlık.Bakanlığı, 2021)

Emergency Response Teams are established as part of health institutions' Hospital Emergency Preparedness (HAP). These teams, composed of trained employees, undergo both desk and field drills to strengthen their skills. Regular training sessions contribute to the resilience of health institutions against disasters. All employees are mandated to receive training in search and rescue, evacuation, firefighting, and first aid in alignment with emergency plans. Managers bear the responsibility of planning and conducting these training sessions and drills.

The unfortunate fire incident at Badim Hospital in Rio de Janeiro, Brazil in 2019 serves as an example of the consequences of inadequate training and improper practices. The fire, originating from the hospital's generator, resulted in challenges evacuating patients due to security deficiencies in the hospital infrastructure, inadequacy of disaster management plans, and a lack of sufficiently trained personnel. Despite the efforts of hospital staff to transfer patients in intensive care units to other health facilities, some patients and personnel were affected by the fire and lost their lives (Plotkowski, 2020).

4. Response

Plans developed during the preparation and mitigation phases outline the actions hospital staff should take based on the type and severity of crises and disasters. Patient safety is a priority. Comprehensive emergency evacuation plans are devised to evacuate both inpatients and outpatients, ensuring their safety and providing necessary treatment if the hospital capacity is exceeded in disaster and crisis situations.

To accommodate surge capacity, hospital corridors are converted into cafeterias and conference rooms into patient care areas. Underground parking lots in hospitals are designed to serve as underground hospitals, while parks and reserve areas in cities are earmarked for the establishment of field hospitals. (Bıçakçı & Ulutaş, 2019; Bulakh & Merylova, 2020; Karakoç & Erdoğan, 2020) Furthermore, in cases where hospitals cannot be utilized due to the nature of the disaster, existing hospital ships are employed as alternative healthcare centers to augment capacity for triage and emergency rescue care.(Çatak, 2021).

(a) (b) (c)

Figure 4 Alternative healthcare areas when the hospital building is not in use, ship hospitals(a,b) and field hospitals(c)(NTV, 2023)

Maintaining effective communication is crucial both within and outside the hospital. Regular reporting of patients and medical resources used to relevant units is vital. Additionally, incoming injured patients should undergo primary, secondary, and tertiary triage procedures, prioritizing them based on their urgent medical attention needs.

Since the morgue capacities of hospitals are arranged according to the population and the region they are located in, they will be insufficient in the event of a possible disaster. Morgue areas that

can be activated in extraordinary situations, accelerating burial procedures and pre-burial identification should be carried out as quickly as possible, following a certain procedure. Patient records and identity information of patients referred to different hospitals, provinces or institutions must be up-to-date and accessible. Stocks of medical equipment and supplies should be reviewed regularly and supply chain management should be constantly updated. Depending on the disaster or crisis situation, the models developed can be used in all response applications (Ali et al., 2021).

Personnel management in human resources is another important issue during the intervention phase. Especially the personnel in critical areas should be checked, and in case the relevant personnel cannot be reached, substitute assignments should be completed as included in the previously prepared disaster plan. It is essential to both fulfill the task assigned to the personnel and ensure the safety of the personnel. Cooperation while providing coordination and management by creating emergency response teams within the hospital; It should be done actively with local fire departments, police and other emergency response teams.

5. Recovery

After disasters, the rehabilitation and recovery process starts in hospitals. This is an important stage to meet the medical and psychosocial needs of the patients affected by the disaster. This process includes maintaining post-disaster health services, providing physical rehabilitation, offering psychosocial support and emotional recovery of patients and their families. Physical rehabilitation, physical therapy and supervision by specialised physicians are especially important for injured or disabled patients Additionally, it is important that the process of coping with the stress and post-traumatic difficulties caused by disasters is supported by psychologists, psychiatrists and social workers. Providing counseling services to patients and families provides better understanding and support of the post-disaster process. In this context, hospital employees should not be neglected.

The healing process of patients and the restructuring process of society, together with public resources, play an important role in recovery. These processes should be coordinated by hospital managements, healthcare professionals and the public. Hospital resilience should be determined dynamically within the disaster management cycle with an approach that covers all hazards and should include all components. Guidelines and conceptual frameworks for increasing resilience should be determined.(Khalil et al., 2022)

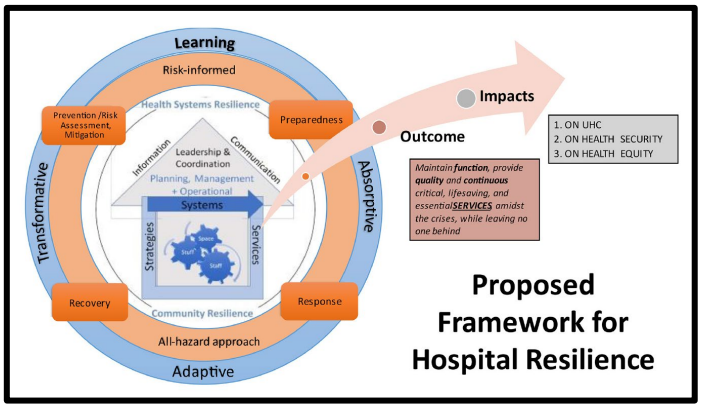


Figure 5 Proposed conceptual framework for hospital resilience.(Khalil et al., 2022)

The resilience of hospitals is critical in maintaining healthcare services, effectively managing emergencies and protecting public health. This resilience is of great importance not only for health systems but also for the overall health of the community. Therefore, it is important for hospitals to have plans ready in advance for crisis situations, communicate effectively in disaster situations, to consolidate infrastructure, to plan logistics, to train staff and to carry out drills in order to increase our capacity to deal with health risks globally.

Future studies aimed at enhancing hospitals' resilience to disasters and ensuring the sustainability of healthcare services should encompass several crucial areas. Firstly, there should be a focus on further research and development to strengthen the infrastructural resilience of hospitals. This is critically important for increasing the resistance of buildings to disasters such as earthquakes, floods, and fires, ensuring the continuity of hospital functions.

Moreover, efforts should be directed toward making emergency preparedness plans more effective and comprehensive. These plans should include aspects such as training emergency response teams, communication strategies, and the management of medical material stocks. Additionally, research focusing on the integration of new technologies, such as telemedicine, to manage healthcare services remotely and effectively is essential.

Studies in the areas of personnel training and psychosocial support can increase the resilience and effectiveness of healthcare personnel during disaster situations, contributing to the rapid recovery of affected communities. Lastly, efforts to enhance collaboration and coordination among stakeholders in the healthcare sector are crucial for providing a more effective response during disaster situations.

Advanced studies in these areas can contribute to increasing hospitals' resilience to disasters, thereby supporting endeavors to preserve and improve public health in the aftermath of such events.

6. Conclusion

In conclusion, the lack of resilience in hospitals to disasters can lead to a range of adverse effects. Disruptions in health services, challenges in emergency interventions, difficulties in patient care, and communication issues are among the factors that can prevent hospitals from providing effective services during disaster situations. Additionally, problems such as shortages of medical supplies and medications, staff shortages, and personnel fatigue can negatively impact hospitals. Therefore, it is crucial to enhance the resilience of hospitals to disasters through effective emergency preparedness plans, robust infrastructure, staff training, and efficient communication strategies. These measures contribute to hospitals responding more effectively and swiftly during disaster situations, ultimately serving the goal of preserving and improving public health.

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Resume

Professor Dr. Rümeyza Kazancıoğlu completed her medical education at Istanbul University Faculty of Medicine between 1985 and 1991. She completed her Internal Medicine residency in 1997 and her Nephrology fellowship in 2001 at the same Faculty of Medicine. She received a fellowship from the International Society of Nephrology (ISN) and worked at the Vanderbilt University Medical Center Transplantation Center, Nashville, TN, USA, from 2000 to 2001. She was an Assos. Professor of Nephrology between 2003-2010 at Istanbul Haseki Training and Research Hospital where she founded a Nephrology Clinic and served as its president. During his leadership, hemodialysis and peritoneal dialysis units and a nephrology fellowship program were launched. She become a full Professor at Bezmialem Vakif University Faculty of Medicine in 2010 and has been serving

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Assist. Professor Özcan Erdoğan completed his undergraduate education at Gülhane Military Medical Academy Nursing School in 1990 and started working as a Health Lieutenant within the Naval Forces Command. She completed his master's and doctoral education in medical microbiology. Between 1990 and 2014, she worked as a manager nurse, manager and branch manager in Military Hospitals and institutions affiliated with the Turkish Armed Forces and retired in 2014 with the rank of Senior Colonel. Since 2014, she has been working as a faculty member at Bezmialem Vakıf University, Faculty of Health Sciences, Department of Nursing and Head of the Department of Disaster Management, Bezmialem Vakıf University, Institute of Health Sciences.