Investigating Organizational Learning and Adaptations for Improved Disaster Response Towards “Resilient Hospitals:” An Integrative Literature Review

Heba Mohtady Ali, MD;1,2 Jamie Ranse, PhD;3,4 Anne Roiko, PhD;1,4 Cheryl Desha, PhD1,2

Abstract

Background: For hospitals, learning from disaster response efforts and adapting organizational practices can improve resilience in dealing with future disruptions. However, amidst global disruptions by climate change, the coronavirus disease 2019 (COVID-19) pandemic, and other disasters, hospitals' ability to cope continues to be highly variable. Hence, there are increasing calls to improve hospitals’ capabilities to grow and adapt towards enhanced resilience. Aim: This study aims two-fold: (1) to characterize the current state of knowledge about how hospitals are gaining knowledge from their responses to disasters, and (2) to explore how this knowledge can be applied to inform organizational practices for hospital resilience. Method: This study used Preferred Reporting Items of Systematic Reviews and Meta-Analysis (PRISMA) guidelines for data collection and framework for data analysis, Covidence software, and Medical Subject Headings (MeSH) terms and keywords relevant to “hospitals,” “learn,” “disaster response,” and “resilience.” The quality appraisal used an adapted version of the Mixed Methods Assessment Tool (MMAT).

Results: After applying inclusion and exclusion criteria and quality appraisal, out of the 420 articles retrieved, 22 articles remained for thematic and content analysis. The thematic analysis included the hospital’s functional (operational) and physical (structural and non-structural) sections. The content analysis followed nine learning areas (Governance and Leadership, Planning and Risk Assessment, Surveillance and Monitoring, Communication and Network Engagement, Staff Practices and Safety, Equipment and Resources, Facilities and Infrastructure, Novelty and Innovation, and Learning and Evaluation).

On applying the Deming cycle, only four studies described a completed learning cycle wherein hospitals adapted their organizational structures using the prior experience and evaluation gained in responding to disaster(s).

Conclusions: There is a gap between hospitals’ organizational learning and institutionalized practice. The conceptualized Hybrid Resilience Learning Framework (HRLF) aims to guide the hospitals’ decision makers in evaluating organizational resilience and knowledge. In the face of disasters, both the stressful factors and the coping strategies that affect the health care workers (HCWs) should be substantially considered.

Mohtady Ali H, Ranse J, Roiko A, Desha C. Investigating organizational learning and adaptations for improved disaster response towards “resilient hospitals:” an integrative literature review. Prehosp Disaster Med. 2022;37(5):665–673.
Introduction
In light of climate change and increasing the severity and frequency of disasters, health care organizations should be able to improve their service delivery during disasters through studying and learning from past disasters that they have faced.1–5 Nevertheless, the lived experiences of hospitals appear ad hoc and championed based on the application of learnings to improve resilience.6–10 Globally, there are several models for hospitals’ “learning from disasters.”6–10 However, in practice, most hospitals still need to undertake such learning. For example, in a study conducted to investigate tertiary hospitals in Shandong Province (China), only one-half (49%) of the surveyed hospitals developed post-disaster evaluation reports about prior experience and evaluation gained from these disasters to improve their future performance.11

In 2019, the world faced a disaster in the form of the coronavirus disease 2019 (COVID-19) pandemic. Although novel in its typology, this pandemic was preceded by other global pandemic concerns in the preceding decade, including Zika, influenza, and Ebola virus infections in 2016, 2017, and 2018.12,13 Despite these opportunities to practice various pandemic response measures, the impact of COVID-19 was still overwhelming for many hospitals around the world.14

COVID-19 led to the evolution of senior hospital personnel appreciating the significance of effective organizational planning and communication to successfully respond to the pandemic.12,13 Moreover, it launched a telemedicine revolution.14 It was apparent that clinical staff can quickly learn from and embed successful reactions to the pandemic.15,16 However, the longevity of the organizational memory of the prior experience and evaluation was less well-understood.15 Disaster preparedness information can enable resilient health care organizations and policy development. Nevertheless, the lived experiences of hospitals appear ad hoc and championed based on the application of learnings to improve performance.16–19

As a part of continuous improvement, system performance evaluation includes the monitoring, measurement, exploration, and appraisal of the process.20 The Deming cycle (the Plan-Do-Study-Act [PDSA] cycle) is an essential component of quality improvement in complex systems with unpredictable processes. Previous efforts have been made within the health care sector to improve hospitals’ capabilities to identify obstacles challenging the post-incident organizational learning process. These efforts included integrating organizational learning theory with the Deming cycle.21,22

Hospitals are considered disaster-resilient when they can endure the disaster’s effects, decrease death and morbidity, and provide their patients with services of the same quality and frequency as everyday services.23 Resilience engineering (RE) is considered a successful approach to organizational change management towards improved performance, providing continuity during uncertainty.24 Four RE capabilities categories comprise the abilities to: (1) respond to events (Actual); (2) monitor on-going developments (Critical); (3) anticipate future threats and opportunities (Potential); and (4) learn from past failures and successes (Factual).25 In a previous paper, the authors conceptualized a RE-based framework to improve hospitals’ disaster resilience. The reviewed literature was considered in the first three RE categories (ie, Actual, Potential, and Critical).26

The fourth RE capability, Factual, was addressed in the current integrative review through the research questions: “How are hospital decision makers learning by responding to disasters towards improved hospital resilience?” and “How are such insights translated into action?”

Methods
Design
This integrative literature review was guided by the Preferred Reporting Items of Systematic Reviews and Meta-Analysis (PRISMA) guidelines27 for data collection and the well-established five steps of Whittemore and Knafel28 framework for data analysis.

Data Collection
Papers were collected from various databases and search engines as evidence artifacts to be included in this review. Peer-reviewed articles were searched for from the publication dates of January 1, 1990 through February 28, 2021. This included the following databases: Web of Knowledge/Web of Science Core Collection (Thomson Reuters; New York, New York USA); MEDLINE (US National Library of Medicine, National Institutes of Health; Bethesda, Maryland USA; Lloyd Wommack, personal communications); CINAHL (EBSCO Information Services; Ipswich, Massachusetts USA); and Scopus (Elsevier; Amsterdam, Netherlands). The search strategy included trying different combinations of Medical Subject Headings (MeSH) terms and keywords relevant to “hospitals,” “learn,” “disaster response,” and “resilience.” The resultant search string used is as follows:

(Hospital* OR Health Care Facilities, Manpower, and Services OR Health Care Facilities OR Academic Medical Centers OR Ambulatory Care Facilities)

AND TOPIC: (Perceive* OR Learn* OR Lesson OR Pivot OR Adapt OR Recall OR Recollect* OR Remember OR Reflect* OR Continuous Improve*OR Success*OR Total Quality Management)

AND TOPIC: (Disaster Response OR Disaster Planning OR Emergencies OR Emergency Shelter OR Mass Casualty Incidents OR Medical Countermeasures OR Natural Disasters OR Rescue Work OR Crisis) AND TOPIC: (Resilience*).

Articles were restricted to the inclusion criteria (considering peer-reviewed journal research articles written in English) and besides application of exclusion criteria (psychiatric, community, and individual types of resilience without reference to hospitals).

The search results (420 articles) were imported into Covidence (Covidence systematic review software; Veritas Health Innovation; Melbourne, Australia) and duplicate records (111) were removed. A minimum of two reviewers conducted the title and abstract screening, full-text screening, and final determination of eligibility and study inclusion. This process started by screening the abstract blindly via Covidence. A third reviewer resolved any conflicts.

Data Analysis
Data analysis was undertaken using the approach from the Whittemore and Knafel framework. An assessment of the quality of the research methodology was undertaken using the revised Mixed Methods Assessment Tool (MMAT).29 Each item of MMAT was given a specific value according to the availability of the criterion (Yes [2]; Somewhat/Partially [1]; and No/Cannot Tell/Not Addressed [0]). Articles should have been assessed as more than 70% to be included in the current study. Information extracted from each paper was entered into a Microsoft Word 2018 table (Microsoft Corporation; Redmond, Washington USA). This information included: author(s), journal, country, type of disaster, methods, and the key themes. The conclusion regarding the number of resources included was reached through rigorous application of the PRISMA method, consultation with expert librarian support, and using Covidence software in blind review.
to ensure that: (1) the search for papers was adequately scoped about the search strings and the chosen databases; and (2) the curation of papers used appropriate inclusion and exclusion criteria.

**Results**

Out of 73 full-text screened papers, 37 papers were identified as being relevant to this study. Figure 1 summarizes the screening process against the PRISMA diagram. The quality appraisal tools yielded 22 articles for thematic and content analysis following the descriptive analysis (Supplementary Tables 1-3; available online only).

**Descriptive Analysis**

There has been a gradual and significant increase in relevant publications since 2006, with a peak in 2019-2021 when 16 out of 37 (43.2%) of the articles were published.

Several types of disasters were investigated in these 37 papers, including 15 papers that addressed infectious disease-related disasters (COVID-19 [11]; Ebola [2]; and non-specific infections [2]), followed by nine papers addressing disasters caused by extreme weather events (EWEs) like hurricanes (3), non-specific EWE (3), flood (2), and typhoon (1). There were five papers regarding mass-casualty incident (MCI)/terroristic attack/bombing, two earthquakes, and one bushfire. Five studies addressed non-specific disasters.

Following the application of the quality appraisal tools, 22 articles were included. Out of these 22 articles, two addressed non-specific disasters and 20 investigated specific disaster types. These specific disasters included infectious diseases (10: COVID-19 [6], Ebola [2], and non-specific infections [2]); EWE (7), and MCI/terroristic attacks/bombing (3; Supplementary Table 4; available online only).

**Thematic and Content Analysis**

First, the various frameworks and theories addressed in the literature were summarized; second, the adopted thematic and content analysis approach was explained; and third, the learning opportunities were depicted.

**Frameworks and Theories**—The system standards, theories, and frameworks adopted or addressed in the included articles were recognized and summarized (Supplementary Table 5; available online only). In addition, those relevant to resilience, disaster management, public health, quality and accreditation, or organizational management were depicted as follows.

Four studies adopted the PDSA quality cycle.1,30–32 Ten thematic categories described by Meyer, Bishai33 as the resilient health systems components and included “core health system capabilities/capacities, infrastructure/transportation, financing, barriers to care, communication/collaboration/partnerships, leadership/command, surge capacity, risk communication, workforce, and workforce infection control.”33 Five categories were identified by Walton, Navaratnam34 as themes for the UK’s emergency departments during COVID-19. These themes were departmental reconfiguration, clinical pathways, governance and communication, and workforce personal protective equipment (PPE). Eleven essential elements of public health emergency preparedness in the Resilience Framework for Public Health Emergency Preparedness (RFPHEP)35 were adopted by Aliyu, Norful8 to explore clinical staff’s preparedness for the COVID-19 pandemic. The RFPHEP
A content analysis was applied within each theme based on nine Adopted Thematic and Content Analysis Approach that emerged in the hospitals during or after disasters (Table 1). The “four S’s” Casiraghi adopted the theory of surge capacity.8 The significant learning opportunities within the three major disaster types encountered in included articles were analyzed in two sections, including four themes adapted from a hybrid method developed by Ali, Desha.26 This model merges the essential elements of the Hospital Safety Index (HSI) and Pan America Health Organization (PAHO) that should be included in evaluating hospital resilience as follows:

- The functional/operational section (staff/HCWs; system/ emergency and disaster management).
- The physical section: non-structural safety elements (eg, architectural safety, infrastructure protection, critical systems, equipment, and supplies) and structural safety elements (eg, building integrity and previous occasions and dangers affecting building safety).

A content analysis was applied within each theme based on nine learning areas (LAs). These LAs were developed by adapting the RFPHEP and represent the different learning opportunities that emerged in the hospitals during or after disasters (Table 1).

Disasters such as Hurricane Harvey (2017) or the early phases of the COVID-19 pandemic confused and frustrated the staff, who questioned the systems’ inconsistency in initiating the emergency response, their hospitals’ disaster response capability, and the frequently changing delivery care policies (LA 1). Additionally, staff were left without assurances in the dark, hearing gossip about the expected patients’ surge, and insufficiency of resources and PPE (LA 4 and LA 6).8,10

Significant resilience of HCWs was demonstrated in stressful infectious diseases working conditions (LA 5).34,39,41 Besides, their age, experience, and confidence in public health authorities contributed positively to their resilience (LA 5).40 The HCWs’ coping strategies during disasters included their sense of duty, religion, family and peer support, resources availability, and the risk allowance motivation (LA 1 and LA 6); communication platform availability (LA 1, LA 3, and LA 4); and orientation, training, and workshops boosting the staff’s confidence and performance regarding their conjoined stigma (LA 5).10,16,39–42 For example, during the Ebola outbreak, caesarean section surgery continued at Sierra Leone public hospitals due to the intrinsically motivated staff performing this surgery, despite infection risks and stigmatization (LA 5). Moreover, the staff surgery performing capacity increased by hospital support from non-governmental organizations and the World Health Organization (WHO; Geneva, Switzerland) agencies that provided the PPE, sterilization equipment and diagnostics, and facilitated the infection prevention and control implementation (LA 1 and LA 6).16

The terroristic attack in Norway and Mumbai underlined the need for public hospital strengthening. It highlighted the significance of HCWs’ continuous training and education in providing them with the experience, knowledge, and skills required for making rapid decisions enduring extreme situations (LA 5).30,43

The novelty was profound during disasters as hospitals’ clinical teams and staff members continuously created profound innovative ideas (LA 5 and LA 8) and practical problem-solving strategies in dealing with and coping with challenges (eg, patient surge and lack of PPEs, treatment protocols, or caring plans [LA 2 and LA 6]).5,31,44 Changes and modifications of official hierarchies empowered the clinical staff care delivery in the face of uncertainty

| LA       | Name                                             | Description of LA                                      |
|----------|--------------------------------------------------|--------------------------------------------------------|
| LA-1     | Governance and Leadership                        | One RFPHEP Element (Governance and Leadership).        |
| LA-2     | Planning and Risk Assessment                      | Two RFPHEP Elements (Planning Process and Risk Analysis). |
| LA-3     | Surveillance and Monitoring                       | One RFPHEP Element (Surveillance and Monitoring).      |
| LA-4     | Communication and Network Engagement              | Three RFPHEP Elements (Communication, Collaborative Networks, and Community Engagement) |
| LA-5     | Staff Practices and Safety                        | Two RFPHEP Elements (Workforce Capacity and Practice and Experience) and a new element recommended by the authors of this study (Staff Safety). |
| LA-6     | Equipment and Resources                           | One RFPHEP Element (Resources).                        |
| LA-7     | Facilities and Infrastructure                     | The current study’s authors recommended this learning area; it is not available in RFPHEP. |
| LA-8     | Novelty and Innovation                            | The current study’s authors recommended this learning area; it is not available in RFPHEP. |
| LA-9     | Learning and Evaluation                           | One RFPHEP Element (Learning and Evaluation). It was considered an overarching LA, representing the organizational learning and evaluation (in alignment with the aim of the current study). |

Table 1. The Nine Learning Areas (LAs) and Their Description. Abbreviations: LA, learning area; RFPHEP, Resilience Framework for Public Health Emergency Preparedness.
and allowed them to adopt an “all hands on deck.” The existing areas were converted into isolation sections, employees were redistributed to other work areas, supplies and equipment were strategically detailed, and educational endeavors were initiated (LA 3, LA 5, LA 6, and LA 8). In the same way, some nurse leaders responded to COVID-19 in novel ways and swayed from normal operations. Hence, a nurse manager labelled the suspected or confirmed COVID-19 cases as “blue patients” as an innovative strategy to keep patient confidentiality (LA 5 and LA 8). In addition, extraordinary clinicians and nurses collaborated to develop a flow chart and separate lanes for better patient management (LA 4 and LA 8). System/Emergency and Disaster Management—Concerning COVID-19 emergency response, a great significance of well-defined leadership, flexibility, and robust communication methods in responding to ever-changing clinical situations were reported in the UK (LA 1 and LA 4). Moreover, there was a genuine need for more communication in the US regarding policies, resources, patient management, and family visits (LA 4), as well as for continuous monitoring and evaluation of the disaster plans regarding the infected cases numbers; staff needs, safety, education and training, infection prevention compliance, and surveillance; and resources and patient care delivery (LA 2 and LA 3). Similarly in Singapore, a lack of a shared definition and decision making of surge threats led to replicating procedures (LA 1). The management was honest, reflecting their transparency principles (LA 1). Nevertheless, the top-down communication flow and instructions from authoritative persons to assigned members were inapplicable and unsuccessful (LA 4).

Many challenges were reported in the literature. Flooding in the UK caused health care disruption and, hence, institutional challenges in recognizing vulnerable and at-risk individuals. These effects highlighted the limited health care system preparedness and response capacity to the future changing climate risks (LA 2). The challenges in a terrorist attack in Beirut included three significant areas: an enormous influx to the emergency department of patients before plan activation, non-essential personnel, family members, and media personnel at the department entrance (LA 1 and LA 8); delay in plan activation and medical supplies deployment (LA 2 and LA 6); and inefficiency or inadequacy of patient registration, paper-based information systems, coordination, existing patients managing, and personnel roles due to ambiguity (LA 3-5).

Hospital decision makers fulfilled the effective health crisis response measures and needs in various ways; for instance, by increasing the staff in the incident command center (LA 5) and sharing planning experiences with the scientific community (LA 1 and LA 4). In Saudi Arabia, the hospital preparedness and response were based on the urgent governmental and public health authorities’ actions and adequate funds allocation. These actions led to hospital readiness and compliance with the WHO and the Centers for Disease Control and Prevention (CDC; Atlanta, Georgia USA) policies and procedures; staff, medicines, and equipment availability; and staff, patients, and visitors’ safety (LA 1, LA 5, and LA 8).
Hospital resources represented one of four factors that contributed widely to the hospital’s total disaster resilience ability (LA 6). Other factors included hospital safety, hospital disaster medical care capability, and hospital disaster management mechanism (LA 1 and LA 7).  

Organizational Learning and Evaluation (LA 9)  
During the SARS outbreak in Singapore, a learning opportunity stemmed from the lack of daily essential hospital supplies and PPEs and led to an enhancement in equipment and stockpiling preparedness since then (LA 6). Hence, when the next pandemic of Swine Flu struck, these resources were ready and accessible, and several hospitals autonomously stored PPEs and drugs for at least three days to have enough time to reorder in any sudden surge in Singapore (LA 1, LA 2, and LA 6).  

Italy suffered a high number of COVID-19 deaths among doctors, and many surgeons felt exposed to infection with an increased risk as the PPE supply was sometimes insufficient (LA 3, LA 5, and LA 6). For example, the Spedali Civili, one of the biggest hospitals in Italy, was highly impacted by COVID-19 infection. However, in its trauma hub, the organization and operational strategies of trauma service provided the health workers with all the mandatory PPE, and no new cases of infection were documented between the doctors and nurses in orthopedic wards and operating rooms (LA 3, LA 5, and LA 6). In addition, they had a well-defined strategy and protocols that supported the systems'
resilience and guided the staff members towards effective and high-quality care delivery (LA 1, LA 2, and LA 6).  

The Deming cycle PDSA addressed the hospitals’ organizational learning in the included studies. Most of the studies completed either two or three stages of the Deming cycle. Out of 22 studies, eight conducted the first three Deming stages (P, D, and/or S) with no further actions implemented. The remaining ten studies were either for one or two stages (P and/or D). Moreover, only four studies completed the entire Deming cycle (PDSA). These four studies adopted different approaches. For example, one of these studies included open-ended questions in the post-intervention survey to depict participants’ feedback and improve future interventions targeting disaster management as a part of the Quality Improvement project.  

Evidence-based educational leadership training aimed to enhance the disaster management knowledge and confidence of 50 nurse leaders to promote resilience, support of employees, and optimal patient outcomes. The results reported significant perceived knowledge and confidence development, with 33 participants completing the post-intervention survey. Hence, the nurse leaders were challenged to respond to the COVID-19 crisis in novel ways by varying their routine operations. In another study, the hospital planners learned from an earthquake experience and utilized it to complete the continuous improvement cycle. Thus, following the earthquake, they incorporated the recommendations developed by the hospital planners as a part of the hospital’s daily activities and monthly meetings of the Emergency Preparedness Committee. These actions eventually enhanced the hospital system’s resilience to future disasters.

Similarly in Lebanon, an analysis, summarizing, and debriefings were done following the terrorist MCI event to modify the hospital’s disaster preparedness plan. Finally, the fourth study addressed the success of the Emergency Medical Services in the local community hospital. Three external bodies evaluated it as successfully dealing with a terroristic attack in Norway. The study showed that the success elements included, but were not limited to, emergency preparedness and competence based on continuous planning, training, and learning. In addition, the involved hospital was one of “the pioneers in team training as part of a continuous quality improvement system.” Analysis of the finally included articles using the Deming cycle is presented in Table 2.

**Discussion**

**Organizational Learning and Evaluation in Hospital Disaster Management**

The findings in the current study showed that only four out of 22 studies completed the Deming cycle (PDSA) and ensured their insights were translated into action. These findings highlighted a gap in conducting continuous quality improvement following a disaster. During disasters, hospitals’ immediate response is facilitated by their existing organizational structures. However, most of them return to their routine activities once the catastrophe is ended. Thus, the knowledge that might be realized by reflective processes are missed. The incomplete learning cycle could be due to a lack of proper mechanisms for debriefing, under-estimating the value of sharing experiences, and reluctance to apply the prior experience and evaluation.

Organizational learning happens when experiences are transformed into beneficial changes in the organization’s collective knowledge, cognition, and actions. Thus, the organizational environment is critical to such learning. The concept of organizational learning is ascribed to developing the “active learning” approach, which employs small groups, rigorous statistical data gathering, and harnessing the group’s positive emotional energy. This approach is also used in Deming’s quality control system, employing quality circles and statistical process control. Similarly, in the resilience engineering approach, four categories of capabilities were defined, comprising: (1) Actual (to respond to events); (2) Critical (to monitor on-going developments); (3) Potential (to anticipate future threats and opportunities); and (4) Factual (to learn from past failures and successes).

Learning is a continuous process in an organization, such as a hospital. Organizational experiences are transferred from internal staff and external stakeholders and continuously converted into knowledge to improve organizational performance.

The current study portrayed the hospitals’ learning opportunities triggered by disasters and identified shared experiences for success and failure. The frameworks and theories adopted in the included literature were identified. The RFPHEP was modified into nine disaster learning areas used in the literature content analysis. Moreover, this process led to describing the most significant recommendations emerged from hospitals’ battles with disasters (Supplementary Table 6; available online only). Besides, a Hybrid Resilience Learning Framework (HRLF) was proposed for evaluating both organizational resilience and learning from disasters in this study. This HRLF was developed by enhancing the adopted RFPHEP framework and integrating it with the Hybrid Method for Hospital Resilience Assessment. The latter included the main sections of the HSI and PAHO (Figure 2).

**HCW’s Safety and Wellness**

Disaster management entails complex processes and systems and mandates a balanced approach to guarantee seamless patient care delivery and rigorous staff safety measures. Unfortunately, during real-life disasters, such balance is scarcely occurring. The findings in this study indicated several stressful factors affecting the physical and mental wellness of the hospital staff and HCWs; some of these stressful factors are unlikely to be preventable. Meanwhile, there were other compensating mechanisms as rejuvenating coping strategies. Hence, to ensure the HCWs’ physical safety and mental wellness, hospital decision makers should be able to create a balanced approach between both stressful and rejuvenating factors. A summary of these factors was conceptualized in this study (Figure 3).

**Limitations**

The selection of original peer-reviewed, English articles limited the included articles. The excluded research studies written in other languages and the excluded non-peer-reviewed articles could have valuable information to inform hospital disaster resiliency. A limitation of the study is the lack of outcome for hospitals and systems described in the literature when presented with a second disaster event or full functional testing of preparedness and resilience. Most of the literature and findings are theoretical in nature.

**Conclusion**

Drawing messages from disaster management is crucial for hospitals’ resilience in future crises. Following a thematic analysis of the findings, nine hospital learning areas were developed for content analysis. However, there is a gap in hospital application of prior experience and knowledge. Additionally, this study highlighted that the hospital decision makers must empower, guide, and motivate all HCWs by...
considering stressful factors and coping strategies. Hence, the authors proposed a "Hybrid Resilience Learning Framework" to evaluate resilience and organizational learning following disasters.

Acknowledgment

The corresponding author is a recipient of the Griffith University PhD scholarship (Postgraduate Research scholarship) and a Griffith University International Postgraduate Research scholarship.

Supplementary Materials

To view supplementary material for this article, please visit https://doi.org/10.1017/S1049023X2200108X

References

1. El Sayed M, Chami AF, Hitti E. Developing a hospital disaster preparedness plan for mass casualty incidents: lessons learned from the Downtown Beirut Bombing. Disaster Med Public Health Prep. 2018;12(3):379–385.
2. Hall ML, Lee ACK, Cartwright C, Marahatta S, Karji J, Simkhada P. The 2015 Nepal earthquake disaster: lessons learned one year on. Public Health. 2017;145:39–44.
3. Hannan RJ, Lundholm MK, Biradon D, Chapman NRM. Responding to unforeseen disasters in a large health system. Am J Health Syst Pharm. 2021;78(8):726–731.
4. Sojani MA, Huang H, Brantlweite J. Learning from incidents in healthcare: critique from a Safety-I perspective. Safety Science. 2017;99:115–121.
5. Bikomeye JC, Rubble CS, Beyer KM. Positive externalities of climate change mitigation and adaptation for human health: a review and conceptual framework for public health research. Int J Environ Res Public Health. 2021;18(5):2481.
6. Bayntun C, Rockenschaub G, Murray V. Developing a health system approach to disaster management: a qualitative analysis of the core literature to complement the WHO Toolkit for assessing health-system capacity for crisis management. PLoS Curr. 2014;6(1):e50286(037259).
7. Aitio E, Khayeri MY-E, Raja S, et al. Resilience training for hospital workers in anticipation of an influenza pandemic. J Contin Educ Health Prof. 2011;31(1):15–20.
8. AlYahwaji S, Norful AA, Schroeder K, Odlum M, Glica B, Travers JL. The powder keg: lessons learned about clinical staff preparedness during the early phase of the COVID-19 pandemic. Am J Infect Control. 2021;49(4):478–483.
9. Mulyasari F, Inoue S, Prashar S, et al. Disaster preparedness: looking through the lens of hospitals in Japan. Int J Disaster Risk Sci. 2013;4(2):84–90.
10. Ybara N. Hurricane Harvey: one hospital’s journey toward organizational resilience. J Perinat Neonatal Nurs. 2019;33(1):246–252.
11. Zhong S, Hou XY, Clark M, et al. Disaster resilience in tertiary hospitals: a cross-sectional survey in Shandong Province, China. BMC Health Serv Res. 2014;14:137.
12. Costa Font J, Levaggi R, Turati G. Resilient managed competition during pandemics: lessons from the Italian experience during COVID-19. Health Econ Policy Law. 2022;17(2):212–219.
13. White SJ, Baroile S, Cao di San Marco E, et al. Critical observations on and suggested ways forward for healthcare communication during COVID-19: ePEACH position paper. Patient Educ Couns. 2021;104(2):217–222.
14. Iyerger K, Maharaj A, Jain VK, Venkatasesu A, Vaidhya R. Learning opportunities from COVID-19 and future effects on health care system. Diabetes Metab Syndr. 2020;14(5):943–946.
15. Huang J-J. Organizational knowledge, learning, and memory—a perspective of an immune system. Knowledge Management Research Practice. 2013;11(3):230–240.
16. Drevin G, Alvesson HM, von Duiyen A, Bolkar HA, Koroma AP, Von Schreeb J. For this One, let me take the risk: why surgical staff continued to perform caesarean sections in the epicentre of the COVID-19 epidemic in Sierra Leone. Emerg Med J. 2019;4(4):10.
17. Hammad KS, Arbon P, Gebbie K, Hutton A. Why a disaster is not just normal business: hospital resilience during the COVID-19 pandemic. Int J Disaster Med Public Health Prep. 2021;8:11.
18. Yip SWK, Law KY, Toh M, et al. A checklist to improve health system resilience to infectious disease outbreaks and natural hazards. BMJ Global Health. 2020;5(8):1.
19. Hong QN, Fargues S, Bartlett G, et al. A Systematic review and meta-analysis of studies that evaluate resilience interventions: explanation and elaboration. Ann Intern Med. 2009;151(4):W65–W94.
20. Boodit H. Sustainable performance management using resilience engineering. International Journal of Engineering Management. 2020;12:1847977902976205.
21. Parij J, Wreathall J, Hutton A, Vrijhoef HJM. Resilience engineering in practice: A Guidebook. Farnham, UK: Ashgate Publishing; 2010.
22. Ali HM, Desha C, Ranse J, Reiko A. Planning and assessment approaches towards disaster resilient hospitals: a systematic literature review. Int J Disaster Risk Red. 2021;102319.
23. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. Ann Intern Med. 2009;151(4):W65–W94.
24. Yi-Feng Chen N, Crant JM, Wang N, et al. When there is a will there is a way: the journey toward organizational resilience. Emerg Med J. 2020;37(12):768–772.
25. Khan Y, O’Sullivan T, Brown A, et al. Public health emergency preparedness: a framework to promote resilience. BMJ Pub Health. 2018;18(1):1–6.
26. Cusimano A, Domenicucchi M, Cattaneo S, et al. Operational strategies of a trauma hub in early coronavirus disease 2019 pandemic. Int Orthop. 2020;44(5):1511–1518.
27. Murshid ME, Riaz BK, Islam Z, Haque M. Assessment of safety status and response capacity of selected primary health care hospitals in Bangladesh. Euras J Emerg Med. 2019;18(3):137–141.
28. Voron L, Lestari F, Wijaya O. Hospital safety index: assessing the readiness and resiliency of hospitals in Indonesia. Facilities. 2019;37(12):39–51.
29. Raven J, Wurie H, Winter S. Health workers’ experiences of coping with the Ebola epidemic in Sierra Leone’s health system: a qualitative study. BMC Health Serv Res. 2018;18(1):9.
30. Toner ES, McGinty S, Schoch-Spana M, et al. A community checklist for health sector resilience informed by Hurricane Sandy. Health Security. 2017;15(1):53–69.
31. Balay-oado EM, Alquez N, Irocain EP, Aloitaib RS. Hospital preparedness, resilience, and psychological burden among clinical nurses in addressing the COVID-19 crisis in Riyadh, Saudi Arabia. Public Health. 2021;81:11.
32. Hsien-Chen C, Grant JM, Wang N, et al. When there is a will there is a way: the role of proactive participation in combating COVID-19. J Appl Psychol. 2021;106(2):199–215.
33. Roy N, Kapil V, Subbarao J, Arshadzai I. Mass casualty response in the 2008 Mumbai terrorist attacks. Disaster Med Public Health Prep. 2011;5(4):273–279.
34. Singh SR, Coker R, Vrijhoef HJM, et al. Mapping infectious disease hospital surge capacity? Factors influencing efficiency of disaster response. Disaster Med Public Health Prep. 2018;12(2):176–183.
46. Chand AM, Loosemore M. Hospital disaster management’s understanding of built
environment impacts on healthcare services during extreme weather events. 
Engineering Construction and Architectural Management. 2016;23(3):385–402.
47. Chand AM, Loosemore M. A socio-ecological analysis of hospital resilience to 
extreme weather events. Construction Management and Economics. 2015;33(11–12): 
907–920.
48. Chand AM, Loosemore M. Hospital learning from extreme weather events: using 
causal loop diagrams. Building Research Information. 2016;44(8):875–888.
49. Landeg O, Whitman G, Walker-Springett K, Butler C, Bone A, Kovats S. 
Coastal flooding and frontline health care services: challenges for flood risk 
resilience in the English health care system. J Health Serv Res Pol. 
2019;24(4):219–228.
50. Lyman B, Hammond EL, Cox JR. Organizational learning in hospitals: a concept 
analysis. J Nurs Manag. 2019;27(3):633–646.
51. Garratt B. The learning organization 15 years on: some personal reflections. The 
Learning Organization. 1999; 6(5):202–207.
52. Wang CL, Ahmed PK. Organizational learning: a critical review. The Learning 
Organization. 2003; 10(3):8–17.
53. Argote L, Miron-Spektor E. Organizational learning: from experience to knowledge. 
Organ Sci. 2011;22(5):1123–1137.