Trauma Monthly 2026; 31(4): 2028-2039

10.30491/tm.2026.591598.1959

Trauma Monthly

Research Article

Hospital Response to Trauma-Related Mass Casualty Incidents: A Qualitative Content Analysis of Experts' Experiences in Iran

Mehdi Tajik-Nodijeh[1], Golrokh Atighechian[2], Mehdi Nasr Isfahani [3], Nahid Tavakoli [4*]

[1] PhD candidate, Emergency & disaster Health department, School of Management and Medical Information Sciences, Isfahan University of Medical Sciences, Isfahan, Iran

[2] Health Management and Economics Research Center, Isfahan University of Medical Sciences, Isfahan, Iran

[3] Department of Emergency Medicine, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran

[4] Health Management and Economics Research Center, Isfahan University of Medical Sciences, Isfahan, Iran

***Corresponding Author:** Nahid Tavakoli; E-mail: tavakoli@mng.mui.ac.ir; Orcid.org/0000-0002-2921-3283

Received 2025-10-05 ; **Accepted** 2026-06-25; **Online Published** 2026-08-29

Abstract

Background: Trauma-related mass casualty incidents (MCIs) can rapidly overwhelm hospital capacity and disrupt routine care processes. Hospitals therefore have central roles in receiving, triaging, treating, and coordinating casualty management. Despite the burden of trauma-related MCIs in Iran, evidence for hospital response planning based on expert experience remains limited. This study explored experiences of hospital experts involved in MCIs in Iran and developed a hospital response framework for traumatic mass casualty incidents.

Methods: This study is qualitative in nature and was carried out in 2025 in eight provinces of Iran utilizing semi-structured interviews. The participants in this study were selected based on purposive and snowball sampling—eligibility factors included at least five years of hospital-based work experience involving traumatic MCIs. Data collection and analysis were conducted simultaneously until themes were saturated after analyzing a total of 20 interviews. Interviews were audio-recorded, transcribed verbatim in Persian, and analyzed using inductive thematic analysis. Lincoln and Guba's criteria ensured trustworthiness, and reporting followed the COREQ checklist.

Results: A total of twenty individuals took part in the study. The analysis produced a total of seventy-four codes, eleven subcategories, and three main categories that concern the actions taken by hospitals across all stages of operation. The Immediate Stage, which consisted of the initial notification and the implementation of the Hospital Incident Command System, the use of surge capacity and resource management technology, triage and patient identification technology, work with communication and information technology, and security and traffic management practices, was noted. The Intermediate Stage included treatment and continuity of care, transfer, referral to other health care institutions, and management by specialists. The Continuing/Recovery stage was characterized by monitoring discharged patients and completing patient folders.

Conclusion: The findings provided a three-phase framework for hospitals' response to traumatic MCIs based on the input of an expert panel in Iran. The framework mainly concentrates on coordinated command, quick expansion of capacity, organized flows of patients, involvement of specialists, mental care provided, and organized recovery efforts. It will allow hospitals to increase coordination in their responses, continue care provision, and improve the management of traumatic MCIs.

Keywords: Mass casualty; Hospital; Response; Trauma

Introduction

Incidents that cause mass casualties, such as natural catastrophes, serious industrial mishaps, or severe road crashes, create pressure on medical systems struggling to take in large numbers of patients [1-4]. The rapid growth of industries, as well as the high number of road traumas in Iran, leads to regular instances when many injured patients arrive [3]. To manage such occasions, it is crucial to have an effective and unique hospital command of operations that is capable of fast mobilization of medical personnel and quick triage[3-5]. While structured

Copyright © 2026 The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

frameworks such as the Hospital Incident Command System (HICS) provide foundational response architecture, their practical execution often falters during acute surges[2-4]. Effective disaster management in healthcare, rather than strict administrative structures, hinges on operational processes that are capable of negotiation between resourcing surge expansion, delivery of quality clinical care, and severe resource constraints. It is imperative to comprehend local operational dynamics, which are critical to health disaster resilience building.

Comparison with International Evidence

International proof uncovers the fact that though principles of disaster response are globally accepted, their operational implementation varies according to the context of events. Healthcare systems of developed countries usually depend on the presence of established mutual assistance and partners, electronic tracking systems, and developed backup arrangements in order to cope with the effects of disasters. On the other hand, developing countries (LMICs) face serious problems such as the inability of their systems to adapt to the situation and delayed assistance from the outside, as well as the varying identification rate of the medical staff. Hospitals in Iran constantly face different operational obstacles in case of emergencies, starting with people converging on one hospital and ending with delayed inter-hospital coordination. In addition to that, though international regulations emphasize the significance of staff protection, practical help on the spot does not take place in many countries. Thus, the use of previously developed disaster models does not always seem appropriate. The research in local hospitals provides an opportunity to ensure the success of combining two different sides of the issue. The aim of the study is to investigate the experiences of hospital staff.

Method

Study Design and Objectives

The research was performed in 2025 across eight provinces of Iran (Nebida, Tian, Moore, Golistan, Isfahan, Kerman, Mazandaran, Kermanshah, Semnan, and Hormozgan) using data acquired from in-depth semi-structured interviews through an inductive thematic analysis methodology. The provinces were purposefully selected to create a diversity of geographical characteristics, population characteristics, health service infrastructure, hospital referral capability, and trauma-related hazard exposure. They covered northern, central, western, southeast, and southern provinces and included hospitals that had advanced referral systems and provinces that had either limited resources or geographical dispersion. The choice of provinces was made to enhance provincial representation but did not aim to create a statistically representative sample from a national perspective.

It aimed to explore the experiences of professionals previously involved in trauma-related mass casualty incidents in Iran. Participants included hospital and health system managers, emergency organization managers, managers of treatment departments at medical universities, emergency medicine specialists, emergency physicians, head nurses, emergency nurses, hospital clinical supervisors, secretaries of hospital crisis committees, professors of disaster and emergency health, and technical experts and specialists in hospital mass-casualty management. Purposive maximum-variation sampling, supplemented by snowball sampling, was used to recruit information-rich participants with relevant experience aligned with the study objectives[23]. The selection of the first participants was done based on their job capabilities and their exposure to experiences with mass-casualty incidents. The successive participants were selected through referral from the previous participants[24]. The method has proven its value for obtaining subjects with relevant backgrounds and motivation to participate in the study. Qualitative research is a naturalistic interpretative methodology in which phenomena are studied in their natural environment[25].

Setting and Participants

Sampling continued with the aim of achieving maximum diversity in profession, educational background, field of expertise, clinical experience, and organizational role. Data collection and analysis proceeded concurrently until thematic saturation was achieved-that is, no new codes or themes emerged from subsequent interviews. Code saturation was reached after 17 interviews and confirmed by three additional interviews, which generated no new codes or subcategories.

In the interviews conducted, participants answered questions about their past experiences with MCI-related training and exercises. The participant-characteristic form did not delineate between the different kinds of HICS training candidates underwent, which made it difficult to collect participant-level frequencies

retrospectively. This is a methodological limitation acknowledged, since exposure to HICS in the past could have impacted their responses. The participants needed to have had a role in managing at least one incident of traumatic MCI.

Data collection

The researchers gathered data via semi-structured interviews conducted over a period of 25–78 minutes. To determine the recurring patterns of response related to various incidents, such as road-traffic accidents, earthquakes, explosions, fires, collapses, and events related to crowds, the sampling method referred to as maximum variation was used. Participants who had experienced multiple incidents in the past were interviewed and asked to give precedence to those incidents where they had acted as leaders directly.

An interview guide based on relevant literature, with open-ended questions, was piloted (Table 1); pilot data (n=5) were excluded from final analysis. Initial interviews were held face-to-face in the provinces of Golestan and Isfahan, with subsequent sessions being conducted over secure videoconferencing. To minimize recall bias, considering the variable intervals since the incidents, the approach was chronological event reconstruction and specific probing. All sessions were audio-recorded with the written informed consent of the participant and were subsequently transcribed verbatim into Persian and checked for fidelity of transcription by a second researcher independently.

Data analysis

Data analysis was conducted concurrently with data collection using inductive thematic analysis based on the six-phase framework of Braun and Clarke. This approach was chosen for its flexibility and suitability for identifying patterns of meaning across diverse professional perspectives[24]. Following transcription, each interview transcript was read repeatedly to achieve familiarization with the data. Codes were generated independently by two researchers, and disagreements were sorted out through reflexive discussion. The process led to the development of a codebook, which was further refined through comparative analysis of the transcripts. An effort to improve analytical rigor entailed the independent coding of a portion of the transcripts by another qualitative research expert. After developing the codes, the main researcher reviewed all the transcripts to ensure uniformity in the coding of codes. Themes emerged through the identification of repetitive and coherent patterns that conveyed common meanings in the experiences of hospitals to MCIs. Data management and analysis were carried out using MAXQDA version 20 software (VERBI Software, Germany). Member checking was done in an effort to improve the credibility of the findings through the presentation of a summary of the preliminary themes to some participants for validation.

Rigor and Trustworthiness

To ensure the rigor of this qualitative study, Lincoln and Guba's criteria were applied.

Credibility: Established through prolonged data engagement, member checking with five participants, and peer debriefing.

Dependability: Ensured by maintaining a comprehensive audit trail and documenting all methodological decisions.

Confirmability: Achieved through collaborative coding, direct participant quotations, and reflexive journaling.

Transferability: Supported by rich contextual descriptions and detailed demographic data.

Reporting Standards

This study adhered to the COREQ guidelines for comprehensive and transparent reporting of qualitative research.

Results

A total of 20 experts participated in the study. Participants were 32 to 49 years old and had a mean professional experience of 16.45 years. Of them, 11 were male and 9 were female. Detailed demographic and professional characteristics are presented in Table 2.

Analysis of the interview transcripts exploring hospital experts' experiences of hospital responses to mass casualty incidents (MCIs) resulted in the identification of 74 codes, 11 subcategories, and three main categories. The main categories comprised: (1) Planning for immediate response at the onset of the incident (Immediate Phase), (2) Planning for stabilization and sustained response during the incident (Intermediate Phase), and (3) planning for recovery and demobilization after containment of the incident (Continued/Recovery Phase) (See Table 3). The complete list of codes and subcategories is provided in Supplementary Table 1.

Table 1. Semi-structured Interview Questions

Sequence	Question
1	What impact did the mass casualty incident have on your hospital, and what was your role in responding to it?
2	What new response requirements emerged in your hospital during the incident?
3	Which components of your hospital's mass casualty preparedness or response plan functioned effectively, if applicable?
4	How would you describe internal and external communication and information coordination during the response?
5	What training or exercises had you completed related to mass casualty response prior to the incident?

Table 2. Characteristics of the study participants

No.	Sex	Work experience (years)	Professional expertise	Age	Duration of interview (minutes)
1	Male	12	Nurse Supervisor	34	31
2	Male	15	Hospital Manager	41	38
3	Female	11	Nurse	32	45
4	Male	21	Nursing Manager	48	45
5	Female	23	ED Head Nurse	45	52
6	Female	11	Nurse Supervisor	46	55
7	Female	12	Hospital Manager	44	40
8	Male	17	Nurse Supervisor	47	66
9	Male	15	Nurse	39	50
10	Female	14	Nurse Supervisor	38	25
11	Female	13	Nursing Manager	40	30
12	Female	13	ED Head Nurse	38	68
13	Male	23	ED Head Nurse	38	70
14	Male	21	Emergency medicine specialist (EM)	42	70
15	Male	26	Nurse	44	70
16	Female	19	Nurse Supervisor	41	55
17	Male	15	DEH Academic Staff	43	78
18	Male	16	Nursing Manager	40	38
19	Female	14	DEH Academic Staff	44	30
20	Male	18	Hospital Manager	49	35

EM: emergency medicine; ED: emergency department; DEH: Disaster and Emergency Health

Table 3. Main categories, subcategories, and number of codes identified through data analysis

Main Categories	Subcategories	Number of Codes
Immediate Phase	Initial Notification and HICS Activation Surge Capacity and Resource Management Triage and Patient Identification Systems Communication and Information Management Security and Traffic Control	42
Intermediate Phase	Treatment and Continuum of Care Transfer and Referral Patients to Other Medical Centers Specialist Physician Management Activation of the Social Work and Psychology Unit	28
Continued/Recovery Phase	Follow-up of Discharged Patients Verification and Completion of Trauma Patient Files	4

Immediate Phase

According to the point of view of the involved individuals, the hospital's response plan during an MCI is one of the most important aspects of the community's ability to be resilient. The primary role played by the plan is to help the hospital move from its regular functioning to responding to the MCI. In this way, the plan helps manage the large number of patients in an organized manner.

Initial Notification and HICS Activation

According to participants, the Initial Notification and HICS Activation component is the starting point of the hospital emergency response. It begins with pre-hospital EMS notification, followed by immediate notification of

the Incident Commander and activation of HICS. As expressed by participant No.4: "The first alert about the event was made by the hospital staff on social media, and soon after, the Emergency Operations Center alerted the hospital personnel that there may be numerous casualties coming into the hospital in the near future, therefore activating the crisis code." As expressed by participant No.1: "Once the event is confirmed from reliable sources, the hospital supervisor needs to evaluate the magnitude of the event, casualties, injuries, etc., in order to activate the HICS."

Surge Capacity and Resource Management

From the participants' perspective, effective response to mass casualty incidents depends on rapid expansion of hospital capacity and organized resource management. These activities include the discharge or transfer of eligible patients, making beds available, use of alternate space, supply of essential equipment, and continuous evaluation and requisition of resources as per the response capacity. According to participant No.1: "In order to increase the capacity of emergency departments, outpatients must be discharged, and in-patients need to be either discharged or transferred, and beds from other wards must be made available for incoming patients." According to participant No.14: "If casualties are more than what can be handled in the hospital, alternate pre-arranged places such as hallways or mosques may be utilized for increasing hospital capacity." According to participant No.10: "Consumable medical supplies and equipment must be available in predetermined quantities in emergency departments and crisis inventory." According to participant No.9: "Hospitals must evaluate the availability of equipment and resources even before the occurrence of any disaster and estimate the amount of resources needed as per the response capacity."

Triage and Patient Identification Systems

The participants have indicated that this process starts with mass casualty triage in order to sort out the casualties based on urgency. In order to minimize internal crowding and keep up the flow, triage should take place outside the emergency room, normally within a triage tent. As indicated by participant No.10: "Triage outside the emergency room should be equipped with sufficient material, especially enough triage tags and patient transportation material, such as wheelchairs and stretchers." According to participant No.1: "Registration of patients either manually or electronically is very important in order to prevent mistakes in the identification and registration of the patients, especially for green-tagged patients released after initial triage."

Communication and Information Management

Participants believed that Communication and Information Management was central to the hospital's response to mass casualty incidents. It begins with managing internal communication tools and patient tracking and documentation systems to maintain a clear real-time overview. As stated by participant No.7: "Communication between hospital departments and the incident commander must remain reliable, and if problems arise, alternatives such as walkie-talkies and backup technical support should be used." As stated by participant No.5: "Overcrowding and heavy workload may lead to loss or corruption of system data and patient records, which can be prevented by an experienced medical records specialist verifying and archiving documents."

Security and Traffic Control

Participants identified Security and Traffic Control as essential for maintaining a safe and organized hospital environment through lockdown procedures, access control, law enforcement collaboration, and traffic management. Participant No. 15 stated: "In mass casualty incidents, the hospital grounds and emergency department often become overcrowded… Physical security personnel, in cooperation with law enforcement, must monitor the entrance… to prevent this problem". Participant No. 6 emphasized that: "Traffic police should play an active role in preventing traffic congestion… and ensuring that medical staff and doctors can reach the hospital… to ensure full coordination".

Intermediate Phase

The Intermediate Phase was regarded by respondents as a necessary process of MCI treatment in hospitals. The Intermediate Phase is responsible for continuity of treatment, patient flow management, timeliness of specialists' interventions, and psychological support. The Intermediate Phase assists in shifting from emergency interventions to continuous treatment without compromising treatment continuity and overcrowding. Four sub-categories have been derived: Treatment and Continuity of Care, Transfer and Referral to Other Medical Centers, Specialist Physician Management, and Social Work and Psychology Unit.

Treatment and Continuity of Care

Treatment and Continuity of care were considered essential in emergencies. The hospital maintains uninterrupted care by coordinating the emergency department, operating rooms, inpatient wards, paraclinical units, and blood bank. Key elements included department-wide preparedness to prevent emergency department overcrowding and ensure its capacity for new cases, as well as the requirement of adequate staffing, surgical instruments, sterile packs, and sterilization in the operating room. As per participant No.11: "Other departments should be prepared for the reception of patients for further treatment in order for the emergency department to avoid overcrowding and ensure the capacity for new casualties." As per participant No.8: "The efficiency of operations in the operating room is dependent on sufficient personnel, enough surgical instruments and sterile packs, and sterilization through the Central Sterilization Unit."

Transfer and referral patients to other medical centers

Patient transfer and referral to other medical centers were highlighted as important components of MCI response. An efficient transfer and referral system helps prevent frontline hospitals from exceeding surge capacity and supports continuity of care by using the capacity of other hospitals. As stated by participant No.2: "Utilizing the capacity of other hospitals through ambulance transfers can help manage mass casualties, and factors such as distance between cities and hospitals, as well as ambulance capacity, are influential in this matter."

Specialist Physician Management

In the current study, it was noted that the management of Red-Tag casualties involved much more than primary triage. The participants pointed out the need for prompt involvement of experts such as anesthesiologists, orthopedists, general surgeons, and radiologists in order to intervene promptly. According to Participant No.13: "Surgeons and anesthesiologists should be immediately available. Involvement of a general surgeon for red-tag casualties transferred into the OR can facilitate timely intervention."

Activation of the Social Work and Psychology Unit

It is worth mentioning that psychological effects need proper handling alongside the recovery of supply and operation. It is noted that proper psychological help will help reduce stress and other implications. According to participant No.7, "The hospital should be able to provide psychological assistance using social workers and psychologists to help reduce stress and anxiety for patients and their families."

Continued/Recovery Phase

From the participants' perspective, the Continued/Recovery Phase of hospital MCI response is important for restoring routine functions and improving post-incident preparedness. It supports a structured transition from response to recovery. Two subcategories were identified: Follow-up of Discharged Patients and Verification and Completion of Trauma Patient Files.

Follow-up of discharged patients

It was highlighted that during the period of activation of surge capacity, there are patients in the hospitals who are discharged in order to have extra beds; hence, there should be proper documentation in case more attention is required for them. Participant no. 15 highlighted this as follows: "In the post-recovery phase, a list of discharged casualties should be available along with a follow-up officer to contact them."

Verification and completion of trauma patient files

The present study showed that the medical records unit must accurately collect and organize casualties' identity and treatment documentation so it can be provided to relevant organizations when needed. As stated by participant No.9: "Many casualties later seek medical records to pursue claims with insurance companies and other organizations, so maintaining complete records is essential in the recovery phase."

Discussion

This qualitative study established an operational, phase-based hospital response framework for trauma-related MCIs in Iran, synthesizing healthcare experts' perspectives across three core phases, 11 subcategories, and 74 codes.

Immediate Phase

The first phase pointed out an important disconnect between administrative readiness and actual execution. Consistent with previous research findings[26], operational effectiveness depends more on well-defined criteria and strong interorganizational coordination than on strict procedures. Though standardizing the process of communication speeds up HICS activation[27], over-centralization is likely to result in communication bottlenecks under poor communication conditions[2,3]; thus, command systems have to achieve an appropriate balance of formal and informal control.

Expansion of surge capacity should be functional rather than just physical. Quick expansion of the capacity of space without an increase in the number of diagnostic and staffing capacities only shifts the problem downstream. Reverse triage and early discharge help to free beds[27,28], but require proper medical control to avoid transferring the risk[3]. In our local environment, pre-tested capacity from outside organizations (halls or community centers nearby) may be considered a flexible additional capacity, when logistics and clinical requirements are met beforehand.

Effective triage and patient identification must function as dynamic, continuous reassessments across entry, treatment, and transfer points, rather than isolated events[29-31]. While external triage posts relieve emergency department saturation[29], their efficacy relies entirely on synchronization with downstream definitive care pathways. Finally, security and traffic control remain interdependent with clinical throughput; adaptive perimeter lockdowns and law enforcement coordination prevent overcrowding while preserving essential ambulance ingress and staff mobilization[31-33]. Ultimately, immediate phase effectiveness depends on the dynamic synchronization of command, surge, triage, and security functions.

Intermediate Phase

This step involves managing patient flow and sustaining care continuity. Continued response hinges on planned pathways and transfers among different departments to avoid overload in the emergency room[34]. For continuity in critical departments such as the ICU, operating theatres, and diagnostic departments, an effective system of identification is required. With the transfer of patients among different teams, any problem that arises from reconciling different temporary IDs can result in medication errors, incomplete diagnosis, and delayed treatment[35]. Patient management tools have to be systematic to guarantee proper data continuity from surge to discharge.

Inter-hospital transfers are important for balancing the burden on the hospitals involved in the trauma networks. However, lack of coordination in patient transfer creates problems for the receiving hospital; coordination is necessary in trauma networks with the help of regional command, capacity data, and transport[36]. In addition, a second surgery triage should move from decision-making at an individual level to an organized, protocol-driven framework involving emergency medicine, anesthesia, and surgery.

Lastly, mental health services play an important part in the operations rather than being supportive of the operations. Psychological first aid and structured support for patients, families, and personnel, especially when considering vulnerable groups such as children, are essential to the HICS process in order to cope with acute stress reactions and separation from family members[37].

Continued/Recovery Phase

There were also fewer qualitative codes in the Continued/Recovery Phase, reflecting the fact that recovery planning after the acute period is still less operationalized than acute triage. This mismatch is essential due to the fact that early surge response plans like reverse triage and rapid discharge pass unaddressed medical and psychosocial risk factors on to the community. Hence, recovery planning must begin during the acute phase of disaster response rather than waiting until the surge ends. Follow-up for discharged patients (both premature evacuations of inpatient and green-tagged patients) must be conducted in order to identify any overlooked injuries, any medical problems, and psychosocial distress while also clarifying outpatient treatment options[38]. Instead of an unworkable universal follow-up plan, a risk-based follow-up strategy for rapidly discharged or high-risk patients using telemedicine connections and primary care connections must be pursued. Documentation review post-incident is just as important. Lack of documentation affects patient safety and medical continuity[39]. In order to avoid distracting clinicians away from their work during surge times, hospitals must use a standard minimum dataset during the acute phase and then reconcile during the continued/recovery phase.

As a whole, it is clear that hospital MCI management is a continuum where each stage depends on another rather than being three independent processes. Namely, acute capacity expansion directly determines what further documentation and follow-up should be done. Even though it varies from one setting to another, depending on whether it is a rural or tertiary institution, this framework gives a well-defined basis for being ready for such situations.

Role of Technology in MCI Response

Some digital technologies might also aid many aspects of the suggested framework. Digital patient identification and tracking, real-time dashboards, interoperable health record systems, telemedicine, and hospital capacity monitoring systems might facilitate

situational awareness, communication, patient distribution, and documentation continuity throughout response phases[40,41]. AI-enabled triage might also assist healthcare providers in synthesizing vital signs, injury patterns, and resource availability, as well as identifying patients who need urgent reassessment[42]. However, such solutions must complement rather than substitute trained healthcare providers since algorithm performance might deteriorate in case of overcrowding, missing data, infrastructure breakdowns, and population-specific peculiarities. Thus, their introduction will also require local validation, human oversight, interoperability, cybersecurity and privacy protections, training, and planned manual backups[43]. In areas where resources are limited, emphasis should be placed on cost-effective technologies that continue functioning regardless of power outages and network failures[43,44]. Future simulations could assess whether these technologies increase the accuracy of triage, tracking continuity, communication reliability, and transfer decision-making without causing delays, biases, or risks related to the over-reliance on automation[44].

Applicability and Adaptation for Different Hospital Settings

This suggested framework consists of certain principles that are not supposed to be used in a standardized format. It is essential to customize the framework to every hospital's environment, including geographic position, the level of care, type of ownership, governing structure, personnel, facilities, and resources. Urban and tertiary hospitals are to implement all the framework components in the context of multidisciplinary teams, specialized departments, sophisticated diagnostics, and incident command. Rural and primary-care hospitals need to concentrate on the issues of fast triage and stabilization, cost-effective surge capacity, communication, and timely transfer to referral centers as the specialist staff, blood, operating rooms, and intensive care unit resources may be inadequate[3,29,32].

Teaching hospitals can benefit from the use of residents, educational experience, simulation activities, and multidisciplinary committees, although role definition and supervision will be needed. Non-teaching hospitals will need less complicated protocols, cross-training, referral arrangements, and technical assistance[30,31,45]. While military hospitals could focus on command discipline, security, preparedness, and response to conflict-related injuries, civilian hospitals need to improve cooperation with EMS, governmental agencies, and other community resources[5,8,9]. Public hospitals may be more burdened and restricted by their resources; private hospitals, on the other hand, may be less restricted in their procurement but different in their economic, legal, and referral considerations. Governance structures and resource-allocation mechanisms should thus be locally determined[28,29].

Adaptations should take place in all three stages of the framework-its immediate, intermediate, and continuity/recovery stages. Every hospital will need to assess hazards and capabilities locally, determine its critical and adaptable features, and then adapt the framework and evaluate the adaptations through drills and Plan–Do–Study–Act loops. Context-specific indicators such as time of activation of the command system, surge capacity, accuracy of triage, delays in transfers, psychosocial care, follow-up care, and documentation completeness will inform revisions. Alternative locations for surge capacity that are culturally and operationally appropriate could also be considered within local adaptations.

Adaptability of the Framework Across Diverse Mass Casualty Incident Scenarios

The suggested model cannot serve as a universal guideline for MCIs of any kind. Rather, it proposes an operational core that consists of incident command system activation, fast triaging, expansion of surge capacity, communication, resource allocation, psychosocial interventions, and continuity of care. The implementation of the model should take into account the nature of the event, casualty profile, residual hazards, security situation, infrastructure availability, and specialized interventions[1,6,7,35].

Regarding road traffic MCIs, which are especially common in Iran, the most important considerations include fast triaging, bleeding control, stabilization, surgical readiness, and proper distribution of casualties depending on the severity of injuries and hospital capacity[3,18,26,30]. On the contrary, terrorism and military conflicts require security and health care sector cooperation, control of hospital access, secondary threat preparation, provision of a safe clinical environment, and continuity of care amid continuous threat[8,34,46]. Earthquakes and floods can at one and the same time result in injuries and disruptions in transport, utilities, communications, staffing, and logistics. Consequently, situations such as these demand decentralized planning, alternative treatment locations, adaptive surge capacity, and long-term logistics[13,15,16,31].

Incidents in industries involving the presence of any hazard involving chemicals or radiological agents will need assessment of the hazard, protection of responders, access restriction, decontamination, and decontamination before proceeding with further treatment in uncontaminated areas. In view of the fact that these incidents may involve illnesses arising from exposure along with traumatic injuries, standard trauma triage will have to be followed by hazard-specific triage and consultation[6,7,35]. Children involved in mass casualty incidents will need age-appropriate triage, appropriate dosage of equipment and medicines, protection, family identification and reunification, and psychological assistance[9]. Burn disasters require immediate identification of airway injury, specific burn management, hypothermia prevention, and rapid coordination with regional burn centers, since capacity may be quickly overwhelmed[47].

Thus, operationalization of the framework will take place through scenario-specific annexes, pre-defined activation criteria, referral procedures, and resource inventories. The modifications will have to be tested using hazard-specific tabletops and simulation exercises, as preparation for one incident type does not automatically lead to preparedness for another[2,5,27,48]. This modular system allows standardized core functions and customized response to different traumatic MCI situations.

Limitations and Future Research

Some senior hospital managers and policymakers could not participate, which may have limited representation of managerial and policy perspectives. Telephone and online interviews improved participation but may have reduced observation of nonverbal communication and rapport. Future research should evaluate the proposed Immediate, Intermediate, and Continued/Recovery Phases in diverse hospitals using larger samples and quantitative or mixed-methods designs. The research should measure coordination, flow, and continuity of care, resource utilization, and hospital performance; test various response plans; and explore training, simulations, and exercises in order to gauge feasibility and effectiveness and make further revisions. The time frame between the index MCI and the interview was not consistently documented among all study subjects. Even with the use of chronological and event-oriented questioning in an attempt to help the subject recall the events, those participants who had been through the event much earlier might have given a less clear and reconstructed account of the event.

Comparison with International Models and Unique Contributions

The three-phase structure identified in this study-Immediate, Intermediate, and Continued/Recovery-does not seek to replace established international disaster-response models. Instead, it operationalizes these models for trauma-related mass casualty incidents within actual hospital settings. In international guidelines, the process of MCI response in hospitals is always described as a multistage process consisting of command activation, surge capacity creation, managing patient movement, maintaining critical services, and recovery after the MCI. According to recent scientific research related to mass casualty management, presented in the 2025 systematic review and guideline update, there are several factors that play an important role in MCI response, including triage, logistics, transportation, and training[1,2,49]. As for ASPR TRACIE hospital response guidance, there are several crucial factors that should be considered during the initial phase of response[1,2,49]. An analysis of a hospital MCI preparedness and response plan in light of the Beirut explosion event of 2026 showed the presence of vulnerabilities regarding activation, communication, interdepartmental coordination, and resource mobilization. This analysis confirms the conclusion that success in MCI response relies less on theoretical preparedness plans and more on their direct operationalization[50]. Altogether, these references show that the phased approach to MCI response is internationally accepted, but what it really boils down to is adaptation of these general concepts into practical hospital protocols.

The purpose of this study is to adapt the internationally accepted disaster response plans into a phased MCI framework based on the experience with this type of disaster in Iran. In addition to providing general initial response steps, this framework includes some critical localized aspects, such as the use of nearby public spaces to handle the surge, establishment of roles for specialist personnel during secondary surgical triage, and creation of documentation and discharge procedures for traumatized patients.

Barriers to Implementation and Systemic Challenges

Even though the existing results have provided insight into the key factors that should be taken into account when responding to trauma MCIs, the main problem is their consistent application in practice under emergency

conditions. Rapid incident command setup, triage process, and expansion of capacities were seen by respondents as the key points. However, their narratives reveal that many organizational weaknesses limit their implementation. It is consistent with the evidence that shows that, even though there are preparedness plans, the hospitals have problems in logistics, coordination, and evaluation[2,48,51,52].

One of the key barriers that arise is the difference between policies and the ability to implement them. With the focus on coordination and roles in the research, it is clear that, for effectiveness, the ability to implement the authority lines and the activation process on a regular basis will be necessary. In similar environments and recent research, it has been seen that even though hospitals have incident management charts, most of the time, there is no functional emergency operations center and no subplans for hazard management[51,52]. It has been seen that communication continues to be a challenge in implementation. It has been observed that with clinical needs arising simultaneously in an MCI, communication becomes difficult.

The results further indicate that surge strategies, such as reverse triage and the use of alternative care areas, are operational only when supported by pre-arranged logistical readiness. Evidence shows that hospital command functions are often more developed than logistics. For instance, in recent evaluations, there have been reported high levels of preparedness in command, but lower readiness in supply chain management[52]. It is clear from these results that surge capacity is a multi-faceted capacity encompassing staff, space, and supplies, and not merely bed capacity. It appears that the problems faced in MCI responses arise from existing barriers to coordination, logistics, and the institutionalization of training, and not the absence of conceptual understanding[52,53].

Actionable Recommendations for Hospital Implementation

In implementing this concept, hospital organizations ought to set benchmarks for the process. The first steps will include identifying the thresholds for activating HICS, revising the system for staff recall, mapping the surge capacities, and developing procedures for transferring patients. Readiness will call for biannual multidisciplinary exercises (full-scale simulation exercises) assessed using performance indicators, including time for activation/recall, triaging, expansion of capacity, delays in transfers, and rates of follow-ups after 48-72 hours of discharge.

Conclusion

An expert-guided model was formulated in this study for hospitals' management of mass casualty incidents in Iran, which involved three phases: The Immediate Phase, Intermediate Phase, and Continued/Recovery Phase. The Immediate Phase is mainly concerned with timely activation of HICS, triage, surge capability, management of resources, communication, and security. The Intermediate Phase highlights the importance of continuity of treatment, transfer of patients, coordination with specialists, and psychosocial support. The Continued/Recovery Phase deals with patient follow-up, completion of medical records, and lessons learned. Strategies for capacity building, taking into consideration the context, add more practicality to the model for its application in Iran.

Acknowledgments

This article is the result of a PhD Thesis conducted at Isfahan University of Medical Sciences. The research team extends its sincere gratitude to the leadership of the Faculty of Management and Medical Information Sciences at Isfahan University of Medical Sciences, as well as to the hospital administrators and faculty members across Iran.

Conflicts of interest

There are no conflicts of interest.

Financial support and sponsorship

This research was funded by the Isfahan University of Medical Sciences, Isfahan, Iran

Authors' Contributions

The contributions of all authors align with the authorship standards set forth by the International Committee of Medical Journal Editors.

Ethical Statement

Ethical approval for this study was obtained from the Research Ethics Committee of Isfahan University of Medical Sciences (IR.ARI.MUI.REC.1402.051). Participants were assured that their personal information would remain confidential. They were also informed that they could withdraw from the study at any stage without any negative consequences. To protect participants' identities, each participant was assigned a code (No. 1, No. 2, etc.) instead of being identified by name. All recorded audio files, transcripts, and

interview notes were stored on a computer protected by a password. All collected data will be destroyed five years after the completion and publication of the research.

Declaration of Generative AI and AI-assisted technologies

Generative AI and AI-assisted technologies were used in the preparation of this manuscript for language improvement, editing, and refinement of academic writing. All authors carefully reviewed, revised, and approved the final version of the manuscript and take full responsibility for its content.

Supplementary Material

Supplementary Table 1 presents the complete details of the identified codes, subcategories, and main categories derived from the interview analysis.

References

1. Suda, A.J., et al., Management of mass casualty incidents: a systematic review and clinical practice guideline update. European Journal of Trauma and Emergency Surgery, 2025. **51**(1): p. 5.
2. Ugelvik, K.S., et al., A national study of in-hospital preparedness for Mass Casualty Incidents and disasters. European Journal of Trauma and Emergency Surgery, 2025. **51**(1): p. 18.
3. Yari, A., et al., Hospital preparedness assessment for road traffic accidents with mass casualties: a cross-sectional study in Kurdistan Province, Iran. BMC Emergency Medicine, 2024. **24**(1): p. 68.
4. Armstrong, J.B.P. Preparing your emergency department for disaster: optimizing surge capacity during mass casualty events. in Healthcare management forum. 2024. SAGE Publications Sage CA: Los Angeles, CA.
5. Basiri, A., et al., Effect of Tabletop Exercise on the Preparedness Improvement of Military Hospitals in Mass Casualty Incidents. Iranian Journal of War and Public Health, 2024. **16**(3): p. 245-252.
6. Racz, L. and A.B. Badiru, Handbook of emergency response: A human factors and systems engineering approach. 2025: CRC Press.
7. Fagel, M.J., R.C. Mathews, and J.H. Murphy, Principles of emergency management and emergency operations centers (EOC). 2021: CRC press.
8. Organization, W.H., A guidance document for medical teams responding to health emergencies in armed conflicts and other insecure environments. 2021: World Health Organization.
9. Organization, W.H., Minimum technical standards and recommendations for reproductive, maternal, newborn and child health care for emergency medical teams. 2021: World Health Organization.
10. Hick, J.L., et al., Duty to plan: health care, crisis standards of care, and novel coronavirus SARS-CoV-2. Nam Perspectives, 2020. **2020**: p. 10.31478/202003b.
11. Petanidis, S., et al. Optimizing Emergency Response in Hospitals: A Systematic Review of Surge Capacity Planning and Crisis Resource Management. in Healthcare. 2025. MDPI.
12. Dichter, J.R., et al., Mass critical care surge response during COVID-19: implementation of contingency strategies–a preliminary report of findings from the Task Force for Mass Critical Care. Chest, 2022. **161**(2): p. 429-447.
13. Khorram-Manesh, A. and P. Phattharapornjaroen, Flexible Surge Capacity in Healthcare. Resilience and Recovery in Disaster and Emergency Management, 2026: p. 55.
14. Paganini, M., et al., Translating COVID-19 pandemic surge theory to practice in the emergency department: how to expand structure. Disaster medicine and public health preparedness, 2020. **14**(4): p. 541-550.
15. Al-Hajj, S., et al., Beirut blast: the experiences of acute care hospitals. Disaster medicine and public health preparedness, 2023. **17**: p. e318.
16. Al Maalouf, N.J. and C. Mouawad, Assessing the impact of the Beirut port explosion on supply chain management and seaport infrastructure in Lebanon: A pathway to resilience and reform. Transportation Research Interdisciplinary Perspectives, 2025. **32**: p. 101555.
17. Visser, L.S. and A.S. Montejano, Rapid access guide for triage and emergency nurses: chief complaints with high-risk presentations. 2023: Springer Publishing Company.
18. Bazyar, J., et al., The principles of triage in emergencies and disasters: a systematic review. Prehospital and disaster medicine, 2020. **35**(3): p. 305-313.
19. Aziz, S., et al., Managing ICU surge during the COVID-19 crisis: rapid guidelines. Intensive care medicine, 2020. **46**(7): p. 1303-1325.
20. Pollock, A., et al., Interventions to support the resilience and mental health of frontline health and social care professionals during and after a disease outbreak, epidemic or pandemic: a mixed methods systematic review. Cochrane Database of Systematic Reviews, 2020(11).
21. Omonaiye, O., et al., Hospital discharge processes: Insights from patients, caregivers, and staff in an Australian healthcare setting. PLoS One, 2024. **19**(9): p. e0308042.
22. Pietrobon, R., et al., Improving Trial Site Operations Using Behavioral Science. Available at SSRN 5537418, 2025.
23. Hennink, M., A. Bailey, and I. Hutter, Qualitative research methods. 2020.
24. Braun, V. and V. Clarke, Thematic analysis: A practical guide. 2021.
25. Elgamri, A., et al., Challenges facing Arab researchers in conducting and publishing scientific research: a qualitative interview study. Research Ethics, 2024. **20**(2): p. 331-362.
26. Sadat, S.J., et al., Exploring barriers and facilitators of inter-organizational management in response to mass casualty traffic incidents: a qualitative study. Bulletin of Emergency & Trauma, 2021. **9**(2): p. 86.
27. Khankeh, H.R., et al., Effect of early warning system on the preparedness of hospitals in emergencies and disasters: a quasi-experimental study. Journal of nursing reports in clinical practice, 2023. **1**(3): p. 126-132.
28. TariVerdi, M., E. Miller-Hooks, and T. Kirsch, Strategies for improved hospital response to mass casualty incidents. Disaster medicine and public health preparedness, 2018. **12**(6): p. 778-790.
29. Hugelius, K., J. Becker, and A. Adolfsson, Five challenges when managing mass casualty or disaster situations: a review study.

International journal of environmental research and public health, 2020. **17**(9): p. 3068.

30. Aзı ksarı , K., et al., The effect of multiple triage points on the outcomes (time and accuracy) of hospital triage during mass casualty incidents. Injury, 2024. **55**(5): p. 111318.

31. Yilmaz, S., et al., February 6th, Kahramanmaraş earthquakes and the disaster management algorithm of adult emergency medicine in Turkey: an experience review. Turkish journal of emergency medicine, 2024. **24**(2): p. 80-89.

32. Aloyce, R., S. Leshabari, and P. Brysiewicz, Assessment of knowledge and skills of triage amongst nurses working in the emergency centres in Dar es Salaam, Tanzania. African Journal of Emergency Medicine, 2014. **4**(1): p. 14-18.

33. Reisi, Z., et al., The level of awareness of the emergency department nurses of the triage principles in teaching hospitals. Journal of Nursing and Midwifery Sciences, 2018. **5**(1): p. 32-37.

34. Bar-On, E., et al., Real-time Innovative Solutions for Ensuring Continuity and Safety of Medical Care in a Hospital Under Wartime Physical Threat. Disaster Medicine and Public Health Preparedness, 2025. **19**: p. e332.

35. Usoro, A., et al., A scoping review of the essential components of emergency medical response systems for mass casualty incidents. Disaster medicine and public health preparedness, 2023. **17**: p. e274.

36. Igra, N.M., et al., Optimizing mass casualty triage: using discrete event simulation to minimize time to resuscitation. Journal of the American College of Surgeons, 2024. **238**(1): p. 41-53.

37. Marik, P., et al., Hospital and community mental health response to a mass casualty incident. Psychological Services, 2025.

38. Wake, E., J. Ranse, and A.P. Marshall, Scoping review of the literature to ascertain how follow-up care is provided to major trauma patients post discharge from acute care. BMJ open, 2022. **12**(9): p. e060902.

39. Ludley, A., et al., Observational analysis of documentation burden and data duplication in trauma patient pathways at a major trauma centre. BMJ Open Quality, 2023. **12**(2).

40. Saini, A., Digital transformation in hospital administration: A literature review on adoption and impact of smart healthcare technologies. 2025.

41. Dilshan Madusanka, C., Data-Driven Approach for Optimising Hospital Management: analysing patient treatment process and implementing a distributed medical care system. 2025.

42. Abualruz, H., et al., The role of artificial intelligence in enhancing triage decisions in healthcare settings: A systematic review. Applied Nursing Research, 2025: p. 152024.

43. Araouchi, Z. and M. Adda, A comprehensive literature review on AI-assisted multimodal triage systems for health centers. Procedia Computer Science, 2025. **257**: p. 206-214.

44. Machado, C. and S. Hessel, Artificial intelligence in the prehospital setting–potentials, challenges, and practice-relevant fields of application in emergency medical services. BMC Artificial Intelligence, 2026. **2**(1): p. 12.

45. Alazmy, W. and B. Williams, Barriers and challenges to emergency medical services response to disasters and mass casualty incidents in the Middle East. International Journal of Emergency Management, 2021. **17**(2): p. 105-121.

46. Levi, H., et al., Evaluating emergency response at a hospital near the Gaza border within 24 h of increased conflict. BMC emergency medicine, 2024. **24**(1): p. 47.

47. Kowalske, K.J., Burn Rehabilitation, An Issue of Physical Medicine and Rehabilitation Clinics of North America, E-Book: Burn Rehabilitation, An Issue of Physical Medicine and Rehabilitation Clinics of North America, E-Book. Vol. 34. 2023: Elsevier Health Sciences.

48. Farahmandnia, H., et al., Major challenges and barriers for successful management of health exercises in emergencies and disasters: findings from a qualitative conventional content analysis study. BMC Emergency Medicine, 2025. **25**: p. 1.

49. Denke, N.J., The Role of Emergency Nurses in Emergency Preparedness and Response. Journal of Emergency Nursing, 2025. **51**(1): p. 30-35.

50. Abou-Abbas, L., et al., Mass casualty incident preparedness and response: A desk review of the Code Orange Plan and Assessment of Healthcare Workers' Knowledge, Attitudes, and Practices in a Lebanese Tertiary Government Hospital. PLoS One, 2026. **21**(4): p. e0348176.

51. Ayenew, T., S.F. Tassew, and B.S. Workneh, Level of emergency and disaster preparedness of public hospitals in Northwest Ethiopia: a cross-sectional study. African Journal of Emergency Medicine, 2022. **12**(3): p. 246-251.

52. Singh, P., et al., Exploring Challenges and Opportunities in Hospital Disaster Preparedness: A Qualitative Study on the Perspectives of Hospital Incident Command System Members. Risk Management and Healthcare Policy, 2025: p. 3499-3515.

53. Turkistani, A.A.H., Evaluation of Hospital DisasterPreparedness .in Makkah The Arab Journal of Scientific Research, 2024. **8**(9): p. 71-116.