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A Scoping Review of the Essential Components of Emergency Medical Response Systems for Mass Casualty Incidents

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Systematic Review

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Abstract

Objective: Emergency medical (EM) response systems require extensive coordination, particularly during mass casualty incidents (MCIs). The recognition of preparedness gaps and contextual priorities to MCI response capacity in low- and middle-income countries (LMICs) can be better understood through the components of EM reponse systems. This study aims to delineate essential components and provide a framework for effective emergency medical response to MCIs.

Methods: A scoping review was conducted using 4 databases. Title and abstract screening was followed by full-text review. Thematic analysis was conducted to identify themes pertaining to the essential components and integration of EM response systems.

Results: Of 20,456 screened citations, 181 articles were included in the analysis. Seven major and 40 sub-themes emerged from the content analysis as the essential components and supportive elements of MCI medical response. The essential components of MCI response were integrated into a framework demonstrating interrelated connections between essential and supportive elements.

Conclusions: Definitions of essential components of EM response to MCIs vary considerably. Most literature pertaining to MCI response originates from high income countries with far fewer reports from LMICs. Integration of essential components is needed in different geopolitical and economic contexts to ensure an effective MCI emergency medical response.

Disasters are defined by the World Health Organization (WHO) as disruptions to a community that exceed its capacity to adjust.[1] Mass casualty incidents (MCIs), also referred to as major incidents in some context, are disasters in which the number and severity of casualties overwhelm the abilities of the local health-care system.[1–3] The heterogeneity of MCIs ranges from natural hazards to manmade events such as infrastructure failures, terrorism, and civil disorder, among many others.[4] MCIs can result from abrupt events, such as in the case of a gas leak explosion, or occur over a more protracted course, when patients arrive more gradually over the course of several hours or even days. Both situations may lead to overwhelmed emergency medical response systems.[5]

The ever-present threat of MCIs has led to the global prioritization of disaster risk reduction (DRR), especially as urbanization has increased globally.[6] Densely populated cities are at increased risk of MCIs tied to environmental, socioeconomic, and security factors. The United Nations' Office for Disaster Risk Reduction (UNDRR) has urged the development and implementation of transdisciplinary, multi-hazard system-based approaches toward addressing MCIs in metropolitan areas, given the complex and dynamic nature of urban risk, coupled with unplanned population growth in low- and middle-income countries (LMICs).[7–9] Critical to the implementation of these recommendations is the capacity of regional emergency medical response systems, which are responsible for delivering life-saving medical care during any MCI.[10] Emergency medical response systems tend to be complex, requiring coordination between community members, health-care service providers, government agencies, media, and law enforcement, integrating different domains.[11,12] Furthermore, response systems in LMICs, which are typically less centralized, make assessment of the system as a whole especially difficult. Understanding components of emergency medical response systems based upon measures of

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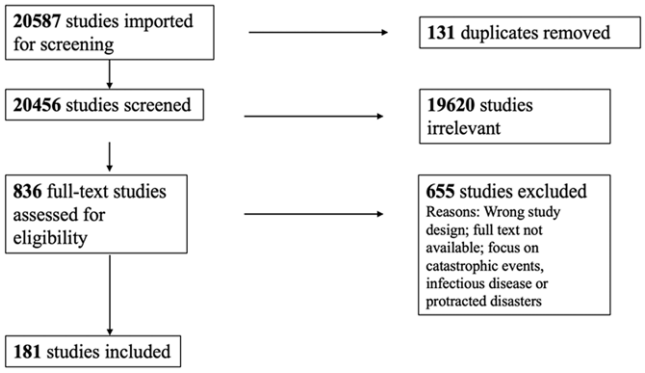

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Diagram.

effectiveness is necessary to assess preparedness for MCIs. Accordingly, the study team sought to answer the question: *What are the essential components of an emergency medical response system in the immediate aftermath of an MCI?*

Methods

As a guiding strategy, we focused on manmade MCIs, excluding events that did not leave an intact health system, given the disproportionately increasing number of manmade MCIs in LMICs.[13–15]

Search Strategy and Databases

A search strategy for peer-reviewed sources was developed in collaboration with a university informationist and modified for different databases. English language articles highlighting emergency response components, and relevant assessments, were identified through structured searches of PubMed, Embase, Global Health, and Scopus spanning a 20-year period from 2000 to 2020. Combinations of search terms, including medical subject headings and keywords, were organized in 3 groups: (1) mass casualty and emergency disasters; (2) response, preparedness, and planning; (3) instruments, measurements, evaluations, and assessments. Human subjects, year, and language restrictions were applied. The detailed search strategy adapted for each electronic database are included in the Supplementary Text S1. The "similar articles" section of the PubMed website and reference lists of the identified articles were also examined to capture other potentially relevant articles. All references were exported to Covidence (Melbourne, Australia) and duplicate studies were excluded.[16] This review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) format (Figure 1).

Inclusion and Exclusion Criteria

Articles included in this review encompassed peer-reviewed English language studies, guidelines, tools, and instruments focused on outlining essential components and measures for evaluation of MCI response at the prehospital, hospital, city, and national levels. The inclusion criteria for citations were intentionally broad, capturing scientific publications, committee reports, evaluations, tools, organizational and governmental guidelines, and emergency preparedness plans and exercises. For the purposes of this review, MCIs that compromised the structural integrity of an emergency medical system or disrupted the ability to deliver emergency care through workforce attrition were not considered. Accordingly, large-scale public health emergencies, infectious outbreaks, and complex protracted humanitarian emergencies were excluded. Articles without full text available in English language were excluded from further analysis. Criteria of eligible studies are outlined in Table 1.

Data Abstraction

Seven team members (A.U., A.M., S.R., A.E., A.A., O.A., and J.D.) independently screened the titles and abstracts of all retrieved studies to identify the relevant studies according to the eligibility criteria, with each title and abstract screened by 2 separate reviewers. Conflicts were resolved by consensus among the reviewers during weekly research meetings, while remaining unsettled votes were arbitrated by the lead author (A.U.). After title and abstract screening, the studies underwent full-text review by the same independent reviewers. Studies were evaluated by the type of study, location, year of publication, key response components addressed, and methods of evaluation. Data extraction was performed using a data extraction sheet developed by 2 team members (A.U., A.M.). Included articles were organized by authors' name and year of publication with an indication of whether the article outlined response activities from a high-income country (HIC) or LMIC. The World Bank classification of countries by income was used to define low-income, lower middle-income, and middle-income countries; this classification is based on gross national income (GNI) per capita.[17]

Data Analysis

Thematic analysis was performed by 2 team members (AU and AM) using traditional content analysis to evaluate the full text of each included article.[18] Emerging themes pertaining to the essential components and evaluation of emergency medical response systems were included. Domains or components of emergency medical responses most frequently mentioned and discussed within the included studies were designated as essential. Included studies were characterized according to the essential components explored (Supplementary Table S2), with quality assessment of the articles conducted with guidance from the Institute of Medicine Standards for Systematic Reviews.[19]

Results

Of 20,456 screened citations, 181 articles were included in the qualitative analyses (Figure 1). A large number of studies were observational and approximately a third of all articles included reports and resource documents as shown in Table 2. Most of the included studies, 165 of the 181, were in HIC contexts (Figure 2). Seven major themes emerged from the content analysis as essential domains of an emergency medical response system: (1) communication; (2) safety and security; (3) human resources; (4) planning, policy, and procedures; (5) command, control, and coordination of the disaster response; (6) care delivery; and (7) health finance for disaster planning and response. Additionally, 40 sub-themes were found to support the essential components of an MCI response as shown in Table 3. A large number of publications focused on care delivery (67%), leadership and coordination (30%), communications (23%), and human resources (19%). Safety and security, as well as planning, policy, and procedures to execute response and assist recovery were also important domains identified in the literature. Each identified

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Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Language: English language	Language: Non-English language
Timeline: publications from 2000 - 2020	Timeline: publications before 2000
Study Types: literature reviews, review articles, case reports, case studies, original research	Study Types: editorials, conference abstracts, abstract with NO full-text article, letters to editor, clinical trials, qualitative research, conference proceedings, textbook chapters, opinion pieces
Types of disasters: mass casualty incidents, man-made disasters, bombings/explosions, mass shootings, building collapses, fires in enclosed spaces, large scale motor vehicle accidents, vapor or chemical exposures	Types of disasters: natural disasters of catastrophic scale (tornado, flood, tsunami, rainstorm, earthquake, hurricane, volcanic eruption, famine, extreme heat, heat wave, tidal wave, wildfire, bush fire, forest fire, rockslide, mudslide, landslide, typhoon, tropical storm, cyclonic storm, cyclone, avalanche); infectious disease outbreaks (endemics, epidemics, pandemics) or zoonotic infections; In flight (during aircraft) emergencies; Bioterrorism or cyberterrorism; Nuclear warfare or nuclear accident or war; Rare terrorism acts (hijacking, kidnapping, assassination, barricade-hostage situation); Infrastructure failures or disruption in power outages; Oil spills
Stages of Disaster management cycle: response, mitigation, preparedness/ readiness	Stages of Disaster management cycle: recovery, rehabilitation
Environment: urban, community or community-based setting, high/dense population	Environment: rural, low population

Table 2. Study design of included articles ($n = 181$)

Study design	Number of studies (%)
Experimental/trials	9 (5)
Quasi-experimental	8 (4.4)
Correlational	5 (2.7)
Descriptive/observational	35 (19.3)
Resource documents/reports/review articles/ literature review	61 (33.7)
Case studies	21 (11.6)
Qualitative/cross-sectional surveys	18 (10)
Delphi/tool development	3 (1.6)
Others	21 (11.6)

essential component and subcomponent of an emergency medical response system is italicized.

What Are the Essential Components of an Emergency Medical Response System in the Immediate Aftermath of an MCI?

Communication

Communication is an indispensable component of a coordinated MCI response. Effective communication during an MCI requires using *modern communication devices* with adequate backup, or *redundant systems* (eg, radio, satellites, geographic positioning systems), or other innovative technology to enable *real-time situational awareness* and *information sharing*.[13,20–62] The evolving role of social media such as live Twitter feeds, Facebook updates, text messages, and chat rooms has been explored for their ability to contribute to situational awareness, communication with the victims and their loved ones, and information sharing among the media, key stakeholders, and frontline providers.[13,20,24,28,29,31,32,35,36,39–42,46,50,51,55,59–61,63–66] *Pre-determined contacts* for designated personnel, collaborating entities and other agencies, improves efficiency and the flow of information.[13,20,21,48,49,59,67–74] Standard and ad-hoc *channels of communication* help provide situational awareness, clarify misinformation, address concerns, and facilitate response activities.[13,20–23,25,26,33,39,44–46,55,60,67,74–77]

Safety and Security

Safety and security must always be prioritized with any MCI, recognizing that some incidents, such as terror attacks or chemical hazards, require *containment* and pose a greater security threat than others.[13,32,34,37,39,47,54,59,62,75,77–92] Moreover, security officials maintain the *law and order* at the scene and at the hospitals receiving injured patients, controlling access points, and restricting it to only authorized personnel, monitoring for suspicious activities, and preventing crowds from interfering with emergency operations.[13,32,34,39,40,47,49,59,62,73,81,87,91–94] Deploying a *safety officer* to identify potential threats and implement appropriate safety procedures is essential in virtually all MCIs.[13,36,39,47,56,75,81,93] In response to the safety and security challenges adopted in some settings is the introduction of *Tactical medicine*, in which out-of-hospital care is provided by specially trained practitioners, many with military and/or law enforcement training, who operate in hostile environments.[33,81,87,95–97]

Human Resources

MCI response depends upon *adequate and appropriate personnel capacity*.[13,20,23,26,28,31,40,46,47,54,55,67–69,74,81,82,91,98–104] Human resources are not limited to paramedics, nurses and doctors, but include all who care for patients during an MCI, such as uninjured or mildly injured survivors, bystanders and community volunteers.[23,33,39,62,68,82,91,102,105,106] Depending upon the extent, location and duration of an MCI, fire, rescue and security services, incident management teams, ambulance and transport crew, hospital ancillary staff, translators, information technology (IT) specialists and engineers, as well as social services—who can assist with emotional trauma and maintain a family information center—should remain engaged and involved in providing acute care.[23,27,38,41,54,68,74,81,82,98,107–113] Some experts outlined *core competencies* for frontline responders participating in an MCI response.[30,33,34,37,58,84,89,98–100,107,114–125] Enabling factors that enhance *core competencies* include specific *training* on the incident command system framework, as well as *collaborative exercises and drills* to better organize a multidisciplinary and multi-agency response.[13,22,23,26–29,34,36,37,40,44,45,49,53,54,56,58,60,73,74,76,80,82–84,96,99,100,107,108,110,111,113,118,121,124,126,127] *Cultural competency* must be kept in mind when responding to any MCI, but especially those predominantly

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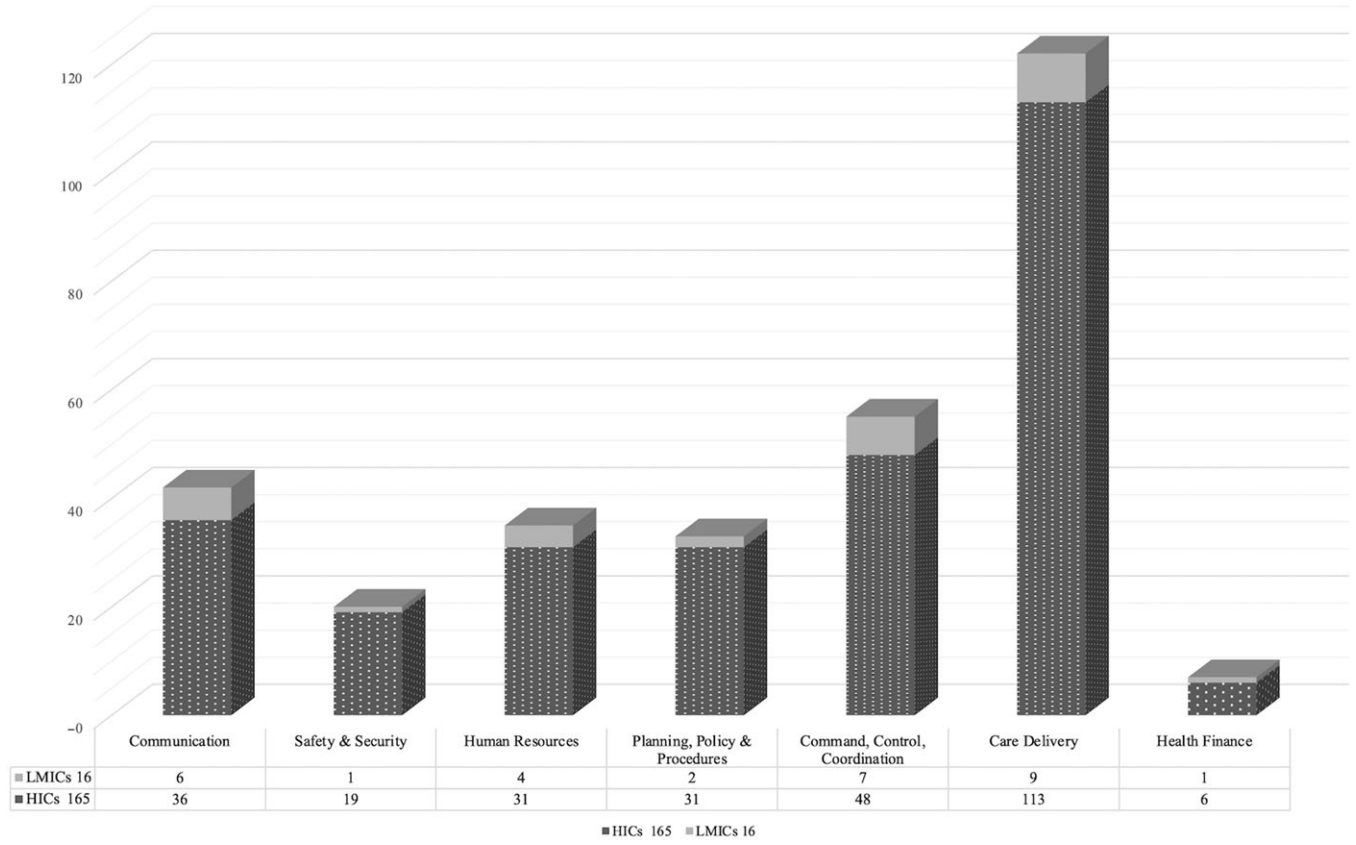

Figure 2. Comparison of included studies from HICs versus LMICs.

affecting minority populations, children, elderly, low-income, and alternatively abled persons.[26,43,47,76,80,84,98,99,108,109] Advance *contingency agreements* between different organizations, institutions, and jurisdictions for resource and personnel sharing can help in recruiting individuals to deal with a large influx of victims over a short period of time.[13,20,26,27,33,43,44,46,47,51,54,74,87,96,101,104,110,118,128–130] Keeping an active roster of available volunteers and required staff is often useful in rapidly building surge capacity by ensuring that personnel are both *prepared and willing* to participate in MCI response activities.[13,20,21,29,33,40,41,46,48,49,68–74,101,104,115,118,120] Addressing the *emotional trauma* of the volunteers and staff in the aftermath of an MCI should be considered during an emergency medical response.[13,21,40,41,47,68,75,82,91,93,105,110,118,119,121,125,131]

Planning, Policy, and Procedures

Local planning, policies, and procedures, or a collective *MCI plan*, provides the framework to *activate and deactivate MCI response* and guide response activities.[13,22,27,32,33,39,40,53,55,58,59,69,71,74,82,89,91,93,93,94,98,110,111,117,118,120,132–134] Following local *standard operating procedures* (SOP) and *predetermined policies and protocols*, next steps include clear role identification, delegation of responsibilities, record-keeping, patient triage, clinical care delivery, resource allocation, maintaining stockpiles of essential equipment and supplies, information flow, victim identification, and routine communication with staff, media and families.[13,27,33,34,39,40,46,53,58,67,69,71,74,82,89,93,94,98,110,111,117,118,120,131–134] When additional health-care personnel are needed, *emergency credentialing* could be used to facilitate the process, and providing *hazard pay and benefits* for first responders should be taken into consideration, including provisions providing legal indemnification to providers, support staff, institutions, and other responding agencies.[33,39,40,46,53,68,73,74,89,104,107,118,120,121,125,126,130,131,133,135–137] *Vendor agreements* and inventory management policies may shorten the time to deploy essential materials and equipment to ensure their availability.[26,28,40,43,46,51,55,74,75,82,98–100,103,111,118,120,129,136,138–140] A post-MCI *debriefing* should be conducted during which participating organizations report their data and respond to questions fostering a culture of transparency, accountability, and community practice.[39–41,69,82,97,110,113,117,137,141–143] *Periodic assessments* of MCI response capabilities and the evaluation of training and preparedness of the responders should be incorporated into the process of ensuring readiness to respond to future MCIs.[13,22,23,27–29,37,45,56,57,62,63,69,70,74,77,80–82,98,99,105,110,111,124,126,129,139,143–149]

Command, Control, and Coordination

A central body or *lead agency* maintains hierarchy, inter-agency response coordination, and mobilizes resources.[13,21,22,28,31,36,45,47,50,55–58,61,62,64–66,73,82,88,89,99,100,110,111,118,119,129,135,138,142,145,149–155] At the local level, a physical *emergency operations center* (EOC) with well-defined jurisdictional responsibility is mandated for MCI management.[13,21,22,28,31,34,36,47,50,55–59,61,62,64–66,73,82,88,89,99,110,111,118,119,129,135,142,145,149,151–158] EOCs play an important role by coordinating amongst organizations that need medical resources with those that can provide medical resources and delegating various emergent tasks among different entities.[39,50,54,118,151,152,155,157,159,160] EOCs follow the framework of a centralized and hierarchical *incident command system* (ICS) in directing all response activities.[13,21,22,28,36,47,50,56–59,61,62,64–66,73,82,88,89,91,99,110,118,119,129,135,142,149,151–155,157,158,161–163] Based on the extent and duration of the MCI, the ICS system can be lean or more expansive, requiring additional

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Table 3. Essential components and sub-components of an emergency medical response

Major themes of emergency response	Subthemes characterizing MCI response components
Communication	Modern communication devices
	Redundant systems
	Real-time situational awareness
	Information sharing
	Pre-determined contact information
	Channels of communication
Safety and security	Security threat containment
	Tactical medicine
	Law and order
	Safety officer
Human resources	Adequate and appropriate personnel
	Core competencies
	Training requirements
	Collaborative exercises and drills
	Cultural competencies
	Contingency agreements
	Preparedness and willingness to respond
	Emotional trauma
Planning, policy, and procedures	MCI plan
	MCI activation and deactivation criteria
	Standard operating procedures
	Predetermined policies and protocols
	Emergency credentialing
	Hazard pay and benefits
	Vendor agreements
	Debriefing
	Periodic assessments
Command, control, and coordination	Lead agency
	Emergency operation center
	Incident command system
	Scene incident command
	Hospital incident command
Care delivery	Triage
	Patient distribution
	Mass decontamination
	Hospital response
	In-hospital clinical care
	Radiology services
Health finance	Financial resources
	Hazard analysis

command and support roles to facilitate the operations of care delivery for at least 10 days without external assistance.[21,29,34,40,43,50,69,75,91,118,120,140,142,145,151–153,163,164] Incident command should be established at the scene of the MCI, within each responding agency, as well as at each health facility that receives victims, and should include clinical and nonclinical representatives to ensure a multidisciplinary approach to disaster management.[29,31,34,47,57,67,74,75,102,128–130,143,150,152,153,157,158,161–163,165]

Care Delivery

Care delivery is an umbrella term that covers a variety of operational and logistical activities. Approximately two-thirds of the articles, or 67%, covered clinical medical response for MCIs in the pre-hospital and hospital setting, discussing rational use of resources, triage, decontamination, surge capacity, stockpiles of medical supplies and equipment, bottlenecks in providing critical services, care of pediatric patients and other special populations, specialized management of burn injuries, and the unique considerations of chemical, biological, radiological and nuclear (CBRN)-related MCIs.

The operational components of pre-hospital MCI care delivery include evacuation, triage, and safe transport of the victims.[57,62,91,134,154] Several different triage methodologies have been used and tested in disasters, such as the START, JumpSTART, SALT, or SORT algorithms, among others, which quickly prioritize victims and assist in casualty distribution and setting up treatment areas where patients can be separated into cohorts based on triage categories.[27,30,31,37,39,40,45–47,52,53,55,60,62,69,75,82,91,99,101–103,105,107,108,110,118,120,125,127,134,145,148,151,154,160,166–184] However, *triage* is a dynamic process, and patients may need to be reevaluated and reassigned to a different category.[23,27,33,36,39,40,46,47,49,50,53,60–62,64,66,67,82,91,95,96,101–103,105,127,128,133,134,144,146,148,150,151,154,160,166,168–174,176–189] In such instances, emphasis is placed upon directing scarce resources to those who have the best chance of survival.[23,75,82,100,101,103,105,108,112,120,125,131,151,160,174,180,181,187] When determining appropriate and timely *patient distribution*, the distance to the nearest facility, type of injuries sustained, special patient needs (eg, pediatrics, burns), and the capabilities of the receiving hospital should be considered, as well as an emphasis of managing families as best as possible.[21,23,27,29,30,33,36,37,39,47,53–55,60,67,73,91,95,98,100,102,103,111,117,120,123,124,128,132,134,138,143–145,147,150,154,164,166,173,187,188,190] When indicated, *mass decontamination* procedures are initiated at the scene of injury and repeated or continued at a health facility.[13,37,75,77–80,82–86,89,90,108,111,144,145,154,165,191]

Hospital response must integrate vertical and horizontal response capabilities, tiered surge capacity (conventional, contingency, crisis), maintenance of supply chain, personal protective equipment (PPE) requirements, secondary patient transfers, and the handling of dead bodies.[23,27,28,33,37,39,40,47,54,55,75,82,83,89,96,101–103,105,110–113,117,120,133,136,139–141,148,164,165,175,186,187,192–194] *In-hospital clinical care* can be facilitated by unidirectional patient flow, keeping triage cohorts together, implementing a disaster patient tracking system, pre-positioning pre-stocked medicines and supplies with adjacent quick-reference or action cards, directing skilled staff to pre-allocated areas to provide care, delegating unskilled volunteers to perform menial tasks (transportation of patients, blood, equipment), enacting an early discharge pathway for non-critically ill patients present within the ED and/or hospital, and using a mobile health-based data entry system.[13,23,38,39,46,49,50,52–56,62,66,67,73,74,82,93,94,96,102,103,108,110,112,117,125,132,141,151,156,165,175,185,186,192,193,195–197] *Radiology services*, primarily x-ray, and CT scans, are relevant diagnostic modalities in traumatic injuries and guide management decisions, particularly with the assumption that 50% of injured patients will require operative management.[23,67,69,74,128,185,198] However, radiology has been recognized as a bottleneck for patient care.[30,51,69,91,102,125,141,198] Lean strategies are recommended, such as limiting radiologic capabilities to only high priority patients, using bedside ultrasound to facilitate rapid identification of operative pathology, stationing a radiologist with the radiology tech in the patient care area to aid in prompt diagnosis, and facilitating paper-charting or use of a simplified computerized electronic order entry to order a diagnostic study.[23,26,30,32,39,46,51,67,69,82,91,102,103,125,131,141,198]

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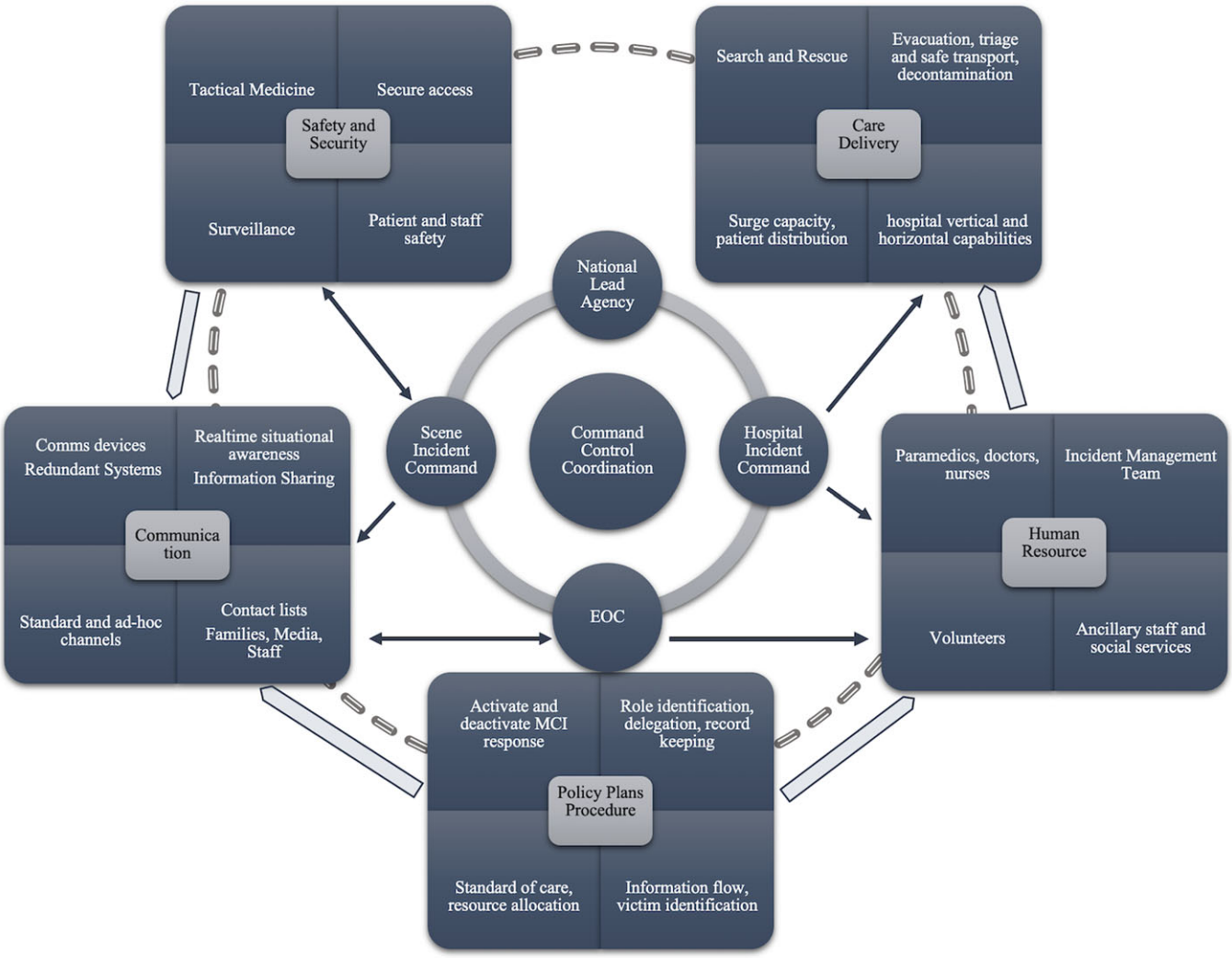

Figure 3. Integrated framework of MCI response.

Health Finance

Seven of the included articles directly addressed the financing of MCI response. *Financial resources*, largely determined by the fiscal budget of the city government, determine the extent at which MCI response activities can be operationalized in an effective and timely manner.[20,27,29,44,87,89,96,104,124,126,130,132,151] Recognizing that there are many competing priorities for municipal funds, local government officials should perform annual *hazard analyses* to allocate resources corresponding to level of risk.[20,27,32,44,55,100,104,110,124,126,130,132,143,147,165]

Discussion

With the premise that an effective and timely response saves lives, the immediate aftermath of an MCI deserves special attention. An effective MCI response minimizes chaos, misinformation, and delays in care. However, defining effectiveness is met with considerable variability. Here, we sought to characterize the essential domains and components of an emergency medical response, specifically pertaining to MCIs. The observed heterogeneity and complexity of emergency medical response system components during an MCI are by and large a function of the scope of the event on the affected population. System-level tools and assessments exist to improve disaster readiness but fall short of comprehensively capturing crucial activities in an MCI emergency medical response framework.[1,199–203] The World Health Organization's (WHO) Emergency Response Framework (ERF) is geared toward emergencies with public health consequences that are outside of the definition of this study's defined MCI (eg, natural disasters, bioterrorism events, or pandemics) and limits its framework to the activities of the WHO.[201] Other frameworks such as the mass casualty management systems framework summarize comprehensive strategies and guidelines for building health sector capacity at the national level, provincial/state level, community and local government level, and health-care facility level.[203] Using the thematic analysis in this study, an *Integrated Framework of MCI Response* with the essential domains and components is presented in Figure 3. The framework highlights the connections and interrelatedness of different components, which is sometimes overlooked when studying one aspect of the MCI response. It is, therefore, imperative to remember how each of these component influences and shapes the other.

Best practices pertaining to MCI response commonly emerge from real-world contexts and are often anecdotal. Real-world experience could better inform practices through more systematic

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collation and rigorous analysis. Few studies based on experimental design pertaining to MCI response were found in this review, likely attributable to the largely unpredictable nature of MCIs. Another notable observation was the predominant focus of literature on process outcomes, such as early MCI activation, EMS response time, shortened transit from scene to facility time, early injury identification, and efficient injury management. In contrast, only a few included articles presented data linking process improvements to improved health outcomes.[38,107,156,176,190] This suggests that further research is needed to explore how health and other impact outcomes are affected by improvements in process indicators.

Furthermore, despite LMICs carrying the global burden of death and disability from MCIs, evidence concerning emergency response from these settings remain sparse.[204] The majority of the studies in this review are from high-income countries, potentially limiting generalizability to LMICs. The essential domains and components of an organized approach to MCIs can be adapted to LMICs but is not representative of the unique challenges facing low-resourced environments and, therefore, should be applied with caution. For instance, very limited information is available on the key responders representing institutions not typically involved in response in HICs. Additionally, many identified components of the emergency medical response were found to hinge upon the preparedness of regional medical centers and the presence of health-care infrastructure capable of providing emergency care services, which often is not as developed in LMICs.[205,206] More research taking into consideration the perspective of MCI response in LMIC settings is warranted. The predominance of descriptive, observational, and case studies provides low-quality of evidence related to education, training, clinical care, and in some instances, policy recommendations.

Limitations

Although this review focuses on the response phase of the disaster management cycle, it is recognized that effective emergency response cannot be separated from preparedness, mitigation, and recovery. Studies pertaining to these other phases were designated as outside of the scope of this review. The selected focus of this review centered on the subset of manmade MCIs due to their increasing frequency and high relevance to understanding emergency medical response capacity and may not necessarily be applicable to other events that are subacute or of a protracted nature. As stated in our findings, the literature on MCI is largely from high-resource settings, despite a relatively higher burden in LMICs. We believe the basic characteristics of a response system would remain the same irrespective of the setting and the specific roles of the individual institutions. Finally, MCIs of catastrophic proportions that resulted in complete disruption of health systems were not examined, and accordingly, findings may have limited generalizability outside of the scope of this review.

Conclusions

This study identified significant gaps in the available evidence on emergency health system response for MCIs, with much of the literature characterized as anecdotal. Most existing literature is also from high income countries, with far less evidence from low resource, particularly LMIC, settings. We identify 7 essential domains, 40 sub-components of an emergency medical response system, and introduce an *Integrated Framework of MCI Response* to highlight the interconnectedness of an MCI emergency response. The framework for MCI response is limited if it is not evaluated and implemented by key stakeholders in the immediate aftermath of an MCI. Further research on emergency response capacity for MCIs tailored to the LMIC context is greatly needed.

Supplementary material. For supplementary material accompanying this paper visit https://doi.org/10.1017/dmp.2022.235

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