

Common Challenges in the Prehospital Management of Mass-Casualty Incidents: A Systematic Integrative Review

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Abbreviations:

EMS: Emergency Medical Services
JBI: Joanna Briggs Institute
MCI: mass-casualty incident
MeSH: Medical Subject Headings

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Abstract

Introduction: Mass-casualty incidents (MCIs) place extraordinary demands on prehospital medical response. However, there remains limited evidence on best practices in managing MCIs, and therefore, there is a need to systematically synthesize experiences from them to build further evidence.

Study Objective: This study aimed to analyze common challenges in prehospital MCI management.

Methods: Seventeen case studies or reports describing 15 MCIs (ie, terrorist attacks, chemical incidents, traffic accidents, weather-related incidents, and fires) were subject to a systematic integrative review.

Results: Common challenges in prehospital MCI management include victim and responder safety- and security-related issues; the need to develop and communicate situational awareness; to develop and apply a prehospital response plan; the ability to deliver care under severe circumstances; and the need for an extended prehospital medical response management strategy.

Conclusion: Resilient prehospital MCI response demands both a clear strategy and improvisation and should be integrated into the overall medical response strategy. Responders must understand the main concepts of prehospital MCI management, have a situational awareness that foresees the event's medical consequences, and have the experience required to interpret the situation. Emergency Medical Services (EMS) personnel and medical incident commanders require specific training and mental preparation to be able to provide care under severe security threats, to improvise beyond routines and guidelines, and to provide care in ways different from their everyday work.

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Introduction

Mass-casualty incidents (MCIs) are characterized by a large number of victims in need of immediate and definitive medical care that exceeds local capacity.¹ Such events are also described as *major incidents* or *disasters*. They are diverse and unpredictable and include accidents, fires, mass shootings, and terrorist attacks. They may result in severe injuries and fatalities, and sometimes devastate communities.² *Mass-casualty management* refers to a coherent and interrelated set of procedures, policies, and plans that contribute to optimizing health care services capacity to respond to the incident and to efficiently increasing capacity throughout the response.¹ Emergency Medical Services (EMS) are often the first point of contact between health care systems and MCI victims; they therefore play a critical role in determining the event's outcome.³ Effective mass casualty or major incident response systems rely on, among other things, a well-functioning communication system, adequately trained human resources, command-and-control systems and structures, adequate medical protocols, leadership, governance, and surge capacity.^{2,4} Previous studies have presented challenges for the overall health care system.⁵ However, the prehospital context presents specific challenges. From a global perspective, EMS staffing and organization differs significantly between countries.⁶ Command-and-control structures and judicial aspects of prehospital MCI response likewise vary. Prehospital MCI response is managed and led according to several concepts, such as the Major Incident Medical Management and Support concept.⁷ Such concepts often focus on safety, command-and-control structures, and structured reports from the scene to the hospital; they are also sometimes used to



introduce mass-casualty triage systems. Some of these concepts have been developed for specific events, such as terrorist or active shooter events,⁸ while others are more general.⁹

Prehospital MCI management has been identified as an essential area of future research,¹⁰ and prehospital guidelines of MCI management still fail to rely on evidence-based recommendations.¹¹ Therefore, a systematic synthesis of real MCI experiences is strongly needed.

This study aimed to analyze common challenges in prehospital MCI management.

Methods

Design

A systematic integrative literature review¹² was conducted on case studies or reports describing specific MCIs.

Terminology Used

This paper uses the term *Emergency Medical Services* to describe responses by ambulances (both airborne and land-borne), emergency physicians' units, or specific prehospital medical teams. The term *EMS personnel* is used to describe medical prehospital responders, regardless of formal education or training. The term *prehospital medical incident commander* is used to refer to the individual of being in charge of the prehospital medical response on an operational level. All affected people, both injured and uninjured, are called *victims*.

Literature Search

On April 2, 2024, with assistance from an academic librarian, the first author conducted systematic searches in PubMed (National Center for Biotechnology Information, National Institutes of Health; Bethesda, Maryland USA); CINAHL Plus with Full Text (EBSCO Information Services; Ipswich, Massachusetts USA); Web of Science (Clarivate Analytics; London, United Kingdom); and Scopus (Elsevier; Amsterdam, Netherlands). The search included Medical Subject Headings (MeSH) terms, subject headings, and free-text searches (Table 1).

The following eligibility criteria were used to select studies: (1) papers describing prehospital management of specific events referred to by the authors as mass-casualty situations, major incidents, or disasters; and (2) case reports, field reports, or other types of academic papers published in English from year 2015 through 2024. Studies were excluded if they: (1) were published as editorials or similar texts; (2) were reviews or studies summarizing data from several incidents; (3) reported on the response solely from the emergency department or hospital perspective; (4) reported on the prevalence of specific injuries or medical conditions following an MCI; (5) reported specifically on the effects of COVID-19; or (6) relied on simulations or exercises. Studies were selected using the Covidence systematic review software (Veritas Health Innovation; Melbourne, Australia).

Data Evaluation

A quality appraisal was conducted by using a modified version of the Joanna Briggs Institute (JBI; Adelaide, Australia) critical appraisal checklist for case reports.¹³ The checklist was modified by the authors such that it was adopted to assess reports of events rather than on individual patients (Table 2). The authors conducted the quality appraisal together. Each report was comprehensively valued and received a final grade of "medium" or "high" quality.

Analysis

Data were synthesized by integrative analysis.¹² First, relevant data were extracted from the reports' results, discussion, or conclusion

sections. Thereafter, they were sorted and integrated thematically. Finally, they were comprehensively analyzed, resulting in themes representing common challenges in prehospital MCI management.

Results

Four hundred and twenty-five papers were retrieved from PubMed (n = 113), Web of Science (n = 213), and Scopus (n = 99). After duplicates were removed, 374 papers remained and were screened by title and abstract. Of these, 342 were excluded. A full-text review of 33 articles was conducted, resulting in the exclusion of 19 papers. A manual search in Google Scholar (Google Inc.; Mountain View, California USA) added three papers, resulting in the inclusion of 17 papers in the analysis (PRISMA flowchart shown in Figure 1).

The 17 reviewed papers covered 15 different events including terrorist attacks, chemical incidents, traffic accidents, a storm, and fires. The events had occurred in Denmark, France, Israel, Italy, Iran, Japan, Lebanon, Malaysia, South Korea, Switzerland, the Netherlands, the United Kingdom, and the United States. The number of victims injured ranged from 15 to 6,000 (Table 3). Most (13) events occurred during the daytime or in the evening.

The analysis identified several common themes and challenges in prehospital MCI management, of which Table 4 presents an overview.

Safe Access to the Scene and Victims

Several challenges were related to physical access and security issues for both victims and EMS personnel.

Assessing Security and Defining Adequately Safe Zones—Assessing the security situation and determining adequately safe zones required the close cooperation of the prehospital incident commander, the police, and rescue services.^{14–16} Sometimes, a joint command team was established, wherein minute-to-minute information sharing enabled informed decisions.^{14,17–19} A common strategy for handling security threats was to divide the scene into different zones described by the level of danger, such as "dangerous" ("red"), "relatively safe" ("orange"), and "safe" ("green") areas.^{15,16} In most events, the security situation developed over time, requiring constant evaluation. Security threats included secondary attacks directed at EMS¹⁴ and the possibility of chemicals or explosives causing serial explosions.¹⁷ The presence of upset or aggressive civilians also posed security risks.¹⁸ Failing to continuously assess the security situation could result in fatalities among primary victims and EMS personnel, in the latter case reducing EMS's ability to respond to the event.

Physically Accessing Victims—In many events, the location of the scene, most often combined with damaged infrastructure, adverse weather conditions, or security issues, made it difficult for EMS to physically access victims. Obstacles included narrow spaces,¹⁶ roadblocks,²⁰ power lines crossing the scene,²⁰ or strong winds.²⁰ In some cases, access was hindered by security threats such as active shooting.^{14,21,22} A strategy for enabling the provision of medical care was to establish medical posts in "safe enough" zones and move victims to these zones.¹⁵

Developing and Communicating Situational Awareness

Several challenges were related to prehospital situational awareness, analysis of the situation, and the sharing of the results of analysis with the strategic command level or the hospital.

Understanding the Situation and its Consequences—In some cases, the first indication of an MCI was a flux of emergency calls

Database and Date for Search		n
PubMed 2024-04-02		
1.	((disaster[MeSH Terms]) OR (planning, disaster[MeSH Terms])) OR (Disaster Management[MeSH Terms]) OR (Mass Casualty Incidents[MeSH Terms]) OR (Mass Shooting Events[MeSH Terms]) OR (Medical Countermeasures[MeSH Terms]) OR (Natural Disasters[MeSH Terms]) OR (Cyclonic Storms[MeSH Terms]) OR (earthquakes[MeSH Terms]) OR (floods[MeSH Terms]) OR (landslides[MeSH Terms]) OR (tidal waves[MeSH Terms]) OR (tornadoes[MeSH Terms]) OR (Wildfires[MeSH Terms])	112,829
2.	((emergency medical services[MeSH Terms]) OR (ambulance[MeSH Terms])) OR (prehospital[Title/Abstract])	182,653
3.	("case reports"[Title/Abstract]) OR ("lessons learned"[Title/Abstract])	133,162
4.	1 AND 2 AND 3	343
5.	Limits: English, publication year 2015-2024	113
Web of Science 2024-04-02		
1.	TS=(disaster OR mass casualty incidents OR mass shooting event OR natural disasters OR Cyclonic Storms OR Droughts OR Earthquake* OR Floods OR Landslides OR Tornadoes OR Wildfires OR Tidal Waves OR Tornadoes OR Typhoon OR mudslide OR brush fire)	643,326
2.	TS=((emergency medical services) OR ambulance OR prehospital)	49,209
3.	TS=(case reports OR "lessons learned" OR report)	5,960,081
4.	1 AND 2 AND 3	489
5.	Article (Document Types) and English (Languages) and 2024 or 2023 or 2022 or 2021 or 2020 or 2019 or 2018 or 2017 or 2016 or 2015 (Publication Years)	213
Scopus 2024-03-19		
1.	TITLE-ABS-KEY ((disaster* OR "mass casualt*" OR "mass shooting*" OR "natural disaster*" OR avalanche* OR cyclon* OR "drought*" OR earthquake* OR flood* OR landslide* OR "tidal wave*" OR tornado* OR wildfire* OR hurricane* OR "tropical storm*" OR typhoon* OR rockslide* OR mudslide* OR tidalwave* OR "forest fire*" OR "wild fire*" OR "brush fire*" OR "wildland fire"*)	1,077,949
2.	TITLE-ABS-KEY (emergency AND medical AND services OR ambulance OR prehospital)	127,519
3.	TITLE-ABS-KEY (case reports OR "lessons learned" OR report)	3,394,866
4.	1 AND 2 AND 3	339
5.	PUBYEAR > 2015 AND PUBYEAR < 2024 AND (LIMIT-TO (LANGUAGE, "English"	99
CINAHL Full Text 2024-03-19		
1.	MH ("Disaster Planning") OR (MH "Disasters") OR (MH "Natural Disasters") OR (MH "Mass Casualty Incidents") OR "disaster")	31,568
2.	MH ((emergency medical services) OR ambulance OR prehospital)	28,192
3.	TX ("case reports" OR "lessons learned" OR report)	1,019,996
4.	1 AND 2 AND 3	233
5.	Academia paper; English Language; Publication Date: 201540101-20241231	72

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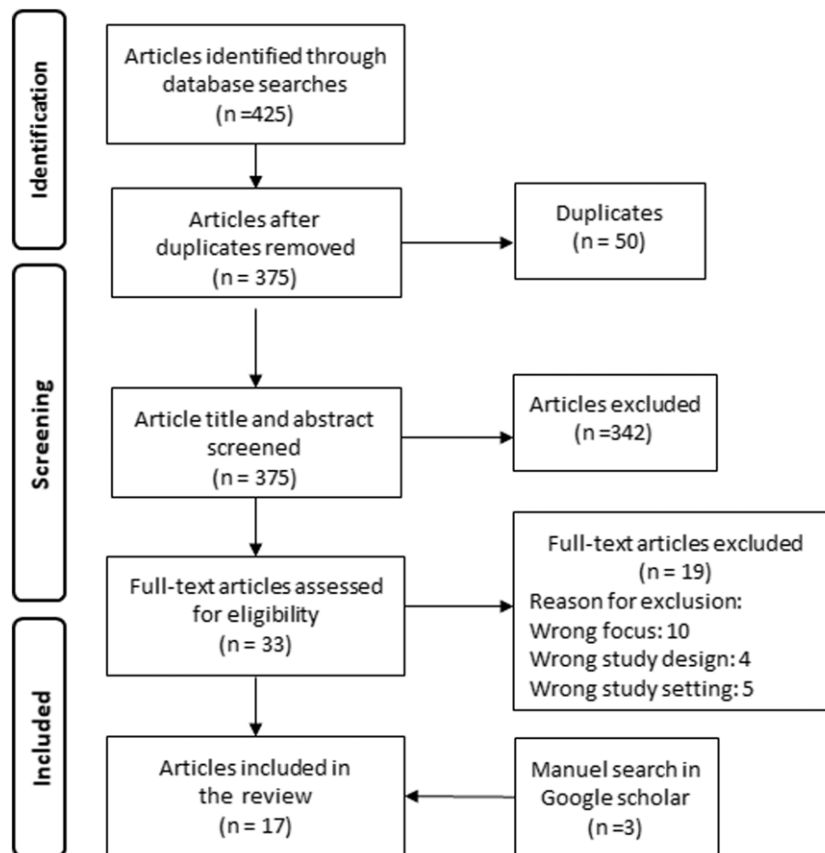
Table 1. Systematic Search
Abbreviation: MeSH, Medical Subject Headings.

overwhelming the dispatch center. In one example, approximately 550 calls were recorded within a few minutes,¹⁴ and in another example, the emergency calls increased by 400% during the first hour.¹⁵ In other cases, the first indication of an MCI was when EMS met with a crowd fleeing the scene as they approached it.^{14,19} Determining the exact or potential number of victims was challenging. Wide-spread scenes, spontaneous evacuations, the movement of people at the scene, and insecure environments often make it hard to make good estimations of numbers of injured.^{14-16,20,23} Sometimes, the prehospital incident commander estimated the number of victims based on location, event type, and a "gut feeling."^{14,15}

Lack of a physical overview of the scene,^{14-16,20,24} uncertainty and rumours,¹⁴ and challenges to obtaining information from the victims²³ made it difficult to gain situational awareness and to analyze its medical consequences. The incident commander had to consider not only obvious injuries, but also pre-event conditions²⁵ and secondary medical effects such as contamination of victims,¹⁷ cardiac infarction or other acute medical conditions,²⁶ secondary injuries from falling debris,²⁷ hypothermia risks,²⁴ or dehydration.¹⁹ The ability to

foresee such needs was limited and required medical knowledge and experience.^{16,26}

Communicating Situational Awareness—It was emphasized that the prehospital response had to be integrated into the overall medical response. One of the greatest challenges to enable that was the sharing of information between the prehospital scene and the hospital, as well as other strategic levels within the crisis management system. Where information sharing failed, hospitals and strategic EMS management could not adapt their responses.^{19,24,25} Communication technologies affected information sharing. Not all prehospital responders deployed units had the possibility or were familiar with the radio communication systems used.^{14,16,18} Where many units were deployed, it was necessary to default to a "listen only, do not answer" basis to ensure radio discipline and clear communication channels,¹⁴ and it was a common problem that much of the information shared through technical systems was not perceived by its intended recipients.^{14,16,17,20,23}



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Figure 1. PRISMA Flowchart.

Determining and Adjusting a Prehospital Management Strategy

In all events, a prehospital strategy had to be developed to ensure effective management of the situation. This strategy most often relied on general guidelines and principles but had to be adapted to the situation.

Adapting the Standardized Plan to the Event—Successful prehospital MCI management required the determination of a clear prehospital strategy and its communication to all actors.^{14–16}

As situations developed over time, these strategies had to be regularly adjusted.^{14,15} Factors influencing the prehospital strategy included the estimated number of victims and their conditions, the location of the scene and of hospitals, logistical matters and the available resources, including staff and means of transportation. Several decisions had to be made based on these factors. A core component of the strategy was to get an effective flow of patients from the scene to the hospital, or designated points such as medical posts, for which there were several options. If the turnaround time for available ambulances was short, weather conditions were severe, or the scene was presumed too dangerous for on-site medical care, a strategy relying on the “load and go” principle was chosen. In such cases, medical treatment was not provided at the scene, but rather, in transit to the hospital, regardless of the standard plan or guidelines.^{14,21,23} In other situations, the strategy was to gather victims for triage and care at the scene or at medical posts in safe areas before transferring them to hospitals.^{15,24} Sometimes, it was necessary to keep ambulances on standby at short distances from

the scene due to security risks or to avoid crowding at the scene.¹⁴ In other situations, infrastructural damage or adverse weather conditions forced the flow in certain unplanned directions, despite the original plan and most suitable hospitals.²⁰

Improvising—Even where general prehospital MCI management principles and guidelines existed, the complexity of the events and the presence of severe security issues required medical commanders’ quick decision making and improvisation.^{14,15,28} Some such decisions were to transport several patients in one ambulance^{14,21} or to use other means of transportation.^{14,28} Others involved abandoning the plan to use triage areas or medical posts due to security risks.^{15,16} If the strategy was to immediately transport all patients to the hospital, the use of pre-planned key functions such as ambulance loading officers or triage officers could be omitted to reallocate manpower to increasing transport capacity.¹⁴

Efficiently Distributing the Injured—A question raised across events was how to best distribute the injured, considering both the prehospital and hospital situations. In most events, both uninjured and injured victims went from the scene to nearby hospitals without assistance from EMS. Such spontaneous evacuation started before the arrival of EMS.^{14–17,19,20,26,28,29} In dangerous situations, such behaviors could be seen as a way of both saving oneself from the scene seeking medical care and were sometimes life-saving.^{14,15}

Overall, EMS distributed patients in two main ways. The first was to transfer them to the nearest hospital, resulting in short

Challenges (Themes)	Safe Access to the Scene and Victims	Developing and Communicating Situational Awareness	Determining and Adjusting a Prehospital Management Strategy	Providing Prehospital Medical Care Beyond Everyday Routines	Ensuring Endurance and Resilience
Subthemes	Assessing security and defining adequately safe zones	Understanding the situation and its consequences	Adapting the standardized plan to the event	Extracting victims and providing care under severe threats	Planning for a long-lasting prehospital response
	Physically accessing victims	Communicating situational awareness	Improvising	Providing services beyond traditional prehospital medical care	Balancing resources
			Efficiently distributing the injured		Promoting resilience among prehospital responders

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Table 4. Overview of Themes and Subthemes

ambulance turnaround times; however, this risked crowding in emergency rooms, especially if many victims had spontaneously evacuated there.^{21,25,27,29} The other option was to transfer to hospitals farther from the scene. This required more ambulances due to the longer turnaround time, but gave the receiving hospitals more preparation time and allowed for fewer secondary transports.^{21,30} Regardless of the strategy, it was important to register and track where each patient had been sent.²⁴

Providing Prehospital Medical Care Beyond Everyday Routines

The studied MCIs required medical care somewhat different from routine care.

Extracting Victims and Providing Care Under Severe Threats—

Some of the events required civilian EMS not only to provide medical care but also to safely extract victims from danger zones. This necessitated close cooperation with the police and military; one strategy was to form a secure corridor, protected by armed police or soldiers, from the scene of the event to an ambulance collecting point.¹⁴ In other situations, injured persons were sheltered in places protected by the police, unable to move.¹⁵ These cases illustrate that EMS personnel sometimes have to assist in both dangerous extractions and provide care under fire.^{15,21,30}

Providing Services Beyond Traditional Prehospital Medical Care—

In most events, natural triage (ie, the on-scene death of victims with severe injuries) was high, and medical interventions were limited to clinical assessment, triage (often “eyeballing triage”), and treatment of minor injuries.^{15,16,19,20,23,27} However, in some, interventions were performed to stop severe hemorrhaging (eg, tourniquets or wound packing) or to provide intravenous analgesics.^{14,15,23,26} Some events required the use of “ad-hoc” triage systems or treatment guidelines due to the nature of the medical conditions.²⁸ An important aspect of prehospital medical care was to ensure the maintenance of ethical principles and to provide quality care for all victims, including suspected perpetrators, even under severe circumstances.¹⁵

Following an event, prehospital EMS also involved providing victims and their relatives with care and services other than life-saving aid (eg, treating minor injuries or assisting with psychological support).^{14,16,20} Victims who had received medical

care at the scene but were directly discharged therefrom required information about their clinical conditions and more extensive advice about self-care in everyday situations.²⁸ Where victims had to remain at the scene or in collecting areas for extended periods of time, EMS personnel, with the help of local authorities, had to provide food, water, and shelter.¹⁹ They were also required to orient family members who arrived at the scene looking for their loved ones.²⁴ They thus had to prepare for such duties, most often in close collaboration with the police and local authorities.

Ensuring Endurance and Resilience

Strategic EMS management was the main challenge to ensuring an enduring and resilient response. Constant strategic revision of the situation was essential to making adequate operational decisions. It was important for the prehospital incident commander and the strategic commander to be aware that their situations most likely differed due to their different perspectives and information sources, and therefore to prioritize regular information sharing.¹⁴

*Planning for a Long-Lasting Prehospital Response—*Most events required the presence of EMS for hours after the initial alarm. In the reviewed events, EMS presence ranged from four-and-a-half²³ to five,²⁴ eight,¹⁷ or ten hours.¹⁹ It was important not to withdraw prehospital resources too soon, as victims could be found during repeat sweeps of the scene.¹⁴ Since most events lasted several hours, the need for food and refreshments for both victims and EMS personnel had to be addressed within a few hours of the start of the event.^{14,19} Even where emergency care was completed, response activities such as victim identification were on-going, sometimes requiring medical backup.²¹

*Balancing Resources—*Everyday emergencies do not cease when MCIs occur. In one case, only 40% of the day’s EMS calls were related to the MCI.²¹ Therefore, strategic prioritization of how to use the available EMS resources to increase the response capacity was challenging. It likewise had to be decided early whether to assign all available ambulances to the incident or to hold some back in case of multiple-site or time-staggered incidents.^{14,15} A common strategy was to request additional EMS resources from other parts of the country as backup or in response to unrelated emergency calls.^{14,15,31} In foreseeable events, such as weather-related events, such preparations were possible to do before the event.³¹ The need

for secondary transport, which could emerge during or after the event and last for several days,³⁰ also had to be weighed against regular emergency calls.

Promoting Resilience among Prehospital Responders—Since the reviewed MCIs required unusual and demanding effort from all EMS personnel involved and lasted several hours or days, actions to promote resilience among EMS personnel were important.^{14,20,21,30,31} Examples of such actions included pre-deployment briefings for incoming personnel,^{15,31} the provision of food and water during deployment,^{14,19} and the implementation of clear stand-down strategies for EMS personnel at the end of their shifts and beyond.^{14,31} Such strategies included short, technical post-action reviews, the monitoring of EMS personnel's well-being over a period of three weeks to three months after the event, and the provision of professional individual psychosocial support.^{14,20,21}

Discussion

This review demonstrates that common challenges in prehospital MCI management include issues related to the safety and security of both victims and responders; the development and communication of situational awareness; the application of a prehospital response strategy; the delivery of care under severe circumstances; and the need for extended strategic EMS management.

Several of the reviewed events entailed security issues for both victims and responders. Previous studies have shown a need for better mental and educational preparation for EMS personnel to act in insecure environments.³² Some of the reports also suggested adapting a tactical medicine mindset within civilian EMS.^{21,22,26} Such suggestions, along with the fact that EMS sometimes have to face severe security issues, might engender ethical dilemmas concerning the balancing of personal risks against professional responsibilities and what “acceptable risks” really means.³³ These matters deserve both scientific and clinical attention. Future research and clinical discussions should therefore focus on the matters of training prehospital incident commanders and strategic EMS officers to assess security risks and use strategies to reduce them; mentally preparing responders for these situations; and discussing what, from a clinical and ethical perspective, “safe enough” means in the context of an MCI.

Creating and communicating accurate situational awareness was another common challenge. The ability to maintain appropriate situational awareness has been identified as an essential competence for incident manager.³⁴ A core component of the Endsley situational awareness theory is to comprehensively interpret the meaning of the event and try to project its consequences onto a near future.³⁵ The present review supports this idea, also reported in other studies on crisis incident management,³⁴ and emphasizes that the prehospital incident commander must be able to analyze longer timeframes and think ahead of the current situation. This requires both a broad medical knowledge and analysis skills. A central part of the situational awareness is the estimation of numbers of victims and injuries. Reports on casualty counts have traditionally been essential to information sharing between prehospital scenes, hospitals, and strategic management levels. However, determining the exact number of victims, considering, in particular, spontaneous evacuation, has proven difficult or even impossible in an MCI's early stages. The incident commander's immediate impression and “gut feeling” may therefore be more efficient than

exact numbers, especially in the first stage of the event management.³⁶ Technical solutions such as drones or artificial decision-making tools were not mentioned in any of the cases. Such solutions may be supportive, but their potential contributions to establishing situational awareness cannot be determined in this study and is a question requiring scientific attention. Also, it is well-known that communication failure is common in the prehospital response to terrorist attacks, with regards to technical systems, overwhelmed communication services, failure due to damaged infrastructure, and by lack of training.³⁷ This should also be taken into consideration when planning for information flow and information needs in other types of MCI.

A question raised by the present study is what kind of training should be required for EMS personnel and prehospital incident commanders. The infrequency with which MCIs occur makes it difficult for EMS personnel in general, and prehospital medical incident in particular, to improve their management skills in real-life situations. Therefore, learning from others' experiences may be a successful alternative.³⁶ Challenges related to communications, leadership, logistics, and resource management are frequently reported in “lessons learned” MCI reports.³⁸ In this study, most of the reported challenges were related to management skills, such as improvisation and situational analyses, rather than to the medical treatment of individual victims. This underscores the need to integrate medical mass-casualty knowledge with common, general incident management skills to improve the effectiveness of prehospital MCI management. The gap between the training and real events is also considerable³⁹ and it is essential that MCI training relies on real-life experiences and evidence rather than on exercises or simulations.⁴⁰ Further studies on how to prepare EMS personnel and prehospital medical incident commanders for the dynamics and the complexity of real prehospital MCIs is therefore needed.

Limitations

There is a general need for evidence- and experience-based information on prehospital MCI management.⁴¹ Using case reports to build such evidence is a method accepted within evidence-based medicine.⁴² The systematic integrative review method enables systematic synthesis of both qualitative and quantitative data.¹² It was therefore considered suitable to the present study. Despite a structured search across four databases, it cannot be excluded that other or more reports were available. Also, the reports' formats varied widely. It has been suggested that uniform MCI reporting and population-based studies would facilitate progress in research.^{41,43} Many reports focus solely on describing injuries or medical conditions, and few report on prehospital management as such. Since medical outcomes are closely related to incident management, it is important to build further evidence incorporating both medical and management science.⁴⁴ This review was not pre-registered, since the study participants were not human.

Conclusion

Resilient prehospital MCI response demands both a clear strategy and improvisation and should be integrated into the overall medical response strategy. Responders must understand the main concepts of prehospital MCI management, have a situational awareness that foresees the event's medical consequences, and have the experience required to interpret the situation in both a short-term and a longer

perspective. Emergency Medical Services personnel and medical incident commanders require specific training and mental preparation to be able to provide care under severe security threats, to improvise beyond routines and guidelines, and to provide care in ways different from their everyday work.

Author Contributions

KH: Conceptualization and design; literature search; quality appraisal; analysis; writing and editing of manuscript. JB: Quality appraisal; analysis; writing and editing of manuscript. Both authors approved the final manuscript.

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Author/s (Year)	Were Event Characteristics Clearly Described?	Was Response Timeline Presented?	Were Methods and Results Clearly Described?	Were Procedures and Incident Commander's Decisions Clearly Described?	Were Outcomes of Event (eg, Number of Injured and Conditions) Clearly Described?	Were Adverse Events or Unanticipated Events Identified and Described?	Does Case Report Provide Takeaway Lessons?	Overall Appraisal
Alpert, et al (2024)	Yes	Yes	Unclear	Unclear	Unclear	Yes	yes	Medium
Carli (2017)	Yes	No	Unclear	No	Yes	Yes	Yes	Medium
Choi (2022)	No	Yes	Unclear	Yes	Yes	Yes	Yes	High
Clancy, et al (2014)	No	No	No	Unclear	No	Yes	Yes	Medium
Gamberini, et al (2021)	Yes	Yes	No	Yes	Yes	Yes	Yes	Medium
Hansen, et al (2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
Hansen, et al (2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
Hardy, et al (2015)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
Helou, et al (2021)	Yes	No	Unclear	No	Yes	Yes	Yes	Medium
Hirsch, et al (2015)	Yes	Yes	Yes	No	Yes	Yes	Yes	High
Idrose, et al (2022)	Yes	Yes	No	No	Yes	Yes	Yes	Medium
Jaffe, et al (2024)	Yes	No	Yes	No	Yes	Yes	Yes	Medium
Keykaleh& Sohrabizadeh (2019)	No	No	Unclear	No	Yes	Yes	Yes	Medium
Koning, et al (2015)	No	Yes	Yes	Yes	Yes	Yes	Yes	High
Maruhashi, et al (2018)	Yes	Yes	No	No	Yes	Yes	Yes	Medium
Pasquier, et al (2017)	Yes	No	Yes	Unclear	Yes	Yes	Yes	Medium
Zhang, et al (2018)	No	Yes	Yes	No	Yes	Yes	Yes	Medium

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Table 2. Quality Appraisal, Based on a Modified Critical Appraisal Checklist for Case Reports
 Note: Modified checklist based on JBI (2020). Checklist for case reports. Critical Appraisal tools for use in JBI Systematic Reviews.
 Abbreviation: JBI, Joanna Briggs Institute.

Author/s (Year)	Type of Event	Country	Type of Report	Number of Deceased/ Injured/ Affected	Major Challenges Reported	Quality Appraisal
Alpert, et al (2024)	Terrorist Attack (Shooting, Missile Fire)	Israel	Field Report	1,200/1,455/–	Secondary transfers started five hours after the event and lasted 24 hours.	Medium
Carli (2017)	Terrorist Attack (Shooting, Bomb)	France	Short Report	137/413/–	Care under fire and extreme insecurity. Tactical medical strategies used. Backup with EMS from across the country.	Medium
Choi (2022)	Hospital Fire	South Korea	Field Report	47/192/–	Cold weather and disruptions in communications made it necessary to transport victims without delay.	High
Clancy, et al (2014)	Storm	USA	Case Report	–/–/–	Weather-related events can be prepared for. EMS response needs to be integrated into overall response.	Medium
Gamberini, et al (2021)	Boiling Liquid Explosion	Italy	Case Report	1/158/–	Cordons made it difficult to evaluate the scene. To avoid crowding, most patients were not transported to the nearest hospital.	Medium
Hansen, et al (2021)	Train Accident	Denmark	Case Report	8/15/–	Weather conditions, access, and communication affected management.	High
Hansen, et al (2023)	Mass Shooting	Denmark	Case Report	3/28/–	Lack of resources made it necessary to improvise.	High
Hardy, et al (2015)	Traffic Accident	UK	Case Report	0/69/200	Long time on scene, problematic weather conditions, lack of communication and of senior management.	High
Helou, et al (2021)	Explosion	Lebanon	Field Report	200/6,000/–	Spontaneous evacuation, lack of EMS coordination.	Medium
Hirsch, et al (2015)	Terrorist Attack (Shooting, Bomb)	France	Viewpoint	129/256/–	No personnel shortage. Previous experience essential to the response.	Medium
Idrose, et al (2022)	Train Accident	Malaysia	Field Research Paper	0/64/214	Logistical challenges due to narrow spaces and climate. Dangerous zones.	Medium
Jaffe, et al (2024)	Terrorist Attack (Shooting, Missile Fire)	Israel	Brief Report	1,200/9,000/–	EMS teams faced overwhelming number of casualties; security, communication, and well-being of staff an issue.	Medium
Keykaleh & Sohrabizadeh (2019)	Bus Accident	Iran	Case Report	11/35/–	Crowding at the scene and lack of coordination between agencies delayed adequate medical care.	Medium
Koning, et al (2015)	Fire at Nursing Home	Netherlands	Field Research Report	0/49/187	Miscommunication and registration problems led to confusion about the victims' location.	High
Maruhashi, et al (2018)	Stabbing Attack	Japan	Special Report	19/26/165	A large area, communication problems led to uncertainty of the situation and delayed response.	Medium
Pasquier, et al (2017)	Carbon Monoxide Poisoning	Switzerland	Field Research Report	0/61/–	Triage systems were adopted and alternative means of transportation were used.	Medium
Zhang, et al (2018)	Chemical Explosion	China	Field Research Report	165/4,000/ 30,000	A massive response was initiated. The prehospital phase lasted several hours.	Medium

Table 3. Overview of Papers Included in the Review
Abbreviation: EMS, Emergency Medical Services.