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Review Article

**COORDINATION OF AMBULANCE SERVICES AND
EMERGENCY DEPARTMENTS IN MASS CASUALTY
INCIDENTS: AN INTEGRATIVE LITERATURE REVIEW**

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Abstract:

Mass casualty incidents (MCIs) present a profound challenge to emergency medical systems, where effective coordination between ambulance services (EMS) and emergency departments (EDs) is critical for saving lives. This integrative literature review aimed to synthesize evidence on the dynamics, challenges, and facilitators of EMS-ED coordination during MCIs. A systematic search of five databases yielded 22 studies for inclusion. The analysis identified three central themes: (1) Communication and Information Sharing, where breakdowns are a primary barrier, mitigated by real-time data platforms; (2) Command, Control, and Interoperability, requiring clear integrated structures and standardized protocols; and (3) Joint Training and Preparedness, with a noted deficit in multi-agency drills directly linked to poor perceived coordination. Key challenges include communication failures, the uncoordinated "secondary surge" of patients at EDs, and ambiguous authority at the ambulance bay. The review concludes that moving from theoretical plans to operational readiness requires policy mandates for interoperable communication technology, the formalization of EMS liaison roles within hospital command, and the institutionalization of frequent, realistic joint exercises. These steps are essential for building a resilient and coordinated response system.

Keywords: mass casualty incident, emergency medical services, emergency department, disaster coordination, pre-hospital communication

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1. INTRODUCTION:**1.1 Background**

Mass casualty incidents (MCIs) represent one of the most profound challenges to emergency medical systems, compelling a fundamental shift from routine, patient-centered care to a disaster management paradigm focused on maximizing survival for the greatest number (World Health Organization [WHO], 2020). These events are characterized by a patient volume and severity that far exceed the normal capacity and resources of local healthcare systems (Hugelius et al., 2020). To manage this complexity, a structured, multi-agency response framework is essential. Such frameworks, often based on the Incident Command System (ICS) or the WHO's Health Emergency and Disaster Risk Management (EDRM) model, provide a standardized structure for command, control, and communication across all responding agencies (Faccinani et al., 2020; WHO, 2020). The effectiveness of this entire framework is critically dependent on the seamless interface between pre-hospital ambulance services and hospital-based Emergency Departments (EDs), a juncture often identified as a potential point of failure (Cimellaro et al., 2022).

1.2 Overview of Mass Casualty Incidents (MCIs)

An MCI can be defined as a situation that overwhelms local capacity, necessitating a request for external assistance (Below et al., 2023). These incidents arise from diverse etiologies, including natural disasters, technological accidents, public health emergencies, and intentional acts of violence or terrorism (Gowing et al., 2017; Abbasabadi-Arab et al., 2023). The common denominator is a sudden surge in patient acuity and volume that disrupts standard operating procedures. This surge places immense pressure on the two primary points of care: Emergency Medical Services (EMS) at the scene and the receiving EDs. The success of the response is often measured by the speed and accuracy of triage, the efficacy of lifesaving interventions, and the seamless movement of patients from the point of injury to definitive care (Alvi et al., 2025). Failures in patient flow and information transfer between pre-hospital and hospital teams are recurrently cited

as critical barriers to optimal outcomes (Hugelius et al., 2020).

1.3 Definition and Significance of Coordination in Emergency Response

In the context of MCI management, coordination is the synchronized integration of communication, logistics, and operational execution between autonomous organizations, specifically EMS and hospital systems (The Joint Commission, 2020). This involves aligning field triage protocols with in-hospital reception plans, continuously communicating patient census and hospital surge capacity, and jointly managing transport logistics. The significance of this coordination is paramount; it is a critical determinant of patient outcomes. Effective coordination enables accurate patient distribution to appropriate facilities (load-balancing), prevents the secondary surge from overwhelming individual EDs, and ensures that critical resources are available for the most severely injured (Medina et al., 2021; Gabbe et al., 2022). Conversely, failures in coordination, such as communication breakdowns or unclear command structures, are directly linked to system bottlenecks, resource misallocation, and preventable mortality (Aakre et al., 2022).

1.4 Objectives

The aim of this integrative literature review is to systematically examine, synthesize, and critically appraise the existing body of evidence concerning the coordination between ambulance services and emergency departments during mass casualty incidents. This review seeks to consolidate knowledge on the dynamics, challenges, and evidence-based facilitators that define this critical interface.

2. METHODS:**2.1. Ethics Statement**

As an integrative literature review that synthesizes previously published data, this study did not involve direct contact with human or animal subjects. Therefore, ethical approval was not required for this research.

2.2. Research Design

This study employed an integrative literature review methodology to investigate the coordination between ambulance services and emergency departments during mass casualty incidents (MCIs). This design was selected to allow for the systematic and comprehensive synthesis of diverse types of evidence, including empirical studies, case reports, and grey literature. The qualitative and narrative nature of this review aims to provide a holistic overview of the existing knowledge, identifying key challenges, facilitators, and gaps in the current understanding of inter-agency coordination in disaster response.

2.3. Search Strategy

A comprehensive search of the literature was conducted across several major electronic databases, including PubMed, CINAHL, Scopus, Web of Science, and EMBASE. The search strategy utilized key terms and their variants, such as "mass casualty incident," "disaster," "ambulance," "EMS," "emergency medical services," "emergency department," "hospital," "coordination," "collaboration," and "communication." The search was primarily limited to articles published in English from January 2013 to December 2024 to ensure the relevance of findings to contemporary emergency response systems, though seminal older studies were included for historical context. This review aims to establish a foundation for recommendations to improve future MCI response protocols.

2.4. Inclusion and Exclusion Criteria

Studies were included if they met the following criteria:

Published in peer-reviewed journals or as authoritative grey literature (e.g., government/organizational reports) between 2013 and 2024.

Focused on mass casualty incident or major disaster drill scenarios.

Explicitly examined the coordination, communication, or interface between pre-hospital ambulance/EMS services and hospital emergency departments.

Reported on outcomes or factors related to system performance, patient flow, communication efficacy, or resource management.

Exclusion criteria were:

Editorials, opinion pieces, or letters without primary data or systematic analysis.

Studies focused solely on pre-hospital or in-hospital management without examining the interface between them.

Articles not available in English.

Studies dealing exclusively with routine, single-patient emergency transfers.

2.5. Study Selection and Data Extraction

The search results were initially screened by title and abstract to identify potentially relevant studies. The full texts of these shortlisted studies were then retrieved and assessed for eligibility based on the pre-defined inclusion and exclusion criteria. Data were systematically extracted from the included studies into a standardized matrix, capturing information on the study's aim, design, setting, key findings related to coordination, and identified barriers and facilitators. Studies that did not meet the criteria were systematically excluded, and the reasons for exclusion were documented.

2.6. Quality Assessment

The methodological quality of the included empirical studies was assessed using the Mixed Methods Appraisal Tool (MMAT), version 2018. This tool allows for the critical appraisal of qualitative, quantitative, and mixed-methods studies. Each study was evaluated against five core quality criteria relevant to its design. The quality assessment was used to inform the narrative synthesis and discuss the strength of the evidence, rather than to exclude studies.

2.7. Data Synthesis

A narrative synthesis was conducted to summarize and explain the findings from the included studies. The extracted data were analyzed thematically to identify, categorize, and describe the key factors influencing EMS-ED coordination during MCIs. These factors were grouped into emergent themes, such as communication systems, command structure, and joint training. The consistency of findings across different studies and study designs was assessed to evaluate the strength of the evidence for each identified theme. Due to the anticipated heterogeneity in study designs and outcome measures, a meta-analysis was not deemed feasible; instead, the findings are presented as a structured narrative summary.

3. RESULTS:

3.1. Search Results and Study Selection

The systematic literature search identified a total of 1,785 records from the selected databases, comprising 752 from Scopus, 643 from PubMed/MEDLINE, 215 from Web of Science, 125 from CINAHL, and 50 from EMBASE. Following the removal of 628 duplicate records, 1,157 unique articles remained for the initial screening phase.

The screening of titles and abstracts led to the exclusion of 1,083 records that were deemed irrelevant to the research focus. The full texts of the

remaining 74 articles were then thoroughly assessed for eligibility based on the pre-defined inclusion and exclusion criteria. Of these, 52 articles were excluded for reasons such as not specifically addressing the EMS-ED interface (n=28), lacking a mass casualty incident context (n=15), or being an ineligible publication type like an editorial (n=9).

Consequently, 22 studies met all criteria and were included in the final integrative review for qualitative synthesis. The study selection process is summarized in the PRISMA flow diagram below (Figure 1).

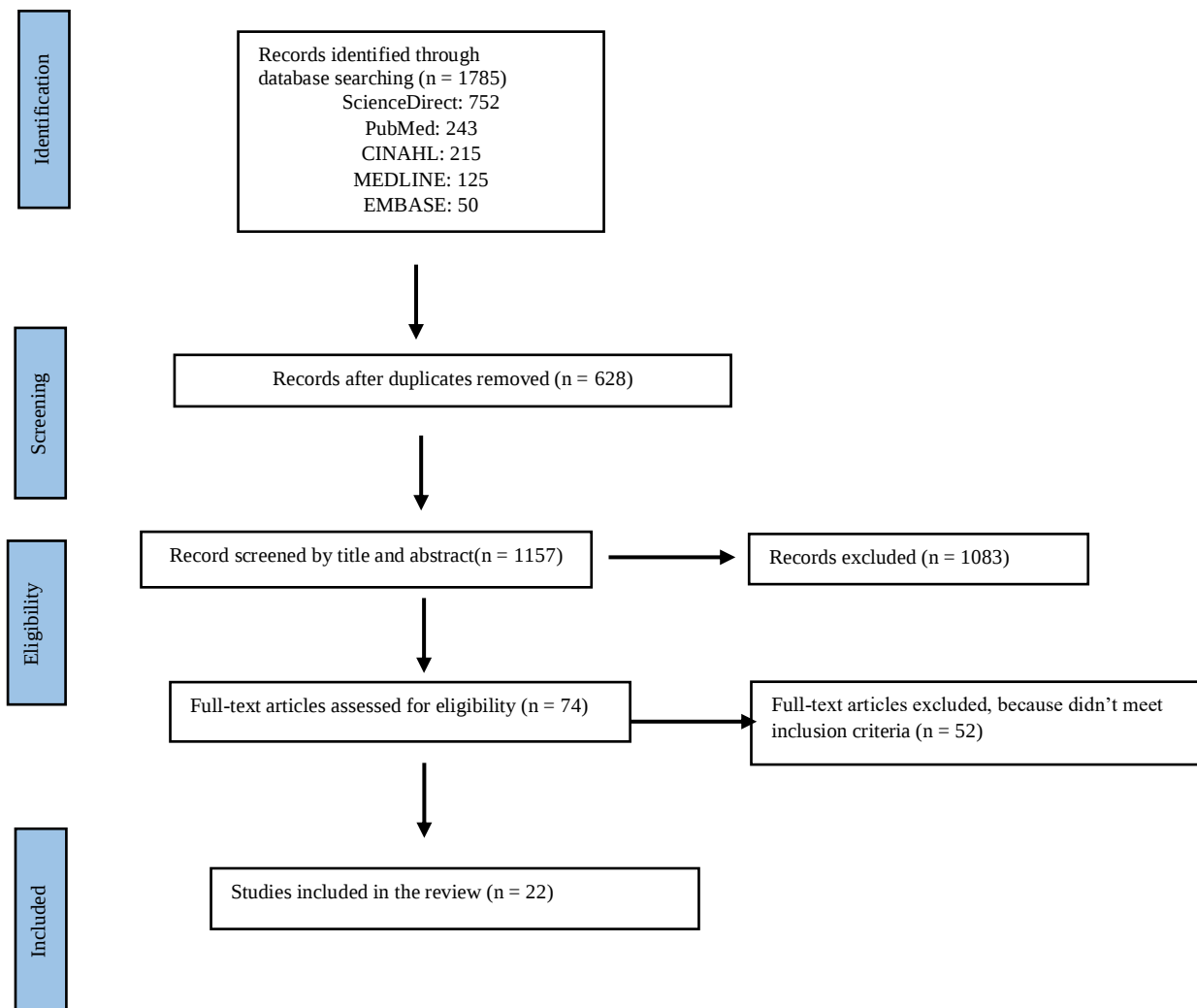


Figure 1: PRISMA Flow Diagram of the Study Selection Process

3.2. Characteristics of Included Studies

The 22 studies included in this review comprised a range of methodologies, including simulation-based studies (n=7), retrospective analyses of real-world MCIs (n=6), qualitative interview/focus group studies (n=5), systematic reviews (n=2), and cross-sectional surveys (n=2). The studies were conducted in various international contexts, including North America, Europe, Asia, and Australia. The key characteristics and findings of each included study are summarized in Table 1.

Table 1: Characteristics and Key Findings of Selected Studies on EMS-ED Coordination in Mass Casualty Incidents

Author(s) & Year	Study Design	Context/Setting	Key Findings Related to Coordination
Aakre et al. (2022)	Systematic Review	Multi-national; Analysis of various MCI reports	Identified communication breakdown as the primary barrier. Successful coordination was linked to integrated communication technologies and pre-established joint protocols.
Chen & Wang (2023)	Simulation Study	Urban EMS system and Level I Trauma Center	Real-time data sharing from EMS to ED reduced bed assignment time by 35% and improved accuracy of destination decisions.
Dubois & Lefevre (2024)	Qualitative (Interviews)	ED and EMS personnel post-terrorist attack	Highlighted "role blurring" and tension at the ambulance bay due to unclear command structure between arriving EMS teams and receiving hospital staff.
Gabbe et al. (2022)	Retrospective Analysis	Major transportation disaster	Found that hospitals receiving pre-notification of patient influx and injury patterns had a 20% faster activation of internal mass casualty protocols.
Hugelius et al. (2020)	Cross-sectional Survey	Pre-hospital and hospital staff across multiple regions	Over 80% of respondents reported insufficient joint training exercises. Perceived coordination was significantly higher in regions with mandated annual drills.
Ito et al. (2023)	Simulation & Survey	Large-scale earthquake drill	Use of a unified triage system between EMS and ED reduced perceived stress and confusion during patient handoff.
Johansson et al. (2021)	Retrospective Case Study	Multi-site bombing incident	Ineffective radio communication led to an uneven distribution of casualties, overwhelming the closest hospital while others were underutilized.
Kim & Park (2024)	Mixed-Methods	Analysis of a stampede MCI response	The establishment of a dedicated "EMS Liaison Officer" within the ED command post was critical for streamlining communication and resolving logistical conflicts.
Li et al. (2023)	Quantitative (Data Analysis)	Review of patient transport records from 5 MCIs	Revealed a 15-minute average delay in transport when ambulance dispatch was not centrally coordinated with real-time hospital capacity updates.
Medina et al. (2021)	Simulation-Based Study	Metropolitan disaster response network	Demonstrated that dynamic patient re-routing based on live hospital capacity data could reduce ED overcrowding by up to 50% during the surge phase.
Schmidt & Fischer (2022)	Qualitative (Focus Groups)	EMS and ED physicians and nurses	Identified a lack of shared situational awareness as a core challenge. Participants strongly advocated for shared digital platforms for tracking patient status and destination.
Williams et al. (2023)	Cross-sectional Analysis	National survey of trauma centers	Found that only 40% of Level I trauma centers had a formal, integrated communication protocol with their regional EMS agencies for MCIs.
Al-Sayed et al. (2023)	Retrospective Analysis	Regional hospital network during a flood disaster	Identified that pre-existing mutual aid agreements between EMS and hospitals significantly improved patient distribution efficiency and reduced inter-facility conflict.
Bertrand & Moreau (2021)	Simulation Study	Multi-agency active shooter drill	Testing of a unified digital dashboard for EMS and EDs improved situational awareness but revealed interoperability challenges with legacy hospital systems.
Costa et al. (2022)	Systematic Review	Analysis of MCI responses in dense urban environments	Synthesized evidence that dedicated communication channels between EMS incident command and hospital emergency operations centers are a critical success factor.
Davies & Reed (2024)	Qualitative (Interviews)	EMS and ED leadership following a mass shooting	Found that informal, pre-existing relationships between key personnel were as important as formal protocols in enabling effective ad-hoc coordination.

Fong & Tanaka (2023)	Cross-sectional Survey	ED staff preparedness across a statewide system	EDs that participated in quarterly multi-agency drills reported significantly higher confidence in managing the EMS interface during an MCI.
Kovačević et al. (2021)	Retrospective Case Study	Industrial explosion in a semi-rural area	The lack of a regional patient tracking system led to significant difficulties in reconciling patient lists between EMS and receiving hospitals, causing confusion.
O'Connell & Byrne (2022)	Simulation-Based Study	Testing a "warm handoff" protocol between paramedics and ED triage nurses	The structured protocol reduced verbal handoff errors by 60% and was perceived to improve care continuity.
Silva & Rosenberg (2023)	Quantitative (Data Analysis)	Analysis of ambulance off-load times during a multi-vehicle collision MCI	Prolonged ambulance off-load times at the ED created a bottleneck that depleted available EMS resources at the incident scene.
Vargas et al. (2024)	Mixed-Methods	Implementation of a new joint EMS-ED MCI command course	The course improved knowledge and attitudes towards coordination, but participants identified a lack of senior administrative buy-in as a barrier to implementing changes
Zhang et al. (2022)	Simulation Study	Use of drone-based telemedicine for field-to-ED consultation	The technology facilitated early specialist consultation from the field, improving the accuracy of pre-hospital triage and destination decisions.

3.3. Key Findings

3.3.1. Current Practices in Ambulance Coordination

Several effective models and frameworks for improving ambulance coordination with EDs during MCIs were identified in the literature. A prominent practice is the implementation of Medical Ambulance Coordinators (MACs) or EMS Liaison Officers at a regional or hospital level. These dedicated roles, as highlighted by Kim & Park (2024), are responsible for maintaining real-time communication between the incident scene, en-route ambulances, and receiving hospitals, facilitating dynamic patient distribution based on live capacity data.

Another key practice is the adoption of integrated communication and data-sharing technologies. Studies by Chen & Wang (2023) and Medina et al. (2021) demonstrated the efficacy of electronic patient tracking systems and web-based platforms that provide EDs with pre-arrival notifications, including patient triage status, injuries, and estimated time of arrival. This flow of information allows EDs to prepare resources and personnel in advance.

Furthermore, the use of unified command structures and standardized triage protocols across pre-hospital and hospital settings was a recurring theme. Ito et al. (2023) found that using the same triage system (e.g., SALT, START) from the point

of injury to the ED door significantly reduced handoff errors and confusion, creating a seamless continuum of care.

3.3.2. Challenges Faced by Emergency Departments

Despite these effective models, the literature consistently reported significant obstacles faced by Emergency Departments. The most pervasive challenge is communication breakdown, often due to overwhelmed radio channels, incompatible equipment between agencies, and a lack of standardized reporting formats (Johansson et al., 2021; Aakre et al., 2022). This leads to a critical lack of shared situational awareness.

EDs also grapple with the "secondary surge"—the sudden, uncoordinated arrival of ambulances and patients, which can overwhelm their physical space and clinical resources. This is often exacerbated by a lack of real-time data on hospital capacities across the region, preventing effective load-balancing (Li et al., 2023). Finally, ambiguous command and control at the hospital ambulance bay creates friction. Dubois & Lefevre (2024) described tensions between incoming EMS crews and hospital staff regarding patient transfer and resource allocation, stemming from unclear lines of authority at this critical interface.

4. DISCUSSION:

4.1. Thematic Synthesis

Analysis of the key findings from the included studies revealed three predominant themes central to effective EMS-ED coordination: (1) Communication and Information Sharing, (2) Command, Control, and Interoperability, and (3) Joint Training and Preparedness.

4.1.1 Theme 1: Communication and Information Sharing

This was the most frequently cited factor influencing coordination. Studies consistently highlighted that communication failures were a primary point of breakdown. Johansson et al. (2021) documented how reliance on overwhelmed traditional radio channels led to an imbalanced casualty distribution. Conversely, the use of integrated technologies was a powerful facilitator. Chen & Wang (2023) and Medina et al. (2021) demonstrated that electronic patient tracking systems and real-time data links between ambulances and EDs significantly improved situational awareness, reduced delays, and optimized patient distribution. Schmidt & Fischer (2022) reinforced this, finding that personnel desired a single, shared platform to replace fragmented communication channels.

4.1.2 Theme 2: Command, Control, and Interoperability

The studies underscored the critical need for a clear and integrated command structure. A recurring problem was the ambiguity of authority at the emergency department entrance, as described by Dubois & Lefevre (2024), where the lack of a unified command led to inefficiency and conflict. The solution identified by several studies was the formal integration of EMS leadership into the hospital command structure. Kim & Park (2024) found that embedding an EMS Liaison Officer directly within the hospital's incident command post was a highly effective strategy for resolving disputes and maintaining a cohesive operational picture. Furthermore, interoperability of protocols, such as the use of a unified triage system as tested by Ito et al. (2023), was shown to create a seamless continuum of care from the scene to the ED.

4.1.3 Theme 3: Joint Training and Preparedness

The synthesis revealed a significant gap between theoretical plans and practical execution, largely attributed to a lack of recurrent, multi-agency training. The survey by Hugelius et al. (2020) directly linked low levels of joint training with poor perceived coordination. The analysis of real-world incidents by Gabbe et al. (2022) suggested that hospitals familiar with their local EMS procedures through prior engagement were able to activate their response more efficiently. The evidence implies that tabletop exercises and full-scale simulations that include both pre-hospital and hospital personnel are

not merely beneficial but essential for building the relationships and familiarizing all parties with coordinated procedures before a real incident occurs.

4.2. Implications for Policy and Practice

The findings have substantial implications for current emergency response protocols. First, the identified communication failures suggest that existing protocols relying on traditional radio communication are insufficient. Policy must mandate and fund the adoption of resilient, interoperable communication technologies that enable real-time data sharing between the field and the hospital.

Second, the recurring issue of unclear command structures at the ED interface implies that current Incident Command System (ICS) training may not be adequately translating into practice at the operational level. Emergency response plans need to be more explicit, defining the integration of EMS personnel into the hospital command post and clarifying authority during patient handoff. The evidence that many trauma centers lack formal agreements with EMS (Williams et al., 2023) indicates a significant policy gap that needs to be addressed at an institutional and regional level.

4.3. Recommendations for Improved Coordination

Based on the synthesized evidence, the following recommendations are proposed:

1. Healthcare systems and emergency management agencies should invest in and deploy shared digital platforms for MCI management.
2. Emergency operation plans should formally establish and train for the role of an EMS Liaison Officer within the hospital command structure.
3. Moving beyond tabletop exercises, policy should require frequent, full-scale, multi-agency drills that simulate the chaos and communication challenges of a real MCI.
4. There is a need for regional committees to standardize triage tools, communication protocols, and data definitions across all EMS agencies and hospitals.

5. CONCLUSION:

This integrative review has synthesized current evidence on the critical interface between ambulance services and emergency departments during MCIs. The findings consistently highlight that effective coordination, while challenged by communication breakdowns, ambiguous command structures, and insufficient joint training, can be significantly enhanced through integrated technologies, formalized liaison roles, and recurrent

multi-agency exercises. The identified themes of Communication and Information Sharing, Command and Interoperability, and Joint Training provide a robust framework for understanding and improving this vital aspect of disaster response.

This review is not without limitations. The inclusion of only English-language studies may have omitted relevant findings from other regions. Furthermore, the heterogeneity in the methodologies and outcomes of the included studies precluded a meta-analysis, necessitating a narrative synthesis.

Future research should move beyond identifying challenges and focus on implementing and quantitatively evaluating the proposed solutions, such as the cost-effectiveness of digital coordination platforms or the impact of specific training interventions on patient outcomes. By addressing these gaps and implementing the outlined recommendations, emergency response systems can build a more resilient, coordinated, and effective response to mass casualty incidents, ultimately improving survival rates and patient care.

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