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Communication in Sudden-Onset Major Incidents: Patterns and Challenges—Scoping Review

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Systematic Review

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Keywords:
communication; disasters; major incidents; management and leadership

Abbreviations:
EMS, Emergency Medical Services; EUPHOREA, European Pre Hospital Research Alliance; JBI, Joanna Briggs Institute; KAMEDO, Katastrofmedicinsk Organisationskomitén; MI, Major Incident; MIMMS, Major Incident Medical Management and Support Courses; OSF, Open Science Framework; PCC, Population, Concept, Context; PRISMA-ScR, Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews; TETRA, Terrestrial Trunked Radio; UHF, Ultra High Frequency; VHF, Very High Frequency

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Abstract

Objective: To identify and describe patterns and challenges in communication in sudden-onset major incidents.

Methods: Systematic scoping review according to Joanna Briggs Institute and PRISMA-ScR guidelines. Data sources included Cochrane Library, EMBASE, PubMed/MEDLINE, Scopus, SweMed+, Web of Science, and Google Scholar. Non-indexed literature was searched as well. The included literature went through data extraction and quality appraisal as per pre-registered protocol.

Results: The scoping review comprised 32 papers from different sources. Communication breakdown was reported in 25 (78.1%) of the included papers. Inter-authority communication challenges were reported in 18 (56.3%) of the papers. System overload and incompatibility was described in 9 papers (28.1%). Study design was clearly described in 30 papers (93.8%).

Conclusions: The pattern in major incident communication is reflected by frequent breakdowns with potential and actual consequences for patient survival and outcome. The challenges in communication are predominantly inter-authority communication, system overload and incompatibility, and insufficient pre-incident planning and guidelines.

Sudden-onset major incidents (MI) are defined as incidents that require the mobilization of extraordinary emergency medical services (EMS) resources.[1] Communication within and between authorities is essential to achieve, maintain, and execute command and control in MI management. The sheer process of creating and sharing information and facts to reach a common understanding is essential.

Disorder and confusion are common in MI, especially in the initial phase before responding staff are in place and organized. Abnormal situations challenge normal communication routines, potentially hindering professionals in obtaining essential information regarding tasks, risks, and ability to command. Communication breakdown is frequent in MI[2,3] and may affect patient outcomes, safety of personnel, and the expedited return to normal conditions. Communication in MI has been sparsely quantified until recently in a case report by Hansen et al.[4]

Modes of communication may range from a verbal exchange of information to sophisticated digital platforms, depending on the geo-political and socio-economic settings of the MI. Low- to middle-income countries may be challenged by a lack of access to reliable, well-functioning communication systems or sufficient communication devices as well as limited planning, education, and training. Conversely, high-income countries with government funded EMS organizations typically utilize encrypted high fidelity and reliability radio systems such as the Terrestrial Trunked Radio[5] (TETRA) standard. Similar systems such as Very High Frequency (VHF)[6] and Ultra High Frequency (UHF)[7] radios, satellite phones,[8] computer-aided dispatch,[9] and digital platforms are in use worldwide. In addition, short wave radios and amateur (ham) radios may be used in MI management.

Communication in MI relies on technological and human integration, interpretation, processing, and output of data. Radiotelephony procedure,[10] radio discipline,[11] the use of the international NATO phonetic spelling alphabet,[12] and voice calling procedures[13] are crucial structural communication adjuncts. Human factors in emergency communication are described in theoretical models such as the Shannon Weaver[14] model of communication and Endsley's

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model of Situation Awareness[15] that describe the influence of factors such as stress, fatigue, interface design, and expectations on emergency communication.

Several emergency authorities are involved in the management of MI, depending on the complexity and severity of the MI in question. Communication between authorities is essential to maintain command and control, and, therefore, inter-authority communication challenges are pivotal to the review. Similarly, communication within 1 authority is defined as intra-authority communication. Therefore, the mechanisms and mitigating actions in MI communication are identical worldwide, whereas the outcome depends on a multitude of factors, such as the socio-economic arena, pre-incident MI preparedness and training, and society infrastructure.

Technology failure due to system overload, damage, or destruction may compromise MI communication.[16] Similarly, incompatibility between systems used by emergency authorities can challenge MI communication.

This study aimed to systematically identify and extract the existing literature on communication in the medical management of sudden-onset MI. Furthermore, the study aimed to provide an overview of both scientific and non-indexed literature on the topic with no limitation concerning the type of study design. To our best knowledge, this is the first review of communication in MI. There is a potential to identify similarities between countries and to call for common techniques for improved results.

The review question asked in this scoping review was: What are the patterns and challenges in communication in sudden-onset major incidents?

Methods

Protocol and Registration

The authors conducted a scoping review with a narrative synthesis and reported this according to the JBI[17] (formerly known as *Joanna Briggs Institute*) protocol and Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews (PRISMA ScR)[18] guidelines for reporting of systematic and scoping reviews. The protocol was published on Open Science Framework (OSF) on November 12, 2021, with registration no. 10.17605/OSF.IO/MBT7V (https://doi.org/10.17605/OSF.IO/MBT7V).

Search Strategy

The search strategy for scientific databases was developed by 1 author who is the subject specialist. The search strategy was peer-reviewed by a research librarian. The search included literature published from 1946 until January 10, 2022. Medical Subject Headings (MeSH) controlled vocabulary was used, including subheadings, various publication types, and the supplementary concept. For the scientific database search, 1 set of entry terms described communication, the second set described MI, and, finally, free search phrases were included. The 3 sets of entry terms were applied and combined (Figure 1). The following databases were searched:

- Cochrane Library
- Embase
- Medline
- Scopus
- SveMed+
- Web of Science

The search strategy was developed in Embase and Medline, validated using known references and translated to the additional databases.

One author developed the non-indexed literature search strategy with the assistance of a research librarian. The search included non-indexed literature issued from 1946 until March 15, 2022. The systematic search was performed on March 16–22, 2022. The following databases were searched:

- Web of Science
- Embase
- Scopus
- Google Scholar
- http://www.ndltd.org
- https://www.dart-europe.org/basic-search.php
- http://www.opengrey.eu/
- https://www-base-search-net.ezproxy.uis.no/;
- https://oatd.org/

Eligibility Criteria

The current review included literature found by an extensive search that described communication in the medical management of an MI. Furthermore, captured literature stating that the incident described was considered an MI was included in the scoping review.

Inclusion criteria

- Literature reporting major incident communication
- Literature published after 1946 and until the date of the literature search

Exclusion criteria

- Non-English literature, except for Scandinavian
- Literature without an available abstract in English or Scandinavian
- Literature reporting only technological aspects

The use of a specific definition was obviated to avoid the exclusion of possible relevant studies. The study population was an MI, concept was communication, and context was medical management of the MI.

Selection of Sources of Evidence

Results were collected and combined in the Endnote20® software[19] (Alfasoft AB, Gothenburg, Sweden), and duplicate studies were eliminated using the Covidence® (Veritas Health Innovation, Melbourne, Australia) software.[20] For the identification of potentially eligible studies and papers, 1 author screened titles and abstracts carefully. For eligible studies, full-text retrieval and review were performed.

Data Charting Process and Data Items

As per protocol, the chosen studies were read for data sampling and quality appraisal. A data extraction template was modified from related studies[21,22] and validated by 2 authors using known references.[23,24] The template included 30 items of interest, divided into 4 subheadings that included MI demography, communication, incident characteristics, and incident response.

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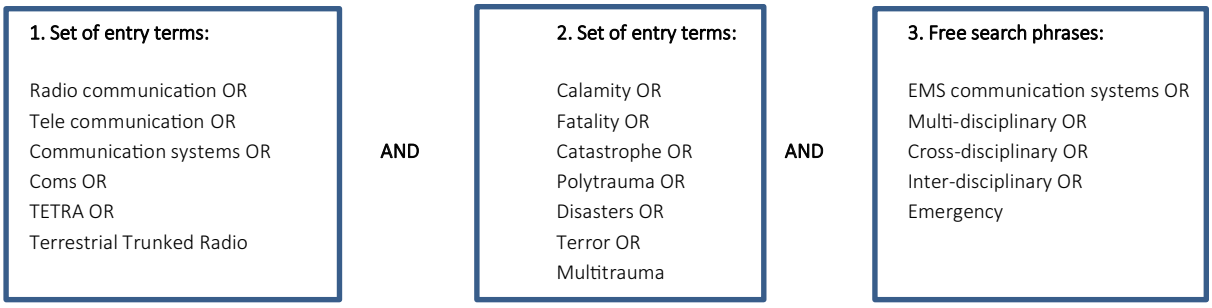


Figure 1. Search strategy. Two sets of entry terms and free search phrases.

Deviations from Protocol in Literature Search

In Scopus, the entry term "tele-communication" was excluded due to many irrelevant results. The amendment was promptly registered in the Open Science Framework for protocol adherence.

Analysis of Identified Literature

A data analysis was conducted according to the registered protocol using Population, Concept, Context (PCC) as per JBI protocol[17] and PRISMA ScR[18] guidelines for non-indexed and indexed literature search. From each of the included articles and papers, 30 data items were extracted in accordance with the pre-registered protocol.

Data Synthesis

Due to the lack of outcome variables per se, 1 author performed a textual narrative analysis of the findings from each of the included studies and structured a synthesis based on the characteristics of the studies on the types of MI and communication challenges they described.

Ethical and Legal Considerations

According to Danish and Norwegian law, ethical approval is not required for scoping reviews.

Results

Identification of Studies from the Main Database Search

In total, 10 494 articles, papers, and studies were imported from 6 databases. The removal of duplicates (2629) produced 7865 studies, whose titles and abstracts were screened. This process rendered 45 full-text articles and papers that were assessed for eligibility. Thirty-one articles were excluded, and 14 that met the inclusion criteria were included in the scoping review. The selection process and the reasons for exclusion are listed in the PRISMA ScR flow diagram (Figure 2). A detailed description of the search strategies can be found in additional material, Appendices 1-6. The PRISMA ScR checklist is provided in Appendix 8.

Identification of Studies from the Non-Indexed Literature Search

The non-indexed literature search identified 256 published articles, of which 238 were excluded after screening based on title and, when available, abstract. Eighteen articles and papers were included after a full-text review. The PRISMA ScR flow diagram (see Figure 2) shows the selection process. The scoping review comprised 32 papers.[2,4,25–54]

Main Results

The main finding of the scoping review was communication breakdown, which was seen in 25 papers. In 18 papers, inter-authority communication was challenged. Communication system overload and incompatibility were both found in 9 papers. Insufficient pre-incident planning and non-intuitive guidelines were important findings as well. Main results are summarized in Table 1.

Basic information on the affected area was available in 28 papers; access to the incident site and the affected population was accounted for in 27 papers. The type of communication device was described in 25 papers, whereas the specific type of breakdown was described in 23 papers. A timeline for the incident was provided in 29 papers, and details on deceased victims, injured victims, and the total number of victims were reported in 26 papers. Basic EMS information was described in 24 papers. Findings from the data extraction are presented in Table 2. Narrative details of the included sources are summarized in Tables 3 and 4 and expanded in supplementary material, Appendix 7.

Limitations

The items for data extraction and quality appraisal were selected according to their assumed relevance and their ability to inform the review question. These items may not be complete or represent a reference standard, since no such standard exists. Similarly, it may represent a potential weakness that only articles in English and Scandinavian languages were included since MIs occur worldwide and predominantly in low- to middle-income countries because of natural disasters.[55,56] This represents a language limitation. Scientific articles without abstracts were not included, which may have failed to identify relevant studies; the single-reviewer format of this scoping review may have also contributed to that.

The single-reviewer format is definitely a limitation and introduces selection and publication bias, since only 1 author performed the initial review of literature for inclusion. One author performed data extraction using templates developed as per protocol ahead of the search and validated using known references. A second author checked the results, but this allows for subjective interpretations of the findings. This represents an important deviation from the PRISMA-ScR guideline, that may limit the screening process, as any disagreement or inconsistency in the review process cannot be resolved. However, this was seen in previous disaster medicine literature.[57]

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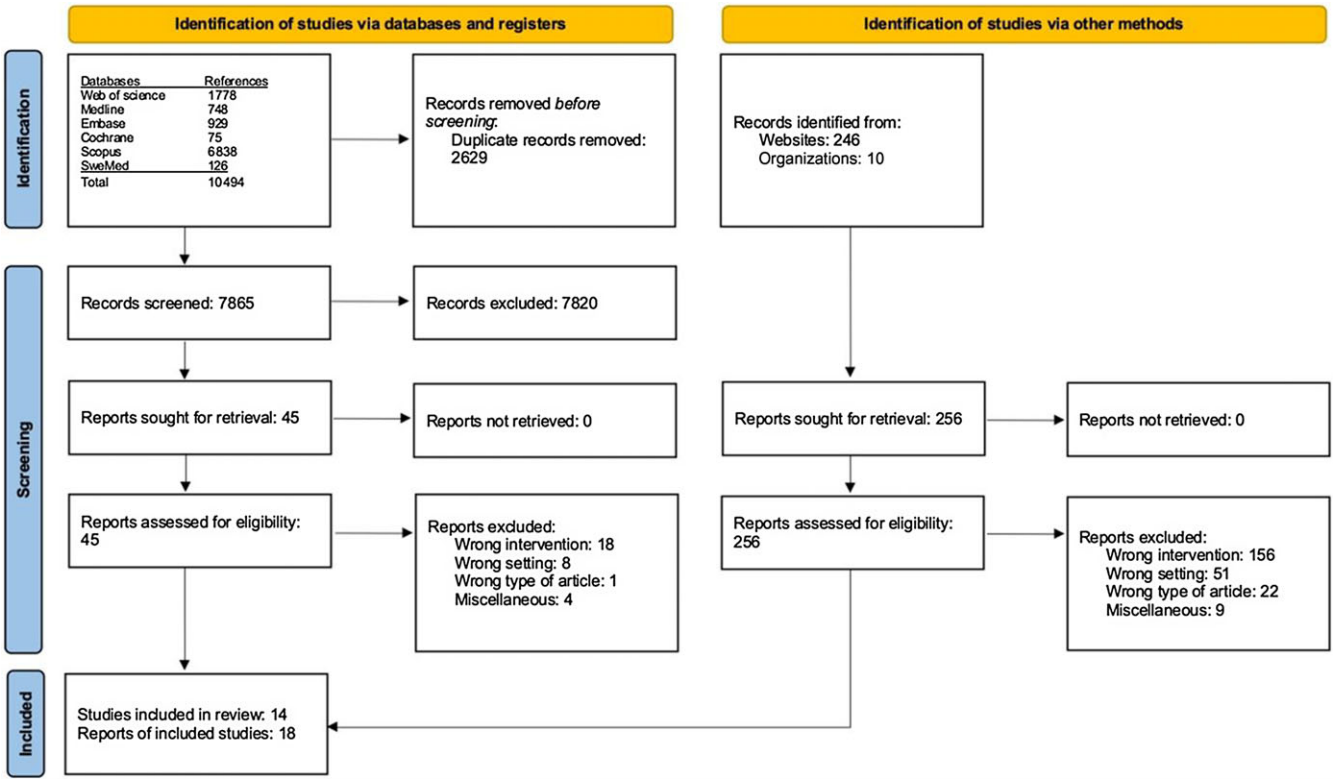


Figure 2. PRISMA ScR flow diagram depicting the different scoping review stages.

Table 1. Main findings from the scoping review

Communication problem	n
Communication breakdown	25
Inter-authority communication challenges	18
Communication system overload	9
Communication systems incompatibility	9
Insufficient pre-incident major incident planning	7
Non-intuitive major incident guidelines	5
Intra-authority communication challenges	4
Cross-border communication challenges	2
Lacking initial training in communication device operation	2
Civilian vs military jurisdiction difficulties	1

Similarly, the unintended inclusion of multiple reports on the same spectacular incidents is indicative of potential skewness, selection, and publication bias. However, the use of a priori protocol registered ahead of any searches contributed to an unbiased search for all literature relevant to answer the review question and 1 single protocol deviation constitutes the strengths of the study.

Discussion

Summary of Findings

The pattern of communication in major incidents is frequent breakdowns for mainly unspecified reasons. The challenges are predominantly inter-authority communication, system overload and incompatibility, and insufficient introduction and training in the use of communication devices. The majority of papers were case reports (78.1%), ranking low in the hierarchy of research. However, the ability to answer the review question was generally good and provides a foundation to identify knowledge and research gaps for future research efforts. The lack of high-quality observational studies hinders conclusions that can be used by policy-makers to develop guidelines for MI management.

Major Incident Characteristics from Included Literature

In general, the included papers described MI and disasters with a high degree of detail. Most papers addressed relevant incident data, access to the incident site, and the characteristics of injured patients and deceased patients. The heterogeneous nature of MI and disasters is mirrored in the descriptions that range from compensated MI with ample resources to sheer chaos, endangering the survival and outcome of the victims. Therefore, the included literature ranges from relatively simple MI related to road traffic incidents to uncompensated natural disasters and complex terrorist attacks killing thousands of people. The included incidents are reported from all over the world, excluding Africa, which is incidental.

The EM-DAT database[55,56] provides full insight into the demographic and geographical distribution of MIs and disasters. The database provides information that natural disasters kill approximately 45 000 people each year.[55] This number has decreased significantly in the last decade[56] as the result of better standards of living, infrastructure, and enhanced response systems in World Bank defined[58] low-income countries.

Communication Breakdown

The scoping review found that communication failure was predominant in the included literature, with breakdown reported

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Table 2. Data extraction instrument

	DEMOGRAPHY				COMMUNICATION				INCIDENT CHARACTERISTICS							
	Basic info affected area	Basic info on affected population	Accessibility in the region	Other relevant pre-incident data	Communication type	Type of coms device	Communication mode – in everyday ops and in MI	Other relevant coms characteristics	Time, date, and place	Description of incident and damage it caused	Number of dead	Number of injured	Total number of victims involved	Scene access	Distance to hospitals	Other incident characteristics
Ackermann et al.	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	N	Y
Björnstig et al.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Brismar et al.	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Brändström et al., 2006	Y	Y	Y	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
Brändström et al., 2007	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Buerk et al.	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	N	Y
Butts et al.	Y	N	N	N	Y	Y	N	N	Y	N	N	N	N	N	N	N
Englund et al.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Gomez et al.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hansen et al.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hardy, 2013	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hardy et al., 2015	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hedelin et al.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Helktne	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hu et al.	Y	Y	Y	Y	Y	N	Y	N	N	N	N	N	N	N	N	N
Huang et al.	N	N	N	N	Y	Y	Y	N	N	N	N	N	N	N	N	Y
Hägnevik et al.	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
Iselius	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Iversen	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Jama	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Kapucu et al.	N	N	N	N	Y	N	N	N	Y	Y	Y	Y	Y	N	N	N
Kulling et al., 1993	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Kulling et al., 1997	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Lavery et al.	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Palttala et al.	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Picazo et al.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Rehn	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Rimstad et al.	Y	Y	Y	Y	N	N	N	N	Y	Y	N	N	N	N	N	Y
Román-Morales	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sollid, 2011	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sollid et al., 2012	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Yamamura et al.	N	N	N	N	Y	Y	N	Y	Y	N	N	N	N	N	N	N

	Information on how the MI was declared	The timeline for the medical response	Who participated	What tasks were performed	Patient logistics	Number of coms devices	Type of coms breakdown	Attempts to rectify coms breakdown	Fall-back/alternative coms system	Fall-back/alternative non-technical coms system	Background coms education	Scene safety	Coms breakdown consequences	Other incident response data
Ackermann et al.	Y	Y	N	Y	Y	N	N	N	N	N	N	Y	N	Y
Björnstig et al.	N	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y	N	Y
Brismar et al.	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y
Brändström et al., 2006	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	Y	Y

(*Continued*)

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Table 2. (*Continued*)

	Information on how the MI was declared	The timeline for the medical response	Who participated	What tasks were performed	Patient logistics	Number of coms devices	Type of coms breakdown	Attempts to rectify coms breakdown	Fall-back/alternative coms system	Fall-back/alternative non-technical coms system	Background coms education	Scene safety	Coms breakdown consequences	Other incident response data
Brändström et al., 2007	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y
Buerk et al.	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	Y
Butts et al.	N	N	N	N	N	N	Y	Y	Y	N	N	N	Y	N
Englund et al.	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y
Gomez et al.	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y
Hansen et al.	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Hardy, 2013	Y	Y	Y	Y	Y	N	Y	Y	N	N	N	Y	Y	Y
Hardy et al., 2015	Y	Y	Y	Y	Y	N	Y	Y	N	N	N	Y	Y	Y
Hedelin et al.	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N	Y	Y	Y
Heltne	Y	Y	Y	Y	Y	N	Y	N	N	N	N	Y	Y	Y
Hu et al.	N	N	N	N	N	N	Y	Y	N	N	N	N	Y	N
Huang et al.	N	N	N	N	N	N	Y	Y	Y	N	N	N	Y	Y
Hägnevik et al.	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y
Iselius	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N	Y	Y	Y
Iversen	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y
Jama	Y	Y	Y	Y	Y	N	Y	Y	N	N	N	Y	Y	Y
Kapuca et al.	N	N	N	N	N	N	Y	Y	Y	N	N	N	Y	N
Kulling et al., 1993	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	Y	Y
Kulling et al., 1997	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	Y	Y
Lavery et al.	N	Y	N	N	Y	N	Y	Y	N	N	N	N	Y	Y
Palttale et al.	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Picazo et al.	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	Y	Y
Rehn	Y	Y	Y	Y	Y	N	Y	N	N	N	N	Y	Y	Y
Rimstad et al.	N	N	Y	Y	N	N	N	N	N	N	N	Y	N	Y
Román-Morales	Y	Y	Y	Y	Y	N	Y	Y	N	N	N	Y	Y	Y
Sollid, 2011	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N	Y	N	Y
Sollid et al., 2012	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N	Y	Y	Y
Yamamura et al.	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Coms, communication; MI, major incident; Y, yes; N, no; ?, unclear.

Table 3. Study designs and description of communication from included literature

Paper	Method	Description of communication
1. Ackermann et al., 2011	Case report	Injury focus; preparedness plans; hospital capacity
2. Björnstig et al., 2011	Case report	Command & control; cooperation; coms breakdown
3. Brismar et al., 1990	Case report	Command & control, MI declaration, coms breakdown
4. Brändström et al., 2006	Case report	Command & control; coms breakdown; Medevac
5. Brändström et al., 2007	Case report	Command & control; coms breakdown, triage
6. Buerk et al., 1982	Case report	Scene description; information flow; triage; HEMS
7. Butts et al., 2007	Mixed methods	Coms breakdown; alternative pathways
8. Englund et al., 2012	Case report	Command & control; inter-authority communication, Intra-authority communication
9. Gomez et al., 2007 (Same MI as Brändström et al., 2007)	Case report	Command & control; coms breakdown
10. Hansen et al., 2021	Case report	Coms grid adherence; affiliation times; pre-incident coms education; coms breakdown consequences
11. Hardy, 2013	Case report	Intra-authority communication issues, inter-authority communication issues
12. Hardy et al., 2015	Case report	Intra-authority communication issues
(Same MI as Hardy., 2013)		
13. Hedelin et al., 2006	Case report	Command & control; pre-incident preparedness
14. Heltne, 2013	Case report	Coms breakdown; coms coverage; coms limits
15. Hu et al., 2014	Literature review	Inter-authority and cross-sector coordination
16. Huang et al., 2012	Mixed methods	Disaster response focus; coms breakdown
17. Hägnevik et al., 1996	Case report	Command & control; inter-authority communication
18. Iselius, 2004	Case report	Command & control; coms breakdown consequences
19. Iversen, 2019	Case report	Command & control; pre-incident coms setup
20. Jama, 2007	Case report	Inter-authority coms; command & control
21. Kapucu et al., 2006 (Same MI as Butts et al.)	Consensus paper	Inter-authority communication; coms breakdown
22. Kulling et al., 1993	Case report	Command & control; cross-nation coordination
23. Kulling et al., 1997	Case report	Cross-nation coordination; alternative coms
24. Lavery et al., 2005	Case report	Intra-authority communication; pre-incident issues; coms breakdown
25. Palttala et al., 2012	Questionnaire	Coms challenges; coms training and experience
26. Picazo et al., 2010	Case report	Command & control; pre-incident preparedness
27. Rehn, 2000	Case report	Command & control; coms breakdown; triage
28. Rimstad et al., 2015 (Same MI as Englund et al.)	Mixed methods	Situation assessment; information sharing; knowledge and experience; decision-making focus
29. Román-Morales, 2015	Case report	Command & control; inter-authority issues; coms breakdown; funding of coms
30. Sollid, 2011	Case report	Command & control; inter-authority communication; intra-authority communication; coms breakdown (Same MI as Englund et al.)
31. Sollid et al., 2012 (Same MI as Englund et al.)	Case report	Command & control; inter-authority communication; intra-authority communication, coms breakdown
32. Yamamura et al., 2014	Questionnaire	Intra-authority communication, coms focus

Coms, communication; MI, major incident; HEMS, helicopter emergency medical services; Medevac, medical evacuation.

in 25 of 29 papers disclosing operational data. Failure may rank from intermittent to permanent, and the consequences depend on the mitigating efforts to rectify or compensate for the breakdown. The definitions by majorincidentreporting.net[21] and Major Incident Medical Management and Support Courses (MIMMS)[59] focus on the availability of extraordinary resources. Therefore, the geo-political and socio-economic setting is paramount, that is, an EMS response to a road traffic incident in Finland may be standard due to ample resources, whereas the similar injury mechanism may represent an MI in Sudan. Accordingly, consequences of communication breakdown will depend on the setting of the MI.

When communication is compromised, command and control may be lost. Measures to mitigate episodes of lost command and control are simple in everyday operations; however, in an MI, the complexity of the situation and the breakdown of essential systems may hamper such attempts. From the definition,[60,61] it follows that the "organizational and technical attributes and processes that employs human, physical, and information resources to solve problems and accomplish missions" are complex entities that involve a solid framework, substantial basic and ongoing training, and the support from leadership and management.

The consequences of a breakdown in command and control may be immense, with unnecessary fatalities[45,46] and prolonged interventions[54] before a society's return to a normal state. Therefore, mitigating actions to re-establish command and control should be part of any MI preparedness framework,[62–64] describing alternative communication pathways and redundancy.

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Table 4. Major incident characteristics from included literature

Paper	Location	Dead/injured	Type of MI/disaster
1. Ackermann et al., 2011	GER	21/500+	Mass gathering at music festival
2. Björnstig et al., 2011	SWE	30/355	Buss crashes
3. Brismar et al., 1990	GER	70/346	Air show plane crash
4. Brändström et al., 2006	RI	202/300+	Terrorist bomb attacks at bars/discos
5. Brändström et al., 2007	ESP	193/2050	Terrorist train bomb attacks
6. Buerk et al., 1982	USA	85/613	Hotel fire
7. Butts et al., 2007	USA	2995/2680	2001 9/11 World Trade Center terrorist attack
8. Englund et al., 2012	NOR	76/159	Oslo/Utøya terrorist attacks
9. Gomez et al., 2007 (Same MI as Brändström et al., 2007)	ESP	193/2050	Terrorist train bomb attacks
10. Hansen et al., 2021	DEN	8/15	Train collision on bridge
11. Hardy, 2013	UK	0/69	Road traffic accident on bridge
12. Hardy et al., 2015 (Same MI as Hardy, 2013)	UK	0/69	Road traffic accident on bridge
13. Hedelin et al., 2006	UK	31/417	Train accident
14. Heltne, 2013	NOR	0/66	Truck and tunnel fire
15. Hu et al., 2014	USA	N/A	N/A
16. Huang et al., 2012	CN	N/A	N/A
17. Hägnevik et al., 1996	USA	6/1000+	1993 World Trade Center terrorist attack
18. Iselius, 2004	GER	101/88	Train accident
19. Iversen, 2019	NOR	0/22	Bus rollover
20. Jama, 2007	FIN	8/14	School shooting
21. Kapucu et al., 2006 (Same MI as Butts et al.)	USA	2995/2680	2001 9/11 World Trade Center terrorist attack
22. Kulling et al., 1993	SWE/DEN	159/30	Scandinavian Star ferry fire
23. Kulling et al., 1997	FIN/SWE/EST	852/137	Estonia ferry shipwreck
24. Lavery et al., 2005	NIR	29/336	Terrorist bomb attack
25. Palttala et al., 2012	N/A	N/A	N/A
26. Picazo et al., 2010	CHI	81/20	Prison fire
27. Rehn, 2000	NOR	19/67	Train collision
28. Rimstad et al., 2015 (Same MI as Englund et al.)	NOR	N/A	Oslo/Utøya terrorist attacks
29. Román-Morales, 2015	MEX	0/71	Gas explosion at neonate hospital
30. Sollid, 2011 (Same MI as Englund et al.)	NOR	68/61	Utøya terrorist attacks
31. Sollid et al., 2012	NOR	76/159	Oslo/Utøya terrorist attacks
32. Yamamura et al., 2014	JPN	19747/6242	Earthquake East Japan

MI, major incident; N/A, not applicable; 9/11, September 11; GER, Germany, SWE, Sweden; RI, Indonesia; ESP, Spain; USA, United States of America; NOR, Norway; DEN, Denmark; UK, United Kingdom; CN, China; FIN, Finland; EST, Estonia; NIR, Northern Ireland; CHI, Chile; MEX, Mexico; JPN, Japan.

Inter-Authority Communication Challenges

Communication is one of the key foundations of inter-authority cooperation.[65] However, several obstacles may compromise communication between authorities, including different terminology and perception of nomenclature; the widespread use of abbreviations; different nomenclature between authorities; and, finally, different priorities in respective sectors.

Especially the use of abbreviations may be a challenge in inter-authority communication and lead to mistakes, described by Holper.[66] In the study, the authors found that more than 30% of all abbreviations used in a general medical unit were ambiguous. Coghlan et al.[67] found the same pattern in the use of abbreviations in hospital discharge summaries, leading to potentially compromised patient care.

MI managers from different sectors have the same objective, but different approaches and priorities may hinder common tactical progression in the management. However, in complex arenas such as MIs, organizations tend to develop both formal and informal relationships for joint efforts, described by Kapucu.[68] Grounded in network and complexity theories, a concept of interdependency between authorities in extreme situations is described. Interdependency may positively influence organizations in their adaptation to complicated or dynamic arenas such as MIs, enabling a better outcome.

Communication Systems Overload and Incompatibility

System overload and/or incompatibility are represented in 18 of the included papers, echoing the fact that communication systems are vulnerable, complex, and subjected to financial priorities, for example. Communication systems that operate close to maximum capacity[69] under normal day-to-day conditions will invariably overload and may consequently suffer breakdown during surge situations such as an MI. Similarly, the compatibility of communication systems between different authorities and sectors[70,71] may present a barrier to MI communication, for example, between military and civilian authorities related to secrecy and encryption.

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Insufficient Pre-Incident Major Incident Plans and Guidelines

In 12 papers, insufficient pre-incident MI plans and non-intuitive MI guidelines are reported. EMS personnel may be challenged by MI guidelines[62–64] that are significantly different from daily operations, although they clearly describe MI communication. Guidelines should serve to establish, maintain, and execute command and control.[60,61]

Consequences of Lacking Initial Training in the Use of Communication Devices

Holm[72] has described the effects of lacking initial training in the use of communication devices among Danish prehospital physicians, reported in 2 papers. This study found that 38% had not received any initial training at all, whereas 29% rated their skills as advanced or expert level. Thirty-one percent of the responders did not feel capable of being able to handle communication sufficiently in an MI.

Simulation training in the use of radio communication has not been utilized extensively,[73] whereas simulations in prehospital trauma care[74] and ultrasound,[75,76] for example, are widely implemented with significantly improved performance after completing training. In the study by Holm,[72] implementation of a simulation is recommended for improvement of communication skills.

Major Incident Case Reports

Most of the included literature in the scoping review are case reports, which are limited by their retrospective, non-blinded, and nonrandomized trial design. As such, this constitutes a source of bias that may affect the study outcome.[77] Any findings provided by case reports might not be generalizable and therefore may not be useful in establishing a cause-effect relationship, with a consequentially high risk of over-interpretation.

A study by Krusenvik[78] found that case reports may provide in-depth relevant data since they originate from reality and may promote an understanding of complex, real-life situations. Findings are context-sensitive and may enhance new theories and add strength to previous research findings. The disadvantages are their limited generalizability and rigor.

Crowe et al.[79] found that case studies are suitable for the detailed, real-life context description of critical events and interventions, for example. Therefore, case studies should be considered when no available experimental design is appropriate to answer the research question or it is impossible regarding setting, legislation, ethics, and so on.

Future Research Perspectives

An agreement on a uniformly accepted nomenclature and a common definition of MI and disasters is essential. The use of common entities in the description of an MI will enhance the evaluation and dissemination of lessons learned in MI management locally and internationally.

This scoping review found that the predominant research design consisted of case reports, suggesting that until hypotheses have been generated for future research, systematic reporting should be endorsed or mandated by EMS management. Reporting resources such as the website, majorincidentreporting.net,[21] and similar portals should enjoy the support and endorsement from management and authorities, perhaps using public outreach in forums such as EUPHOREA.[80]

The future might call for an international multicenter, prospective observational study on MI communication with a focus on command and control and intra- and inter-disciplinary communication. Similarly, feasibility or simulation studies of new communication methods and implementation of guidelines could provide knowledge on future MI communication progression. This scoping review has demonstrated research and knowledge gaps that would benefit from a deeper understanding of experience, for example, from studies performed during large-scale exercises or tabletop scenarios.

Systematic scientific research in the field is called for, since most of the included papers describe communication breakdowns, with both potential and actual consequences for patient survival and outcome and for society's expedited return to a normal state.

Implications of the Findings

The included material discloses that communication challenges and breakdowns are predominant in MIs and represent potential and actual threats to (1) command and control, and (2) patient survival and outcome. There is a need for high fidelity and reliable communication devices and easy-to-follow guidelines for communication with a clearly defined grid. Pre-incident training in the use of communication devices should be highly prioritized at the same level as medical skills, and efforts to enhance resilience are paramount. The implications may be applied worldwide, as MI mechanisms and mitigating actions are uniform, however, context-sensitive, which should be taken into account in MI preparedness planning.

Conclusions

Frequent breakdowns in communication are a pattern in MIs, mainly for unspecified reasons. The challenges in communication are predominantly inter-authority communication, insufficient pre-incident planning and guidelines, lost command and control, and system overload and incompatibility.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/dmp.2023.132

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Ethical standard. According to Danish and Norwegian law, ethics approvals are not required for scoping reviews.

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