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# Perceived competency requirements for emergency medical services field supervisors in managing chemical and explosive incidents – qualitative interview study

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## Abstract

**Background** Chemical, biological, radiological, nuclear, and explosive (CBRNE) incidents present rare and complex challenges for Emergency Medical Services (EMS), necessitating effective incident command to manage occupational and patient safety risks. EMS incident commanders must make quick decisions under pressure, coordinating medical responses and ensuring personnel's safety. This study examined the perceived competence requirements of Finnish EMS field supervisors in managing C and E incidents.

**Methods** This study was a qualitative interview study among EMS field supervisors ($n=12$) in Southwest Finland. Individual interviews utilized fictional C and E case descriptions. The data was analyzed using inductive-deductive content analysis, with the Major Incident Medical Management and Support model as the theoretical framework.

**Results** The results were grouped under one inductive main category, "Being Prepared," and six deductive main categories: "Command and Control," "Safety," "Communication," "Assessment," "Triage and Treatment," and "Transport." Under the main categories, there were a total of 16 upper categories and 15 subcategories. Broadly similar content emerged from the C and E cases, although some categories had specific areas of emphasis.

**Conclusions** The perceived competence requirements of EMS field supervisors in managing C and E incidents align well with the Major Incident Medical Management and Support model. Also, EMS field supervisors should be mentally prepared and well-trained for handling C and E incidents. The results support the development of specific C and E training and guidelines beyond the "all hazards" approach. Further research should focus on assessing the current level and gaps in competence and optimizing training methods for different CBRNE situations.

**Keywords** EMS, Field supervisor, Management, Competence, Chemical, Explosive

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## Background

A CBRNE (chemical, biological, radiological, nuclear, explosive) incident, especially large-scale, is a rare and exceptionally challenging scenario from the perspective of emergency medical services (EMS) [1]. The incidents involve several occupational and patient safety risks, as well as uncertainties that the EMS incident commander must be able to consider [2–4]. Effective incident command is crucial in the successful management of these challenging situations [5–7]. There are several operational models—such as Major Incident Medical Management and Support (MIMMS) [8, 9], also known as Command and Control, Safety, Communication, Assessment, Triage, Treatment, and Transport (CSCATTT) (see Hansen et al. 2023) [10], Incident Command System (ICS) [11, 12] and Mass Casualty and Disaster Management (MCDM) [5]—which are used for managing a variety of major incidents as an "all hazards" approach.

However, in addition to their rarity, CBRNE situations have many exceptional elements that distinguish them from other major incidents. According to previous evidence, medical coordination of the incident plays an important role in the successful management of a large-scale CBRNE incident [5–7], as the EMS incident commander makes several decisions affecting patient access to care and also ensures the occupational safety of EMS providers [2–4]. The priority is to ensure that EMS personnel do not rush into hazardous areas [3] and to ensure the use of appropriate protective equipment [3, 4]. It is also essential to be capable of determining situation-specific factors affecting occupational safety quickly, such as acceptable risk or "safe enough," if EMS personnel's safety cannot be guaranteed [5].

During these kinds of incidents, the incident commander faces significant stress factors, especially in large-scale situations, when one is required to make quick and precise decisions, often with insufficient initial information [2]. For example, C incidents with severe consequences continue to occur globally. Over the past few decades, a series of major incidents have resulted in fatalities, injuries, significant environmental contamination, and extensive economic damage [13]. In these incidents, the EMS incident commander must consider the potential necessity for decontamination of those exposed. This is a crucial factor to grasp because a contaminated patient exposes emergency responders, patients, and personnel at the receiving health care facility. However, cleansing procedures may delay the initiation of treatment for severely injured or symptomatic patients [2, 3]. Moreover, explosions within civilian populations are not as prevalent as other types of incidents, but they are not uncommon either. For example, since 1991, the United States has reported over 1200 intentional bombings annually, indicating a noteworthy occurrence rate [14]. In these incidents, it is necessary to assess the risk of the diversity of injury profiles, as explosions can cause injuries through multiple mechanisms. Additionally, it is fundamental to consider the potential deliberate nature of the explosion and the associated risks, such as secondary devices or actions directed at the responders [4, 14, 15].

In the Finnish EMS system, the EMS field supervisor acts as the incident commander, especially in cases involving multiple authorities or casualties [16, 17]. The competence to manage these incidents presumably varies greatly from person to person, and there is no uniform view of the expected or required competence [11]. In this study, competence is defined as the ability to integrate and apply knowledge and skills to perform tasks most effectively [18, 19], while also having the appropriate attitudes and values to do so [19]. These major incidents require specialized knowledge and skills to ensure the safety of both responders and casualties, and there is a need to specify the required content in greater detail. This study focuses on C and E incidents due to their global prevalence and relevance [13, 14], which differ from more common mass casualty incidents (MCI) based on mechanical trauma. In C and E incidents, while the occurrence is rare, there is a significantly higher demand for occupational safety than usual, as the injuries sustained by casualties require immediate response. Our research question was: What are the perceived competence requirements of Finnish EMS field supervisors in managing C and E incidents?

## Methods

This study was a qualitative interview study. All the EMS field supervisors in the Wellbeing Services County of Southwest Finland were the target group of this study. The interviews were conducted in the spring of 2024. The COREQ (Consolidated Criteria for Reporting Qualitative Research) Checklist [20] was utilized when reporting the results.

### Setting

Finland is a Nordic country, geographically one of the largest countries in Europe, but at the same time, one of the least densely populated in the world. The surface area is 308,316 square kilometers, when including maritime areas, 338,450 square kilometers and the population is approximately 5.6 million, of which 86% live in urban areas [21]. Finland is divided into 23 wellbeing services counties, which largely follows regional boundaries, each responsible for organizing rescue, social, and healthcare services, which includes EMS [22]. The Finnish EMS system is tiered, consisting of first-response units, basic-level units, advanced-level units, EMS field supervisors, and EMS physicians [16, 17]. The annual number of EMS missions in Finland is approximately 800,000, which

constitutes over half of all missions dispatched by emergency response centers to all authorities [17].

Southwest Finland is the third largest county in Finland, with 493,470 inhabitants, and its population density exceeds the national average more than twofold. The total land area of the county is 10,912 square kilometers, which increases to 20,537 square kilometers when maritime areas are included. The western part of the region consists of a section of the largest archipelago in the world in terms of the number of islands, with approximately 40,000 islands, about half of which are located within the territorial waters of Southwest Finland [23]. There are 17 high-risk sites in the region, including upper-tier chemical production facilities as defined by the EU Seveso III Directive [24] and three large import harbors. Chemical products are transported in the region by road, rail, and sea. The region also has stores of explosive materials. There have been no massive CBRNE incidents in the region, only occasional minor chemical leaks that have not escalated to MCIs. There are approximately 62,000 EMS missions conducted in the county of Southwest Finland each year.

Each well-being service county is required to have an on-duty EMS field supervisor to oversee operational activities and maintain preparedness within their jurisdictions. Primarily, EMS field supervisor units refrain from engaging in patient transportation but provide support to ambulances during their missions. EMS field supervisors lead regional EMS operationally, operate as first-response units when necessary, and serve as EMS incident commanders during multi-agency or major incidents. Training for MCIs varies significantly between regions, and there is no mandatory national requirement for such training. Typically, EMS field supervisors have completed a one-year specialization course in EMS leadership, which emphasizes MCI management.

EMS field supervisors are required to possess the competence of advanced-level paramedics, as well as adequate administrative and operational expertise in EMS along with the necessary experience required for the role [16, 17]. The Wellbeing Services County of Southwest Finland has a tiered system for EMS field supervision. The EMS field supervisor in the situation room oversees and organizes EMS operations across the entire county, while the vehicle-based EMS field supervisor participates in missions as incident commander under the direction of the situation room. All the EMS field supervisors work in both roles, so their placement varies. Both the situation room and the vehicle-based EMS field supervisor unit are located in Turku, the central city of the region, from which the distance to the outer edges of the wellbeing services county is up to approximately 90 km as the crow flies.

The Finnish incident command model shares the same basic ideology as well-known international systems (MIMMS(/CSCATTT) and ICS), making it an "all-hazards" approach system. The main differences lie in the terminology, hierarchy, and interactions between the various actors. The most broadly presented organization model is more simplified than international systems, although the same functional elements are included. In the Finnish system, each authority independently manages its own activities, while the overall incident commander, designated according to the type of incident, holds responsibility for coordinating inter-authority cooperation and ensuring alignment towards a unified objective [25].

### Designing the interviews

Two fictional case descriptions (Appendix A) and an interview framework (Appendix B) were created. The case descriptions were written by the first author (JK) and finalized by the whole research team. Neither case was based on previous incidents, but inspiration for the environments and risks was drawn from the target region and previous research evidence [6, 26]. The research group prepared themes and clarifying questions to ensure the subject was comprehensively discussed. The themes were not based on a specific operational model. Instead, they were based on a wide range of previous studies regarding the medical management of CBRNE incidents: occupational safety [2–4], action plan [2, 5, 26–28], triage [3–7, 26–28], communication [3, 4, 7, 26, 27], collaboration with authorities [5, 6], and MCI [2–7, 26–28]. Two background questions were included regarding experience as an EMS field supervisor and training in response to C and/or E incidents.

In order to test the case descriptions and create interview themes, the interviewer (JK) conducted a pilot interview via Microsoft Teams with an experienced paramedic familiar with conducting interviews. The pilot interview did not lead to changes in the case descriptions or interview themes.

### Data gathering

Data gathering was conducted from March to May 2024. The participants were recruited by the first author (JK) through email, which provided comprehensive information about the study and data protection. The actual interviews were conducted individually and face-to-face. At the beginning of each interview, the interviewee was asked to sign a consent form, which every interviewee signed. It was also emphasized to the interviewees that it was not an assessment of their competence. Then the interviewee was allowed to familiarize themselves with the case descriptions (Appendix A) one by one and in their own pace, followed by an interview regarding the

respective case description. The order was always E-case first and C-case second.

The interview themes (Appendix B) were not disclosed to the interviewees beforehand. The interviews started by asking, "What are the EMS field supervisor's competency requirements in managing the pertinent incident?" No predetermined questions were derived from the interview themes; instead, when a theme arose from the interviewee's narrative, the interviewer asked for clarification. The intention was also to utilize the themes if the interviewee had trouble freely narrating, but this was not necessary in any of the interviews. The order of the themes varied depending on the interviewees, and additional questions were also derived from their responses. At the end of the interviews, they were asked for a subjective assessment of which case would be more challenging.

Twelve EMS field supervisors participated. The total duration of the recorded interviews was approximately 811 min. The shortest interview lasted 49 min, while the longest interview lasted 92 min. On average, an interview lasted 68 min. The first author transcribed the recorded data, which comprised 124 pages (12-point font, Arial, single-spaced), 66,076 words, and 458,680 characters, including spaces.

### Data analysis

The interview material from both cases was first combined and analyzed using inductive content analysis [29, 30]. Initially, the first author (JK) identified meaning units from the material that corresponded to the research question. These meaning units were then condensed by transforming them into formal language and removing filler words, ensuring the content remained unchanged. The condensed meaning units are called codes [30]. In our analysis, each of them ($n=1195$) included the interviewee's number (1–12) and was color-coded to indicate whether it was stated during the E-case or C-case part of the interview to allow quantification of the results [31].

The analysis continued following the inductive process described in Elo & Kyngäs [29] identifying differences and similarities among the codes. Similar codes were grouped together and named based on content. The breadth of the grouped content was considered; detailed contents formed sub-categories, which were then grouped under upper categories, and broader content formed individual upper categories. This process was carried out by the first author (JK) under the guidance of the last author (HN).

In contrast to the typically proceeding inductive content analysis [29], the forming of main categories was done utilizing the MIMMS(/CSCATTT) operational model [8, 9]. This decision was made because after forming the sub-categories and upper categories, it was observed that the inductively formed initial results fit the MIMMS framework. Utilizing MIMMS at this stage was justified because it was seen as enhancing the usability of the results as it is internationally recognized, and its principles are also applied in Finnish guidelines for major incident management in EMS. Despite utilizing the MIMMS framework, it was decided not to change the analysis to an entirely deductive approach, as the previous phases followed the inductive approach, and there was still a desire to include all content that answered the research question in the results. Thus, the MIMMS framework provided the main categories, and the results under these main categories remained inductive. The flexible combination of inductive and deductive, meaning theory-driven content analysis, has been noted in a recent methodological article by Elo et al. [31]. Contents that did not fit the MIMMS model formed one additional inductive main category [31]. Two MIMMS components (Triage and Treatment) were combined as one main category to allow for a hierarchical structure that included both upper categories and sub-categories as per the content analysis [29]. Forming the main categories was mainly conducted by the last author (HN). At the end of the analysis process, the entire research team conducted a further review of how categories were named according to their content. The entire analysis process was carried out so that the original codes were retained during the grouping phase. This enabled quantification [31, 32] of how many interviewees mentioned the content that formed the categories and how many times it was mentioned in the E-case and C-case parts of the interview for each subcategory and upper category (if it did not contain subcategories). A figure of the hierarchical structure of the results was created, and the first (JK) and last (HN) authors wrote the results following the hierarchy and order of the figure. Quantification was included as part of the result text. The final results were reviewed by the whole research team. Quotes from the original material were provided to validate the conducted analysis.

## Results

On average, the participants ($n=12$) had eight years of experience as field supervisors. Only one participant reported, by their assessment, receiving extensive additional training for C and E incidents. Three respondents mentioned having attended only limited training, such as a single lecture on the topic but did not consider it significant. One respondent mentioned having received training so long ago that it was no longer viewed as entirely relevant. Of the 12 EMS field supervisors, seven named the C-case, and five named the E-case as the more challenging (Table 1).

The results of the research question, "What are the competence requirements of Finnish EMS field supervisors in managing C and E incidents?" were grouped under one inductive main category emphasizing preparedness

**Table 1** Characteristics of the participants ($n=12$)

| Work experience (years) | *n* |
|---|---|
| Less than 5 | 4 |
| 5–10 | 4 |
| More than 10 | 4 |
| Additional C and/or E training | |
| Extensive | 1 |
| Limited | 4 |
| No | 7 |
| Most challenging case | |
| C | 7 |
| E | 5 |

and six main categories based on MIMMS (as Triage and Treatment were combined) (Fig. 1).

## Being prepared

### *Prepared mind*

Participants ($n=7$, *17 codes (9/C; 8/E)*) emphasized the importance of mental rehearsal for rare scenarios to ensure preparedness. They highlighted the necessity of understanding the incident commander's roles and responsibilities. Participants felt that training and regular practice in managing C and E scenarios laid the foundation for more confident actions. Additionally, having

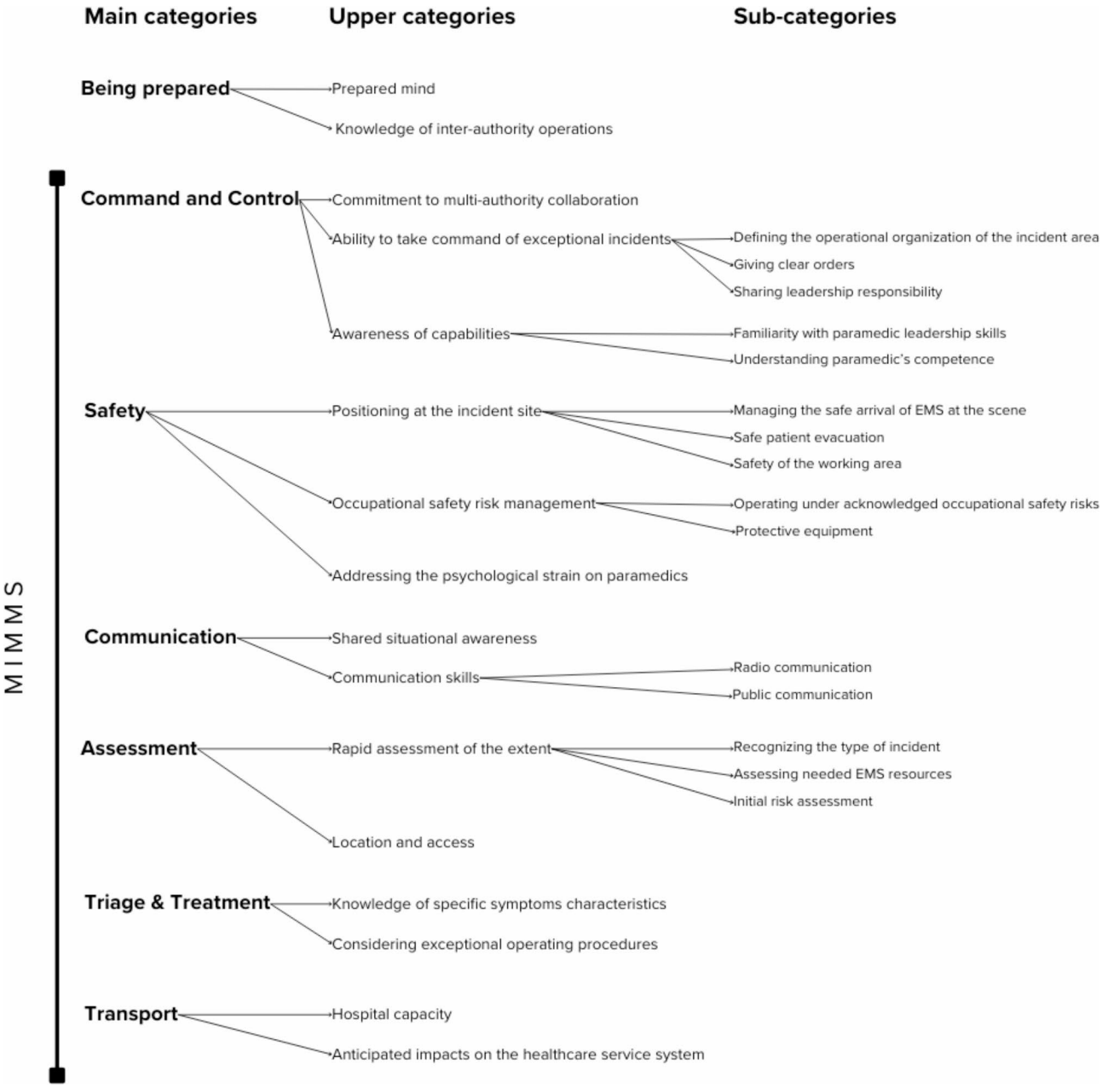


**Fig. 1** Competence requirements of EMS field supervisors in managing C and E incidents

pre-established plans and operational guidelines would highly support the field supervisor's actions.

> *"These types of incidents can be well-prepared for if we want to because all these risks are known in advance. And I don't understand why we don't prepare better for them." Participant 1 (P1), case C.*

#### *Knowledge of inter-authority operations*

Participants (*n*=7, *23 codes (12/C; 11/E)*) saw that understanding the operational focus and capabilities of fellow authorities would ensure comprehension of their priorities at different stages of the incident. In addition, it would also enhance multi-authority coordination of actions and help in assessing actual operational readiness and the workload of different authorities. Familiarity with specialized equipment was also seen as necessary, especially if it could be directly beneficial to EMS.

### Command and control

#### *Commitment to multi-authority collaboration*

Participants (*n*=9, *37 codes (13/C; 24E)*) underlined the importance of understanding that no single authority can handle the incident alone, highlighting the importance of multi-authority cooperation skills. Communication skills and risk assessment skills that involve all authorities were emphasized.

#### *Ability to take command of exceptional incidents*

*Defining the operational organization of the incident area (**n**=11, 57 codes (8/C; 49/E))* The ability to quickly develop an adaptable plan for using EMS resources at the scene was viewed as critical. Expertise in situational assessment and resource management was required to ensure that the EMS on-site organization was functional. Establishing a major incident organization with triage, treatment, and transport sectors and assessing its suitability for the situation was necessary.

*Giving clear orders (**n**=8, 31 codes (12/C; 19/E))* Participants stressed the importance of the ability to articulate both operational and care guidelines to paramedics, enabling them to act independently. However, it was recognized that field supervisors must have the expertise to convey certain specific instructions related to exceptional incidents.

*Sharing leadership responsibility (**n**=11, 112 codes (36/C; 76/E))* EMS incident command in exceptional incidents was perceived as a comprehensive task requiring total concentration. Participants recognized that the field supervisor would face significant pressure and needed proficiency in communication and decision-making. Therefore, the participants noted the importance of recognizing the need to delegate leadership during the incident. Identifying the need for a separate on-scene commander closer to the patients allowed the field supervisor to focus on multi-authority collaboration and resource management. Similarly, recognizing the leadership resources required for a major incident organization was essential.

> *"There are like fifty things happening kind of simultaneously, and one person can't organize it all, but that's why we have these sector leaders to whom the tasks should be assigned." P12, Case E.*

#### *Awareness of capabilities*

*Familiarity with paramedic leadership skills (**n**=5, 21 codes (4/C; 17/E))* Participants felt it was of utmost importance to know who they were choosing for the deputy leadership role while also recognizing that in the current organization, they might not be capable of assessing everyone's leadership skills.

> *"In principle, it shouldn't matter, but in practice, it does. I would definitely want to know who I can choose as the deputy leader if there's an option." P3, Case E.*

*Understanding paramedic's competence (**n**=8, 33 codes (23/C; 10/E))* Knowledge of the paramedics' expertise would help to assess the overall operational capacity of EMS at the incident. Recognizing the deficiencies in paramedics' training was viewed as crucial so that these issues could be addressed during the incident.

### Safety

#### *Positioning at the incident site*

*Managing the safe arrival of EMS at the scene (**n**=11, 47 codes (18/C; 29/E))* Participants stressed the importance of ensuring that EMS does not inadvertently drift to hazardous zones upon arrival at the scene. It was deemed critical to possess the knowledge to use the overall incident commander's expertise in determining the approach route and entry threshold. Nevertheless, the field supervisor would also need to be capable of independently defining these parameters in the initial stages.

> *"We need to take into account the immediate danger zone, request a threshold from the rescue services incident commander that is sufficiently far from the scene to avoid entering the immediate danger zone, and inform the arriving ambulance units about this." P5, case E.*

*Safe patient evacuation (**n**=9, 45 codes (22/C; 23/E))* The EMS incident commander would need to have the skills to plan patient evacuations from hazardous areas in collabo-

ration with other authorities. It was considered imperative to understand that another authority conducts evacuations from hazardous areas, with EMS support positioned as close as possible.

*Safety of the working area (**n**=12, 46 codes (20/C; 26/E))* At the incident area, it was seen as fundamental to identify a sufficiently safe working area for EMS, as they are not deemed to operate in hazardous zones. Understanding of the significance of structural protection was emphasized in E situations and wind direction in both E and C scenarios.

#### *Occupational safety risk management*

*Operating under-acknowledged occupational safety risks (**n**=12, 118 codes (61/C; 57/E))* Participants underscored the importance of recognizing that the safety of paramedics cannot be fully guaranteed in these incidents. The field supervisor should be able to determine adequate safety measures while also expecting paramedics to take responsibility for maintaining their safety. Field supervisors' consideration for occupational safety was viewed as more vital than usual in both scenarios, with the risk of EMS personnel getting injured perceived as higher than normal. Understanding the importance of procedures for decontamination emerged as a crucial theme in C situations to effectively manage the threat. Additionally, the ability to communicate work safety threats judiciously was seen as essential to avoid exaggeration that could paralyze the overall operation.

> *"I have to decide whether to lose lives or take a small risk." P10, case E.*

*Protective equipment (**n**=11, 40 codes (31/C; 9/E))* According to the participants, the field supervisor would need to be aware of the available personal protective equipment (PPE). The understanding to assign the PPE was considered necessary, but it is also essential to understand the level of protection it provides.

#### *Addressing the psychological strain on paramedics*

Participants (*n*=12, *40 codes (7/C; 33/E)*) felt that the field supervisor should recognize the psychological burden these incidents cause for paramedics, as they may simultaneously experience fear for their safety and pressure to succeed in treating multiple patients. Additionally, it is crucial to acknowledge the possibility that some paramedics might refuse to work near hazardous areas.

Participants felt that the field supervisor should consider providing clear instructions and delegating smaller tasks amidst the chaotic environment to alleviate this emotional burden. The importance of post-mission defusing was considered crucial, and the field supervisor should possess the skills to organize such sessions.

> *"In this case, paramedics are probably scared, and it emphasizes the incident commander's determination somewhat, and the sharing of information and clear instructions and tasks." P9, case C.*

### Communication

#### *Shared situational awareness*

Participants (*n*=7, *27 codes (3/C; 24/E)*) saw that the ability to create a unified situational awareness by authorities would be requisite. Active information exchange and physical proximity would ensure that every responder has up-to-date information and could understand the interdependencies of different responders' actions. Additionally, it was noted that a shared situational awareness requires that all authority leaders have the expertise to recognize and convey the importance of certain information to others effectively.

#### *Communication skills*

*Radio communication (**n**=10, 40 codes (4/C; 36/E))* Proficiency in radio communication was seen as requisite. A thorough understanding of the technical features of the devices and their potential limitations supported their effective use. It was also felt that the ability to maintain calm and consistent radio communication had a calming effect on paramedics' actions.

*Public communication (**n**=8, 14 codes (10/C; 4/E))* The capability to assist in informing the public was viewed as essential during an exceptional situation. Expertise in informing and guiding the public in using health services during the incident was considered relevant.

### Assessment

#### *Rapid assessment of the extent*

*Recognizing the type of incident (**n**=11, 59 codes (19/C; 40/E))* Early recognition of the extent of the incident was considered fundamental. The ability to conduct an initial assessment based on available information was essential, and this expertise could be supplemented with additional details from the emergency dispatch center or fellow authorities. Identifying the type of incident would also determine the overall incident commander responsible for the entire incident and the EMS field supervisor's position in the management system.

*Assessing needed EMS resources (**n**=12, 101 codes (38/C; 63/E))* It was seen that the field supervisor must be able to immediately assess the number of EMS units needed for the incident based on its magnitude and casualties. Immediate recognition of the operational priorities of

EMS was viewed as extremely important, with an emphasis on the understanding that effective triage and transportation are key factors in EMS actions. In addition, recognizing other daily EMS operations was important, but participants thought that the field supervisor acting as the incident commander could not be responsible for them. Therefore, the immediate involvement of a second field supervisor and the dispatch of additional resources were viewed as necessary for managing the entire EMS system with full concentration on the incident.

*Initial risk assessment (**n**=12, 115 codes (76/C; 39/E))* Recognizing the hazardous substances was considered critical in C incidents and the risk of additional explosions in E incidents. In both scenarios, it was regarded as essential to consider the possibility of intentionality as the cause of the incident. Recognizing the dynamic nature of the incident and considering it in EMS operations were seen as crucial for ensuring occupational safety and managing the potentially increasing number of casualties effectively.

#### *Location and access*

Participants (*n*=6, *25 codes (19/C; 6/E)*) expressed the importance of understanding the physical incident area. It was seen as crucial to identify pathways, buildings, available resources on the scene, and distances to hospitals.

> *"And it's important to understand the impact of distance. I probably didn't mention it, but I meant that it's already a challenging area, and our next units are practically half an hour or more away." P6, Case C.*

### Triage and treatment

#### *Knowledge of specific symptom characteristics*

According to participants (*n*=11, *37 codes (25/C; 12/E)*), in E situations, understanding the mechanism of traumatic injury was viewed as crucial, as was knowledge of the symptoms caused by hazardous substances in C situations. If the field supervisor did not know this information, it was seen as important to be aware of the relevant sources of information in each case.

#### *Considering exceptional operating procedures*

Participants (*n*=4, *18 codes (15/C; 3/E)*) highlighted the need for an ability to consider unconventional solutions in the treatment of patients during exceptional incidents. From a leadership perspective, such discretion was seen as necessary in timing treatment and decontamination, using exceptional vehicles (such as privately owned vans or other situational creative solutions), as well as helicopters to ensure rapid transportation to treatment, arranging exceptional treatment resources at the hospital, and organizing treatment according to urgency. Nonetheless, it was also seen as vital to acknowledge the risks associated with such deviations from standard procedures.

### Transport

#### *Hospital capacity*

According to the participants (*n*=8, *14 codes (3/C; 11/E)*), the field supervisor must understand how to select transport destinations. There must be knowledge or a way to ascertain the receiving capacity of various hospitals, considering both the number of patients and the nature of their symptoms or injuries.

> *"It does require an understanding of the hospital's resources, resources from other hospitals, and then sort of whether we can and if it's sensible to transport to another location." P8, case E.*

#### *Anticipated impacts on the healthcare service system*

Participants (*n*=12, *116 codes (49/C; 67/E)*) highlighted the importance of recognizing that the incident would be exceptional for the receiving hospital as well and that the hospital's emergency operations should be promptly activated. It would be also necessary to understand the impact of the exceptional incident on the availability of other EMS services. Field supervisors should acknowledge that non-urgent EMS missions may need to be suspended and that even urgent missions will have a limited number of units available. Therefore, field supervisors would need to understand the cruciality of the ongoing sharing of situational awareness with the hospital and note that individuals will inevitably seek emergency care independently. Some of those individuals would be exposed to the incident.

> *"At the earliest possible stage, we need to get the right decision-makers at the hospital around a table to discuss what might still happen. Essentially, the field supervisor on the scene serves as the link in this process." P2, Case C.*

## Discussion

This study examined the perceived competence requirements of Finnish EMS field supervisors in managing C and E incidents. Based on the results, the view of EMS field supervisors on the perceived competence requirements fit well into the MIMMS(/CSCATTT) framework, even though the interviews were not conducted with a specific operational model-driven approach. The emphasis on preparedness in the inductive category complemented the view of competence requirements well, as the effort towards preparedness can be considered as an attitude and an accumulation of knowledge and skills. In this study, competence in preparing for exceptional

incidents at a personal level, including mental preparation and training, was deemed essential for EMS field supervisors, and was brought up similarly in both cases. Understanding organizational-level preparedness was also considered crucial, as mentioned in previous studies on C and E incidents [2, 5, 13, 27, 28]. The importance of preparedness is also noted in the MIMMS manual [9]. A recent national study from Norway highlighted that there is still much to improve in preparedness for major incidents [33], and this can also be considered applicable to Finland.

In this study, effective multi-authority collaboration skills were seen as crucial, along with the understanding that no single authority can handle them alone. These aspects were more prominently highlighted in the context of the E-case but were also present in the C-case. Previous research also underlines the importance of close inter-authority cooperation in the successful management of C and E incidents [5, 6], which reinforces the importance of understanding the content of other authorities' operations. Acknowledging the overall incident command structure was seen as an important factor in enhancing inter-authority cooperation. The significance of understanding the command organization has also been highlighted in earlier studies [11, 25]. The results also highlighted a clear need for leadership, as instructed in both the MIMMS model [8] and the ICS model [12]. These observations were also especially emphasized in the E-case. Still, a previous literature review has identified that this competence requirement cannot be overlooked by any operational model [11]. Therefore, it can be considered as a specific skill. In further research, it would be useful to investigate the personality traits the role requires, as these traits were not sufficiently highlighted in this study or previous studies. Moreover, recognizing the capacity required for managing the situation and responding by delegating leadership responsibilities was also seen as essential in this study, especially in the E-case. The significant amount of communication and the rapid decision-making under pressure was seen to demand full concentration, which could not be combined with overseeing other daily EMS operations, a finding also noted in previous research [25]. Knowledge of the capabilities of paramedics was considered to contribute to the effective use of resources in both cases, enabling maximum performance from limited resources. This consideration might not be emphasized in the more common MCIs, as Finnish paramedics are inherently highly educated and very skilled. In the future, it would be beneficial to investigate more thoroughly the various leadership, leadership delegation, and resource management methods in EMS according to the incident.

According to Finnish legislation, the employer holds the primary responsibility for ensuring workplace safety. The key obligations include identifying and mitigating occupational safety risks and providing proper orientation to employees [34]. Due to the diverse nature of the EMS work environment, some responsibility for ensuring safety has been assigned to the field supervisor, particularly when acting as the incident commander, a responsibility that previous research has also emphasized [2–4]. Of the MIMMS components, Safety was emphasized among the competence requirements, similarly as in previous CBRNE research from an EMS perspective [3, 4]. In this study, the positioning of the EMS at the incident site was strongly highlighted for both cases, and the issues presented are closely connected to both the training content of the MIMMS model and the role of the incident commander as a safety assurer [8]. In line with this, managing the protection from hazardous materials, especially in the C-case, was seen as crucial for maintaining EMS operational capability, in line with previous studies underscoring the importance of on-site decontamination for continuity management [2, 3]. One critical finding in the current study was the unanimous agreement among respondents that it is impossible to ensure the safety of paramedics completely in either example case. This can be seen as a clear challenge compared to more stable MCIs, such as traffic accidents, where ensuring occupational safety can be assumed to be more straightforward. Nevertheless, EMS must still be able to operate. Occupational safety risk management, including defining an acceptable level of risk was seen as an essential skill for the EMS field supervisor, which has also been noted in previous research [5]. The process of defining an acceptable risk should be further studied to reduce the stressfulness of the situation and ensure that the process is transparent and not solely dependent on individual judgment. Moreover, CBRNE incidents have been found to cause a psychological burden on responders [35], and the current study also recognized the exceptional psychological strain on paramedics in both cases, but particularly pronounced in the E-case. Major incidents have been found to cause significant mental stress in paramedics, possibly leading to long-term depression and post-traumatic stress disorder, for which paramedics are already considered a high-risk group [36–38]. In contrast to the MIMMS model, the EMS field supervisors in this study did not highlight perspectives on the safety of the survivors at the scene [8, 9]. However, it would still be an important competence. The unfamiliarity of the situation may have led respondents to prioritize the safety of their own teams over that of the survivors.

A shared situational awareness among involved authorities was pronounced more in the E-case than in the C-case, particularly stressing the importance of effective communication and information flow, as in previous studies [3, 4, 7, 25–27]. However, not all field supervisors

emphasized this in the current study. In the MIMMS training content, both effective response-supporting communication and more practical skills in radio communication [8] are considered. In this study, the practical aspect received more attention in the E-case from field supervisors. However, particularly in connection with the C-case, the perspectives of public information were also noted. The importance of public communication skills may be more emphasized in the current world than before, as highlighted by Hansen et al. [10] in their recent major incident case report from Denmark, which strongly points out that the spread of information through numerous different channels also affects EMS operations.

The current research underlines the needed ability of an EMS field supervisor to quickly assess the situation and adapt their leadership, including creating action plans, employing situation-specific procedures, and allocating resources. A similar finding has been reported in a recent major incident case report [10]. The rapid assessment competencies are also recognized in other studies [3, 4, 7, 26, 27], and in addition, the identification of hazardous materials, quick initiation of resource management, and assessment of access to the incident site were consistent with the training contents of the MIMMS model [8]. In this study, these competency needs were strongly emphasized for both cases. The results also highlighted the importance of preparing for an increasing number of patients. The progress of the C and E situations was perceived as difficult to predict for various reasons, such as ambiguity about the cause and the impact of weather conditions. Previous research has mentioned these factors, but they have not received significant attention [4], although these factors can be seen as significantly complicating the management of an MCI. Regarding resource management, it could be possible that some paramedics might either refuse or be unable to operate in the exceptional C or E situation. Previous studies have noticed this phenomenon in disasters, terrorist attacks, active shooter incidents, and CBRNE incidents [35, 39–41]. However, this perspective and the factors influencing it should be examined more closely worldwide, as it greatly affects EMS performance.

From the MIMMS components, Triage and Treatment received the least content from EMS field supervisors' interviews. The results emphasized the exceptionality of C and E incidents, including specific injury mechanisms and also the possible need to rely on atypical action to enhance efficiency in demanding conditions. It can be considered natural that there were no "basic" mentions of performing triage and treatment, as the role is to manage these situations, not to carry out the actual tasks. Triage and Treatment are important MIMMS components, and in another study with paramedics as a target group, those aspects were emphasized [42]. In contrast, the Transport component received more attention from the EMS field supervisors in this study, highlighting the smoothest patient flow from the incident site in the E-case and healthcare system-level effects in both cases. However, the results are quite general, and no more detailed competency requirements were gathered on these issues. In Finland, EMS organizes responses to major incidents by following the guidelines of their respective regions, and these guidelines incorporate elements from the MIMMS model and the ICS model. In these models, the role of the incident commander—a role that Finnish EMS field supervisors would also take on—is specifically to lead transportation efforts, although responsibilities are shared, as noted by Lincoln et al. (2023) [43]. The general findings of this study can be seen as reflecting this role.

In this study and previous studies, it has become evident that EMS field supervisors, and more broadly, EMS personnel, require significantly more training on C(BRN)E incidents, and in addition, major incident preparedness should be emphasized [10, 11, 34, 44]. The results of this study can be used to support the design of C and E training for EMS field supervisors. However, further research should focus on this target group, for instance, examining how they perceive their current level of competence, whether there are possible competence gaps, and what types of training they would particularly benefit from. For example, MIMMS model training includes lectures, practical exercises without casualties, tabletop exercises, examinations, skill stations, and workshops [8]. Assessing the appropriateness of these teaching methods in C and E –related training in the current resource-constrained healthcare system would be valuable.

#### Methodological considerations

The participants were selected based on their predetermined roles as incident commanders in larger incidents. This study is intended to open the door for further research from a competence perspective—hence the focus on a single professional group.

All interviewees worked in the same region, ensuring a similar baseline for the interviews, as the special preparedness and skills required for specific sites are identical. Different regions have varying risk profiles, which suggests that competencies may be unevenly distributed within the country. In this study, one limitation is that none of the participants had prior experience with large-scale C or E incidents. Consequently, the absence of experiential insights may have led to an incomplete understanding of certain real-world challenges, opportunities, and needed competence. Additionally, the participants' organizational context may have influenced their competence development. Moreover, participants from a single region may possess a narrower perspective,

potentially overlooking the strengths and preparedness practices of other regions, which in turn impacts the transferability [30] of the results.

The first author who conducted the interviews (JK) works in the same community as a colleague, not as a supervisor to the participants. This could be seen as a strength, creating immediacy and a conversational atmosphere during the interviews and also a limitation if some felt uneasy discussing their competencies for rare incidents. Regardless, it is likely that those who felt uneasy did not volunteer for the interviews. 70% of the target group was interviewed. However, non-participants may have had unique insights that could have enriched the results, meaning that some valuable perspectives might not have been captured.

Individual interviews were chosen to ensure each interviewee had the opportunity to express their thoughts without dominant personalities influencing the discussion, allowing for the expression of divergent opinions.

Content analysis was selected as the method due to its suitability as it allowed the quantification of results [30–32], which was desired to highlight the different competencies' emphasis. The content analysis followed the inductive process as described by Elo & Kyngäs [29] until the formation of the main categories, where the compatibility with the MIMMS framework was observed. Utilizing the MIMMS framework as the main category offers several advantages. The study aligns with current practices and standards by incorporating the internationally recognized MIMMS framework, which is also reflected in Finnish guidelines. This may increase the practical value of the research, making it more accessible and likely to be utilized by professionals in the field. A recent methodological article [31] describes the flexibility of content analysis and the combination of both inductive-deductive and deductive-inductive approaches. Still, the methodological literature on such an approach is limited. In this study, because the MIMMS framework was only used at the main category level, it did not compromise the richness of the inductive findings formed before the framework's incorporation. The decision to maintain an inductive approach avoided a scenario where the content would be forced to fit the MIMMS framework, potentially omitting some of the results now described. Nonetheless, using the MIMMS framework to form main categories could introduce confirmation bias, where data is interpreted in a way that overly favors the framework. This could limit the exploration of alternative interpretations that might be equally valid but do not fit the pre-established categories as neatly.

A multidisciplinary research team enhances credibility [32]. The first author (JK) has over ten years of experience as an EMS field supervisor and a professional interest in major incidents and CBRNE-related issues. The second author (TI) is a chief EMS physician with extensive research experience. The last author (HN) heads the master's degree program in the development and management of EMS and has significant experience in qualitative research. The research team collectively designed the case descriptions used in the interviews, and the first and last authors jointly conducted the analysis.

Each interview was extensive in both time and word count, and the number of codes can be considered substantial. All interviewees spontaneously began to approach the topic by describing the step-by-step management of the respective incident and the necessary competencies involved, which may have influenced the results to fit into the MIMMS framework rather than highlighting only certain areas of competence. Responses began to saturate by the fifth interview. An in-depth description of the phenomenon in this target group was achieved, with interviewees providing comprehensive justifications, resulting in rich perspectives. In line with the qualitative approach, generalization was not sought [45].

There are significant differences internationally in EMS organizations and the role of EMS field supervisors, but the required competencies in these incidents are likely to have many similarities. In order to improve transferability, the study clearly described the setting and participant characteristics, outlined data collection and analysis methods, and presented detailed results supported by quotes from the original data [30].

Dependability [30] was reinforced by the data collection being conducted over two months in the spring of 2024, with no CBRNE incidents or training occurring during this period. On the one hand, using case examples strengthens the results, as the competencies described in the interviews are tied to specific scenarios, acknowledging that there might not be experiential knowledge of these situations, which could have also contributed to data saturation. Using open-ended questions without case examples could have resulted in narrower descriptions. On the other hand, it is possible that the case descriptions, which contained a lot of details and were used as the basis for the interviews, influenced the responses too much. Thus, in future studies, it could be beneficial to allow interviewees to form their responses without specific cases, especially if they have extensive training or experiential expertise in the situations of interest.

## Conclusions

According to the results of this study, the views of EMS field supervisors on the perceived competence requirements in managing C and E incidents align well with the components of MIMMS: Command and Control, Safety, Communication, Assessment, Triage, Treatment, and

Transport. In addition, EMS field supervisors should be mentally prepared and well-trained for C and E incidents, supported by pre-established preparedness plans and clear major incident guidelines.

From our results, it can be concluded that EMS field supervisors have a strong overall competence in managing MCIs. However, CBRNE incidents can be particularly challenging, for example, due to their rarity, exceptional elements, and associated occupational safety risks. Therefore, preparing for them through training is crucial. The results highlighted important competency areas that can be used in the design of C and E training for EMS field supervisors. Additionally, the findings can be utilized to develop more detailed guidelines for C and E incidents than those provided by the "all hazards" approach. There is still a need to examine the current level of competence, gaps in competence, and the most appropriate training methods to enhance competence to respond to different CBRNE situations.

**Abbreviations**

| | |
|---|---|
| CBRNE | Chemical, Biological, Radiological, Nuclear, Explosive |
| EMS | Emergency Medical Services |
| MCI | Mass Casualty Incident |
| PPE | Personal Protective Equipment |

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12873-024-01157-w.

Supplementary Material 1

Supplementary Material 2

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**Author contributions**
JK: Conceptualization; Data curation; Formal analysis; Investigation; Writing–original draftTI: Conceptualization; Writing–review and editing; SupervisionHN: Conceptualization; Methodology; Formal analysis; Writing–review and editing; Supervision.

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**Data availability**
The datasets generated and analyzed during the current study are not publicly available due to the limitations of the research permit.

## Declarations

**Ethics approval and consent to participate**
In this study, the principles of research ethics were adhered to, along with the guidelines for good scientific practice [46, 47]. The study was conducted per the Helsinki Declaration [48] and all the appropriate national guidelines [46, 47]. The appropriate research permit for the study was sought and obtained from the Southwest Finland Wellbeing Services County. At the outset of the interviews, each participant received comprehensive information about the study, a data protection form, and a consent form. Additionally, each participant acknowledged the fictional nature of the cases and was informed that the research data would be analyzed and published. The participation of each interviewee was contingent upon informed consent. In accordance with the Finnish guidelines outlined by the Finnish National Board on Research Integrity, ethical committee pre-evaluation (equivalent to an IRB) was not required for studies addressing nonsensitive topics conducted among working adults who provided informed consent [46].

**Consent for publication**
Not applicable.

**Competing interests**
The authors declare no competing interests.

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## Publisher's note