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RESEARCH REPORT

CHEMICAL INCIDENT PREPAREDNESS AMONG SWEDISH EMERGENCY MEDICAL SERVICE NURSES: A QUALITATIVE STUDY

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ABSTRACT

Background: Hazardous chemicals are essential for modern society, but their use bears the risk of major incidents. Past incidents have revealed the importance of preparing and training emergency medical service (EMS) personnel when responding to these incidents. However, studies have shown the level of preparedness to be insufficient. There needs to be more knowledge about how EMS nurses perceive their preparedness and response when facing chemical incidents.

Aim: This study aimed to qualitatively investigate the working procedures regarding chemical incidents among a cohort of Swedish EMS nurses.

Method: Seventeen EMS nurses from rural and urban areas in Sweden were individually interviewed using four different realistic scenarios (vignettes). The transcribed text from the interviews was analyzed using qualitative content analysis.

Result: The results were derived into two categories with underlying sub-categories: a struggle to organize the onsite work situation (insufficient managerial support, limited resources, trust in rescue services, difficult decision making, stressful responsibilities) and decontamination—a demanding and risky situation (risk management, work in protective gear, aggravating circumstances). Participants often lack real-life experience in facing a chemical incident and training that improves preparedness and the ability to respond adequately.

Conclusion: Chemical incidents pose many challenges for EMS nurses, but with proper training efforts, many of these challenges can be solved. This study has shown the need for more accessible chemical incident training targeting EMS nurses, primarily focusing on risk assessment, managerial support, resource management, equipment, and decontamination, including stress management and decision-making. Research in chemical incidents is sparse, and there remains much to understand concerning work procedures during chemical incidents.

INTRODUCTION

Chemicals and chemical-based products are important for economic development and essential for modern life, and they are used daily in large quantities. Millions of potentially hazardous chemical substances are produced and transported globally daily. However, this also creates a considerable risk for chemical (C) incidents (World Health Organization, 2017). A C-incident is a harmful event that causes the spread of chemical substances or toxins into the environment. When a C-incident occurs, individuals and the environment are at risk of harm (Thornton et al., 2004; Barelli et al., 2008). In the case of a C- incident, intentional or not, the spread of a chemical substance constitutes a danger, regardless of where it may originate. C-incidents are potentially challenging due to the risk of rapid events, possibly leading to fatal consequences within minutes (Chilcott, 2014).

A tragic example is the devastating incident in Bhopal, India, in 1984, where clouds of isocyanate gas spread from a factory to a nearby residential area, causing over 8,000 deaths and a considerable number of injuries in the first week following exposure (Eckerman, 2011). A recent example is the Salisbury and Amesbury incident, where the Soviet-era Novichok class of nerve agent was used (Haslam, 2022). Concerns have been raised, and improvements are needed concerning C-incident prevention, preparedness, and response (International efforts for industrial and chemical accident prevention, preparedness, and response [Downloaded 23-08-22]. In the present paper, we considered preparedness (i.e., development of accident preparedness plans, early warning measures, communication with the public, and emergency exercises) and response (i.e., all the actions to be taken once an accident has occurred or there is an imminent threat of an accident) and investigate work procedures among EMS nurses.

Internationally, several major incidents have occurred over recent decades, and hundreds of C-incidents go unnoticed every year. In Sweden, there have only been relatively minor incidents involving chemical substances. However, one example of a severe C-incident is the chlorine gas incident at the bathing facility VanadisbadetÓ in Stockholm in 1993. A human mistake led to more than five cubic meters of chlorine gas being formed and released over the pool area. Thirty-one people, mostly children, were treated at the hospital (The National Board of Health and Welfare, 1996). Another example was an incident involving the release of ammonia at a food distribution factory in Helsingborg in 2010, where 16 workers were affected, and five had to be decontaminated in the hospital (Davidsson, 2010). Although these incidents did not involve a high number of deaths and thus seem undramatic, they indicate that these incidents could pose the potential risk of mass-casualty incidents (Khajehaminian et al., 2018).

EMS personnel, together with rescue services and the police, are typically the first responders to a C-incident and are responsible for incident management and onsite treatment of patients (Thompson et al., 2014). C-incidents pose a considerable risk to the first responders, as the spread of chemical material may seriously affect their health. There is also a risk of secondary contamination (whereby a victim contaminates first responders) during the response (Westman et al., 2021; Clarke et al., 2008). Generally, all first responders receive training in managing major incidents through Prehospital Health-

care Management (Rüter et al., 2006). However, in significant incidents like C-incidents, there is an additional need for knowledge and skills related to particular chemical substances. Studies have shown that successful and safe handling of C-incidents—including care of the injured in both the prehospital and hospital environment—requires careful planning, training, and preparedness (Kirk et al., 2007; Kenar & Karayilanoglu, 2004).

While it is generally true that all first responders in Europe are trained to manage significant events, there needs to be more C-incident preparedness among EMS personnel. EMS personnel have demonstrated inadequate training in responding to C-incidents involving a substantial number of exposed individuals. Challenges regarding resource allocation, treating chemical injuries, and effectively aiding contaminated victims have arisen (Jama & Kuisma, 2016; Davidson et al., 2019). In light of European studies, it is essential to study further how prepared EMS nurses consider themselves to be when facing incidents involving multiple injuries due to emissions of chemical substances.

Aim

This study aimed to qualitatively investigate the working procedures regarding chemical incidents among a cohort of Swedish EMS nurses.

METHODS

Study design

The design of this study was qualitative (Graneheim and Lundman, 2004). Data was collected through semi-structured individual interviews based on participant's reactions, discussions, and opinions to short story hypothetical scenario vignettes, which resemble realistic situations. This method is relevant for researching areas where empirical data is scarce or lacking (Schoenberg& Racdal, 2000). This design allows for an exploration of matters that are unique to the experiences of the participants and will contribute deeper insight into a phenomenon, which in the case of this study means how C-incidents are perceived, although participants lack real-life experiences (Schoenberg& Racdal, 2000; McGrath et al., 2019).

The four vignettes were constructed by an expert group of researchers and were based on disaster medicine research and grey literature (Newmark et al., 2016), actual incidents and models, and theories regarding major incident medical management (Mackway-Jones, 2014). Each vignette included one or more aspects important for prehospital medical management of major incidents, such as command and control, safety, communication, assessment, triage, treatment, and transport. (Figure 1.)

Participants

In this study, a cohort of EMS nurses from Sweden was recruited using a purposive sample; in this case, participants who had participated in a training course for risky environments such as C- incidents were asked to participate (n=8). Thereafter, a snowball sampling was executed as the first participants to enroll in the study reached out to potential colleagues interested in the phenomena (C-incidents) and asked them to participate (n=9).

In total, seventeen EMS nurses, both men (n= 9) and women (n= 8), aged 27 to 56 (mean 44) years, participated in the study. All participants but two had a specialist nursing degree in emergency care; their work experience as an EMS nurse was an average of 18 (4-36) years. In the Swedish EMS, all personnel are trained to handle major incidents through Prehospital Healthcare Management (Rüter et al., 2006). However, in major incidents like C-incidents, there is an additional need for knowledge and skills related to particular chemical substances.

You and your colleague received an alarm from SOS Alarm, which informs you that there has been a traffic incident on the main road, where a heavy goods vehicle drove into the ditch and overturned. The truck was carrying dangerous goods and how the driver fared is unclear. You arrive at the scene first, and emergency services are ten minutes away.
You and your colleague are alerted to a priority runner-up, but you come across this event on the way there, where you are first to arrive. You see a car burning heavily in a residential area near a preschool. As you get closer, you see an electric car on fire. The electric car has collided with a gas bus. Another motorist has stopped, and a person is on his way forward with a hand-held fire extinguisher. Around the site, several passers-by have stopped, and some are filming the incident with their smartphones.
You and your colleague arrive at an apartment building. SOS Alarm informs you that they have received several calls from residents of the house stating that they feel dizzy, lethargic, and nauseous, they are coughing, and that some have lost consciousness. At the same time, those affected indicate that they smell something strange, which becomes stronger in the stairwell. Emergency services and police are on site, and emergency services are evacuating all residents out of the house after they discover a drug lab in the kitchen of one of the apartments with several unmarked chemicals. You will work here on site with the evacuees.
You and your colleague are alerted regarding an incident in the local battery factory. When you arrive, you are informed by the supervisor that there has been an incident in production and that a large amount of corrosive substance has been spilled. At least seven people have had this corrosive substance on them. Eight people from emergency services who have entered the factory discover that their clothes are starting to corrode and that their skin is starting to react. Two of the factory workers who have had a significant amount of corrosive substance on them are assessed as critical and need rapid transport, and you have access to ambulances for transport to the hospital.

Figure 1. Vignettes used in the study.

Data collection

Individual semi-structured interviews were performed via digital platforms. The interview started with the interviewer presenting the vignette on a PowerPoint slide.

The discussion started with the interviewer reading the vignette out loud and then asking: "What would you do?" The vignette included aspects that the participants could interpret in different ways. Depending on the participant;s answers, the interviewer asked questions to support discussions about alternative solutions. In that way, the interviewer and participant interaction shaped a unique narrative and gained an even more nuanced answer. The interviews lasted for a mean of 78 minutes (min: 0:49, max: 1:48), and. Interviews were taped and transcribed verbatim.

Analysis

The interview text was analyzed using qualitative content analysis (Graneheim & Lundman, 2004; Graneheim et al., 2017), where qualitative data is analyzed systematically. It involves interpretations and descriptions at different levels of abstraction (Lindgren et al., 2020). The original interview text was broken down into meaning units and labeled as codes using MS Word. The codes were sorted by similarities and differences and abstracted into sub-categories and categories. Categories, sub-categories, and participant quotes made up the final presented results.

Ethics

This study was performed according to the Helsinki Declaration (WHO, 2013). Study participants are professionals and not patients, thereby not regulated by The Act concerning the Ethical Review of Research Involving Humans (2003). All participation in the study was voluntary. Full informed consent was given by participants with the option to withdraw from the study at any time. Results were presented at the group level, and individual participants cannot be identified.

RESULTS

A struggle to organize the onsite work situation

Insufficient managerial support

Categories	Subcategories
A struggle to organize the onsite work situation	Insufficient managerial support
	Limited resources
	Trust in rescue services
	Difficult decision-making
	Stressful responsibilities
Decontamination—a demanding and risky situation	Risk management
	Work in protective gear
	Aggravating circumstances

Table 1. Categories and subcategories.

Participants' descriptions of onsite management were that it was insufficient and poorly structured even though they stated that they relied on their onsite work regarding concepts (Prehospital Healthcare Management) and recognized the tools for rapid patient assessment (Airway, Breathing, Circulation, Disability, and Exposure). EMS managerial support appeared to be minimal to non-existent compared to rescue service support. It was stated that rescue services had well-developed onsite support and incorporated support management in education. Participants described that organizational support from other EMS colleagues was needed within EMS to handle onsite management. Lack of support was experienced as problematic.

"If we compare us to the rescue services, they know who their onsite officer is; with us it may be a new unexperienced employee who will act as onsite manager." [Male, age 55, experience 33 years, no risky environments course].

It emerged that an early establishment of collaboration with rescue services and the police appears to be essential for the EMS commander to manage onsite teams. Cooperation emerged as necessary for the EMS commander to establish effective and safe care of the injured. The EMS commander will not be able to section the incident scene into different zones unless cooperation with the rescue service commander is established.

The participants highlighted zones as the foundation for strategy—planning, re-evaluation of the incident, and care of the injured. Zones at the incident site were also important for the commander's work procedures, as the level of personal protective gear and decontamination of victims varies due to different safety zones.

"When it comes to the EMS part, it is extremely insufficient, we are talking it's now 2021 and we have no digital support in management." [Male, age 55, experience 30 years, risky environments course].

Limited resources

The distribution of resources proved to be a significant problem, as the nature of most C-incidents might involve many injured persons. To request extensive resources early on came across as advantageous. The availability of resources differs depending on the location of the C-incident, and what time of the day and what day of the week the incident occurred. In the case of a rural location, the general experience was that resources would be sparse, and it would be difficult to receive resources at the incident site within a reasonable timeframe. This makes distributing and utilizing resources more challenging, and participants expressed that they would have to make uncomfortable decisions in an already difficult situation.

"I think the whole work will suffer and become more cumbersome if you do not have enough ambulances; it is definitely a question of resources. It will affect both the direction in decision-making, and it will affect the outcome for the patient." [Male, age 31, experience 6 years, no risky environments course].

Moreover, considering onsite resources and conveying information to and preparing hospitals for receiving the injured were emphasized as significant. Early notification to hospitals, the requirement for further decontamination upon arrival, and an onsite report of the situation were especially important for organizing work. This was mentioned to give the receiving hospital time to gather resources and prepare.

Trust in rescue services

Participants described having confidence in the rescue service commander to take control of the onsite situation. They considered the rescue service commander—compared to themselves as commanders—to have appropriate knowledge on how to make adequate risk assessments and decisions about safe approaches to the chemical incident site. Rescue services personnel have suitable equipment and protective gear and were considered better educated managing C-incidents.

Difficult decision-making

When decisions relevant to EMS nurse's work situation were delegated to the rescue service commander, for example the decision on when it was safe enough to access victims, the participants experienced a delaying in reaching the victims. Trust in rescue services was discussed as an advantage but also as a hindrance if rescue services personnel

were, for any reason, absent at the incident site, in which case it could be a problem if the EMS commander is insecure about how to manage C-incidents.

"Once rescue services arrive, we can definitely lean on them." [Male, age 39, experience 10 years, no risky environments course].

Participants described decision-making during a C-incident as more critical, time-sensitive, and, therefore, more challenging than general emergencies. Decisions that addressed the level of care to patients were in focus and based on the current situation and resources. The participants stated that all decisions were based on whether there were lives to save. If there were, the decision required treatment provision. No treatment provision was required for patients with a low chance of survival. It was stated that more experience and training were needed in making such uncomfortable and difficult decisions. In contrast, participants with long work experience expressed less insecurity and fewer uncomfortable feelings than their less experienced colleagues.

"…it's a very difficult situation and very difficult to make that decision. It's probably one of the situations that clenches my stomach. At the same time, we have the resources that we have. Then you might focus on those you can save instead of those who are seemingly beyond rescue…" [Male, age 31, experience 6 years, no risky environments course].

Stressful responsibilities

The participants described that the ability to be flexible was needed to handle stressful and unpredictable C-incidents. Adapting and preparing mentally for the specific situation would help EMS nurses handle stress and improve their response. It emerged that the participants' work procedure for handling the unpredictable was not generic, and they expressed a need to discuss strategies for handling stressful situations.

"…this is something that you mentally wish to have gone through before that you are not surprised by difficult decisions that you actually have to make. For example, prioritize down patients in need, deviate from routines, send several patients in one and the same ambulance… There are many things that are different from the usual ambulance work you do." [Male, age 39, experience 10 years, risky environments course].

Participants described how to consult the Swedish Poison Information Center to gain better knowledge of the chemical's impact and how to handle and treat exposed patients, especially with antidotes. A common symptom when exposed to chemicals would be coughing and a high respiratory rate, which was described as relatively easy and straightforward to treat. The participants described how these patients needed to be taken outside for fresh air and then treated with oxygen and inhalation medication. If there were signs of smoke inhalation poisoning, the patient should be treated with medications.

"…you need to know what chemical it is… I would use the Swedish Poison Information Center and then I would presumably have to state… I have my current scenario and these symptoms…

Then we would probably start treating symptoms." [Female, age 46, experience 27 years, risky environments course].

Decontamination—a demanding and risky situation

Risk management

One challenge in managing risk was obtaining an overview of the situation and gaining sufficient information about the chemicals involved. It was stated that initial decisions were based on what was visible at the incident site. However, this could be treacherous as some chemicals, e.g., gas, are invisible and, therefore, very hard to detect. Participants were better acquainted with chemicals such as petroleum products, but they were more uncertain when facing batteries and corrosive materials.

"If we don't know what it is about, it will be very difficult to think about what the consequences may be… But you have to keep in mind that it can have many consequences when we don't know what it is about and what the consequences are for the patients." [Female, age 29, experience 4 years, no risky environments course].

It emerged that managing risks onsite at the C-incident was crucial for EMS work procedures and often posed several challenges. One challenge was that all EMS nurses were responsible for their safety and should not act in any way that could expose themselves, or others, to unnecessary risks.

Participants said that undressing and washing the patient with water was essential. However, EMS nurses could not be responsible for the decontamination, as they do not have any equipment. Thus, they rely on rescue service personnel to carry out the decontamination. The degree of decontamination required depends on what chemical was involved and the patient's condition.

"…Even if they (patients) are in a bad condition, you have to… decontaminate and get them into the ambulance… Some corrosive substances cannot be rinsed off with water only, since water can aggravate the corrosion even more. You have to find out what kind of corrosive substance they have on their body and how we… get off the clothes…" [Male, age 54, experience 30 years, no risky environments course].

The participants described solutions to prevent secondary contamination, such as wrapping the patient in sealing material (e.g., bubble wrap or blankets) before transport. However, depending on how critical the patient's condition was, the decision was not easy, and participants described being uncomfortable about transporting a patient unless they had been decontaminated in some way.

"…we have to prioritize, scrub with soap and water, and they will be wrapped in blankets and transported. Then you get to find out about these chemicals and how they… yes, so that we are not affected…" [Male, age 54, experience 30 years, no risky environments course].

A challenge related to risk management that was described as frustrating was the complicated task of clearing the uninjured and bystanders from the incident site, as they could make the situation even worse. A general experience expressed by participants was that some bystanders did not listen to them. Participants described that they tried to position the ambulance so that it would hinder people from accessing the incident site or tell them to evacuate to a safe area. The fact that some bystanders intentionally put themselves at risk and were unaware of the potential consequences was highlighted as a problem.

"…today they don't care in what we have to say, and it is up to the police to remove them… we have an obligation to warn and inform them but if they don't care about what we have to say they have themselves to blame. Everyone is responsible for their own actions, and it is up to the police to remove them. It's not our job, we can only warn them." [Male, age 54, experience 30 years, no risky environments course].

Work in protective gear

It emerged that the EMS's everyday work wear was not suitable to work at the scene of a C-incident, although this was what would happen if they were dispatched to a C-incident. It was stated that protective gear was rarely included in ambulance inventories, and thus, participants described that EMS nurses generally lacked the equipment to handle chemical substances if they dispatched to a C-incident. Moreover, it was described and experienced that working in protective gear was difficult.

"…no, we do not have much protective gear… the equipment we have and could use is at the ambulance station and we are already out on the roads and do not have the opportunity to take it with us, so we have no protective equipment." [Male, age 27, experience 7 years, no risky environments course].

Regarding what level of protective gear is required for the EMS nurses at the incident site, participants highlighted consideration of what chemical substances personnel might be exposed. The chemical substance at play will guide decisions as to the required level of security. However, having access to adequate protective gear and equipment in the ambulance vehicles was something participants requested. Participants stated that corrosive substances were the most hazardous and difficult to handle without proper protective gear.

When working with chemically contaminated patients, the ambulance and the protective gear the EMS nurses wear may become contaminated, requiring careful decontamination before the ambulance vehicle can be used again. It became clear during the interviews that the process of decontaminating an ambulance differed depending on who in the EMS crew was responsible. Lack of information on how this procedure should be done was the reason. The respondents said they experienced that the Emergency Department had more elaborate routines for decontamination.

"...you have to be aware that if there was a chemical release, you have to be conscious of how you remove this. Then what do I do with this substance, it's not just throwing it in the trash." [Male, age 55, experience 30 years, risky environments course].

Aggravating circumstances

Exposure to chemicals, especially those in batteries, gases, or corrosive substances, makes any situation more difficult. Risk of explosion, fire/smoke, and unknown gas were named "no-approach" risks. Participants referred to no-approach risks posing such a great threat that patients could not be approached safely. However, no-approach situations could vary. For example, approaching vehicles with battery packs—such as hybrid or electric cars—should be done cautiously.

"We are very concerned about safety because we are our own safety representatives as well. In that way, we do not approach something that is not safe." [Male, age 31, experience 6 years, no risky environments course].

Another example of the complexity of no-approach risk that came up during the interviews was assessing patients in potentially deadly situations, e.g., in a burning vehicle, in trucks carrying unknown cargo, or in a hazardous environment. Participants stated that one way to manage the risks of the situation was to try to have the patient evacuate on their own. However, actions not in line with no-approach risks were described in a scenario where this was not possible. One suggestion was that despite the awareness of the risk and consequences it may have for their own safety, they would run to the scene and try to pull the patient out of the burning vehicle into the safe zone. However, it was also stated that it would never be acceptable to take such risks and attending to patients should always be done in accordance with standardized working procedures. Once the patient was in the safe zone, participants were confident in their ability to examine patients using the tool for rapid patient assessment used in non-chemical injuries.

DISCUSSION

The main findings are that EMS nurses perceive a lack of support when arriving at the scene of an emergency. The legislation concerning workplace safety needs to be proactively reviewed to prevent any EMS nurses from being injured or losing their health or lives due to inadequate equipment. Compared with the rescue service, the role of EMS at the scene depends on the first ambulance arriving at the incident site. Thus, the experience of the crew in the ambulance could be insufficient. EMS personnel did not feel confident at the scene without rescue services. In the case of an ambulance being the lone first responder and no rescue service yet on site, EMS personnel must be able to handle the situation. Responding to C-incidents means stressful responsibilities and difficult decision-making, adding to an already challenging situation. These findings correspond to previous studies that show that the treatment of chemically effected patients in the field needs to be improved (Maguire et al., 2007; Phelps, 2007; Jama & Kuisma, 2016).

The results of this study also state that EMS protective gear needs to be improved. The result reveals that EMS nurses must adopt more extensive safety measures on-scene at a C-incident than are usually required. The participants described this as not easily attainable, as most ambulance vehicles do not carry extended safety equipment. Furthermore, the results show that personal protective gear was unsuitable for protection against chemicals and was not easy to work in when performing standard work procedures. It is argued that standard EMS protective gear will provide little protection against chemical contamination (Monteith & Pearce, 2015). The legislation concerning workplace safety needs to be proactively reviewed to prevent any EMS personnel from getting injured or losing their health or lives due to inadequate equipment. Not being able to access a C-incident in a safely would critically delay the management of patients and intensify the stress placed on EMS nurses. An aspect that needs to be considered is that working in chemical protective gear is challenging (Wiyor et al., 2020). Appropriate protective gear in the ambulances and periodic scenario training with protective gear would contribute to EMS nurses' safety at the incident scene and faster management and treatment of patients.

Another result is that an early start to the decontamination procedure was stated as essential for both patient health and response effectiveness. However, this result indicates that an incident in a rural area complicates an early start due to prolonged transportation time. It is unclear, however, how the condition of rural areas impacts the amount of time a patient is in contact with a contaminant (Ingrassia et al., 2014). Additionally, previous studies also indicate that patients in rural areas have higher overall prehospital mortality following injury, and mortality risk increases with the degree of ruralness in which a patient is situated (Jarman et al., 2019; Keeves et al., 2019). Specific knowledge of the relationship between the health of the decontaminated patient and the specific chemicals and time to treatment needs to be included in training personnel to support effective response.

The results also suggest that working procedures involving electric vehicles were laced with uncertainty, and the initial response needed to be handled carefully. As incidents with electric vehicles are becoming more common, and EMS nurses are uncomfortable with this situation, this issue calls for further attention. Since there has been limited research in this area, more research is needed to map out the potential dangers for EMS personnel when working with patients involved in an incident with electric vehicles (Thermaenius et al., 2022; Liu et al., 2023).

Another point in the result highlighted stressful responsibilities. The results show that mentally adapting and preparing for a specific situation would help EMS nurses handle the stressful C-incident and improve their ability to feel confident about the situation. Studies have shown the importance of coping strategies in handling stress, especially when it comes to preventing Post-Traumatic Stress Disorder PTSD (Hruska & Bardhun, 2021). Furthermore, acute negative stress has also been proven to lower the quality of EMS personnel's decision-making and patient care (Regehr & LeBlanc, 2017; Eiche et al., 20191). Whether the training given to EMS personnel (Mackway-Jones 2014) provides resources such as knowledge and capability in coping with the situational demands of C-incidents has not yet been evaluated.

Methodological considerations

This study used a qualitative design (Graneheim & Lundman, 2004; Graneheim et al., 2017). In qualitative design, trustworthiness is a central concept of the analysis, which, in turn, summarizes the different aspects of credibility, dependability, and transferability (Lindgren et al., 2020).

The fact that an expert group of researchers constructed the four vignettes and that the researchers participated throughout the analysis process strengthened the dependability of this study. Using vignettes to explore participantsÕ experiences of work procedures in C-incidents increases the result's credibility.

A purposive sample of participants who had participated in a training course in risky environments increased the study's credibility. However, snowball sampling is reliable, as all Swedish EMS nurses might be dispatched to a C-incident.

Because most EMS nurses do not have experience with C-incident response, the vignette-based interviews and the interaction between the interviewer and the participant strengthen credibility. The interviews were thorough and contained extensive stories with rich and detailed insights about C-incident response. However, in qualitative research studies, it can never be excluded that another study cohort, the timing of the data collection, or the vignettes forming the basis of this study might have influenced the results.

The description of the participants' demographics and experience increases the possibility for the reader to decide on the relevance of transferring the results to another context. A clearer description of previous work experience could have increased transferability.

CONCLUSION

The results of this study show that EMS nurses face many challenges when handling a C-incident, such as a lack of support and protective gear and insufficient knowledge about particular C-incidents (e.g., electric vehicles or incidents in rural areas). All these challenges impact EMS nurses' feelings of insecurity related to C-incident response. Training that improves preparedness and the ability to respond adequately, such as collaboration exercises is requested, which also emphasizes the need for research in multidisciplinary fields to fill the knowledge gap of EMS nurses' work procedures regarding chemical incidents.

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