The Role of Pre-Incident Information and Responder Communication in effective management of casualties, including members of vulnerable groups, during a Decontamination Field Exercise

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Abstract

During a CBRNe incident, it is essential that those affected are decontaminated as quickly as possible. Factors which may enhance the speed with which decontamination can be carried out include the provision of pre-incident information to members of the public, an effective responder communication strategy, and consideration of the needs of all those affected. In the current study, we ran a field exercise involving mass decontamination in response to a simulated chemical incident. The study aimed to understand the role of responder communication, the needs of vulnerable individuals, levels of compliance, and the impact of pre-incident information, during decontamination. Eighteen participants took part in the exercise with nine participants having vulnerabilities. Participants completed pre-exercise and post-exercise questionnaires and took part in a post-exercise focus group. Participants' and responders' behaviour was also observed during the exercise. Results showed that participants reported issues associated with both practical aspects of responder communication (e.g., background noise) and overall responder communication strategy and stated that poor communication from responders would have led to less compliance in a real incident. Vulnerable individuals reported that their needs were not always met, with issues including poor physical and communication-related support, and a lack of consideration for functional aids. However, participants reported positive perceptions of the actions in the pre-incident information. Overall, this research suggests that effective management of a chemical incident must include an effective communication strategy (both before and during an incident) and consideration of the needs of vulnerable individuals.

Keywords: Communication, Vulnerability, CBRNe, Incident, Decontamination, Exercise.

1.Introduction

Chemical, biological, radiological, nuclear and explosive (CBRNe) incidents, through either accidental or deliberate release, pose a global threat and security concern (EU

Parliament, 2021; Malizia, 2016). The persistent threat of CBRNe incidents can be attributed to advancements in technology and science, easier dissemination of information, and increased travel of people and goods (EU Parliament, 2019). Among the different CBRNe substances, it has been suggested that chemical agents are the most likely to pose a threat (EU Parliament, 2021). In the event of a chemical incident, decontamination is an intervention that can be employed by emergency responders. Decontamination aims to remove the contaminant from the skin and hair of those affected, with various methods employed including use of absorbent materials to soak up the contaminant or use of water to flush the contaminant from the skin. Effective decontamination reduces harm posed by contact with the contaminant, and also reduces the spread of the contaminant to other people and places. Delays or failure to conduct decontamination can result in greater numbers of casualties (Collins et al., 2021). Therefore, it is essential that casualties are decontaminated as quickly as possible. Factors which may improve the speed and efficiency with which decontamination can be carried out include: providing pre-incident communication to members of the public about decontamination actions; ensuring that emergency responders communicate effectively with members of the public during a decontamination incident; and considering the needs of all of those affected, including members of vulnerable groups, when planning for incidents involving mass decontamination. These three factors are described in more detail below.

1.1. Pre-incident information

One way to improve the speed with which decontamination can be conducted is to provide members of the public with pre-incident information about actions that they can take to reduce their risk from CBRNe agents; these actions can be taken immediately by members of the public, prior to the arrival of specialist responders and equipment. Such actions include

removal of outer layers of clothing and removing any contaminant from the skin using either dry absorbent materials or an available water source.

Previous research has examined the potential role of such pre-incident information in improving public preparedness to take actions during the early stages of a CBRN incident (Carter et al., 2019; Carter et al., 2020a; Carter et al., 2021). In the UK, the REMOVE campaign has been developed to provide members of the public with three specific actions that they can take during the early stages of a chemical incident: remove themselves from the immediate hazard, remove their outer layers of clothing, and remove the contaminant from their skin (National Ambulance Resilience Unit, 2018). Research into public perceptions of REMOVE shows that the information significantly increased public knowledge and confidence associated with taking action during a CBRNe incident (Carter et al., 2019; Carter et al., 2021) and that members of the public wanted to receive this type of information in advance of a chemical incident occurring (Carter et al., 2021).

Similar pre-incident information has been developed and evaluated as part of the EU Horizon 2020 PROACTIVE (PReparedness against CBRNE threats through cOmmon Approaches between security praCTItioners and the VulnerablE civil society) Project (see Supplementary Materials; Nicolson et al., 2021). Focus groups showed that this pre-incident information was perceived positively by the public and increased confidence and knowledge of actions to take during a CBRNe incident for up to 6 months after the information was presented (Nicholson et al., 2021). However, previous research into pre-incident information for chemical incidents has used hypothetical scenarios, rather than simulated incidents, and may therefore have lacked ecological validity (making it difficult for participants to accurately visualise how they would experience decontamination or how useful the pre-incident information would be).

1.2. Effective communication during an incident

While effective pre-incident information is likely to be key to improving speed and efficiency of decontamination, it is also essential that responders communicate effectively with members of the public during the incident itself. Effective communication strategies require responders to: i) convey practical information about the decontamination process that informs the public of actions to take during decontamination (e.g., how to wash in the shower) (Carter et al., 2012; Carter et al., 2013a; Carter et al., 2013b; Carter et al., 2014; Carter et al., 2015a); and, ii) communicate openly and honestly with members of the public (Carter et al., 2013b; Carter et al., 2014). During a CBRNe incident effective communication from responders which incorporates these two aspects is vital in increasing public willingness and ability to take recommended actions (Carter et al., 2015b), and in improving the speed with which decontamination can be carried out (Carter et al., 2014). Effective communication is also likely to increase perceived legitimacy (Carter et al., 2013b; Carter et al., 2014; Carter et al., 2015a) and competence (Long et al., 2022) of emergency responders, reduce confusion about actions to take (Carter et al., 2012, Carter et al., 2014), and reduce public anxiety (Carter et al., 2015a).

Effective communication can led to greater compliance with responders. In a large decontamination exercise, Currie and Heslop (2012) found that casualties reported a lack of communication from responders that led to casualties not knowing what instructions to take and in turn non-compliance. Another key reason that effective communication increases compliance with decontamination instructions is that it increases shared identification between members of the public and emergency responders (Carter et al., 2014, Carter et al., 2015a). The social identity approach suggests that people have both personal and social identities, and that different identities can become meaningful in different contexts (Tajfel & Turner, 1979; Turner et al., 1987). While shared identification is likely to develop spontaneously among members of the public during disasters and emergencies, as a result of

the sense of common fate that they all face (Drury et al., 2009), it is also important that members of the public identify with the emergency responders managing the incident. Shared identification has a range of benefits, including internalisation of shared goals (Drury et al., 2019), a sense of collective agency (a belief that people can work together to achieve shared goals) (Haslam et al., 2009), and increased motivation to help and cooperate with other group members (Drury et al., 2009); these are all key factors which are likely to improve speed and efficiency of decontamination, and therefore it is important that members of the public identify with each other, and with the responders managing the incident (Carter et al., 2015b, Carter et al., 2020b).

1.3. Considering the needs of vulnerable groups

When planning for quick and efficient decontamination, it is essential that the needs of all of those affected are considered. During CBRNe incidents, some people will have greater needs than others, and will therefore be more vulnerable. In the context of decontamination, vulnerable individuals will include those with: i) increased physical needs (e.g. anything that may make it more difficult for them to physically undergo decontamination); ii) increased communication needs (e.g. anything that may make it more difficult for them to see, hear, or understand instructions provided); iii) increased social or cultural needs (e.g. any social or cultural needs that may make certain aspects of the decontamination process more difficult); and iv) increased medical or health needs (e.g. anything that may make someone more susceptible to the effects of the contaminant, or put them more at risk during the decontamination process) (Carter & Amlôt, 2016). During emergencies standard resources are not always accessible to vulnerable individuals (Wingate et al., 2007), and it is therefore essential that planning for such incidents includes specific strategies for those with additional needs. Indeed, several recommendations have been made for incorporating needs of vulnerable individuals when planning for decontamination,

including: asking each individual if they have any additional needs; treating each person as an expert in their own needs; providing support and assistance to those who may physically struggle with decontamination; and providing information in different formats such as sign language and pictograms (Carter & Amlôt, 2016; Carbon et al., 2022a).

However, reviews of guidance documents for incidents involving decontamination show that limited attention has been paid to planning for the needs of vulnerable individuals during CBRNe incidents (Carter & Amlôt, 2016; Davidson et al., 2021). Hignett et al. (2019) conducted a systematic review on CBRNe events including vulnerable individuals and found limited inclusion of vulnerable individuals and when vulnerable are included there are communication and mobility issues. Recent research supports this, demonstrating that CBRNe practitioners rarely consider vulnerable individuals in communication strategies and make few adaptions in communications for vulnerable individuals (Arnold et al., 2021; Carbon et al., 2022a), and that vulnerable individuals are not included in training (Arnold et al., 2021; Havarneanu et al., 2022).

In order for decontamination to be quick and efficient (and therefore to save lives) members of the public must know what actions are required of them and be willing and able to take recommended actions. To achieve this, responders must communicate effectively, both before and during an incident, and the needs of members of vulnerable groups must be considered. However, as noted above, research into public perceptions of pre-incident information has lacked ecological validity, and the needs of vulnerable individuals have not been thoroughly considered in planning and training for incidents involving decontamination. We therefore aimed to address these aspects in the current study.

1.4. The Current Study

In the current study, we ran a field exercise involving the release of a chemical substance and subsequent decontamination of volunteer members of the public. This exercise

was run as the first of a series of exercises as part of the EU H2020 PROACTIVE project, which aims to enhance CBRNe incident response by preparing both emergency responders and members of the public, including members of vulnerable groups, to respond to CBRNe incidents. Field exercises represent a unique opportunity to gain insights into public perceptions and experiences of decontamination, including experiences of undergoing decontamination, perceptions of responder management, and interactions between members of the public and responders. Given that the needs of vulnerable individuals have previously been overlooked during exercises and training, we aimed to include a minimum of 15% of participants with additional needs within the sample (Carbon et al., 2022b). We also aimed to extend previous research by examining public perceptions of previously developed pre-incident information (Nicholson et al., 2021) in a setting with high ecological validity.

We evaluated public and responder experiences and behaviours during the exercise using a variety of different methods including pre- and post-exercise questionnaires, observations during the exercise, and post-exercise focus groups. In doing this we had four aims. First, to understand the experiences of members of vulnerable groups, including evaluating responders' ability to identify and assist those with additional needs. Second, to assess participants' perceptions of the previously developed pre-incident information. Third, to replicate previous findings (Carter et al., 2013a) in identifying and examining the ways that responders communicate with the public and the public's perception of responder communication in Germany. Last, to replicate previous findings (Carter et al., 2015a) to assess if perceptions of responder communication, practical information, identification with responders, and responder legitimacy predict compliance during the decontamination process. Carter et al.'s (2015a) whole model was not replicated in the current study due to sample size constraints.

2.Method

2.2.Exercise Scenario

The exercise took place in a city in Germany and involved decontamination of civilians following a hypothetical chemical incident resulting from a leaked freight wagon near a Public Train Station. The unknown chemical substance was simulated with a machine generated fog. Decontamination was carried out by a specialist unit from a city in Germany using local operating procedures for mass decontamination. The decontamination showers were set up prior to the start of the exercise and had two lanes, one for ambulant casualties (those who were not seriously injured in the incident and were able to walk through decontamination) and one for non-ambulant casualties (those who could not walk through decontamination either due to an injury caused by the incident or to pre-existing impairment). The ambulant lane involved casualties walking through and washing themselves whereas, in the non-ambulant lane, casualties were taken through decontamination on a stretcher and washed by responders. The exercise took place in May 2022 and lasted approximately an hour. We used a mixed methods design to evaluate the exercise, including pre- and post-exercise questionnaires, exercise observations, and post-exercise focus groups.

2.1.1. Pre- and Post-Exercise Questionnaires

Participants were asked to complete a pre-exercise questionnaire immediately prior to the exercise, and a post-exercise questionnaire immediately after the exercise. Each questionnaire took approximately 10 minutes to complete. Questionnaires were completed in German and were subsequently translated into English for analysis.

2.1.2. Focus Groups

Three focus groups were carried out with participants immediately after they completed the post-exercise questionnaire. Each focus group included 4 – 8 participants and lasted between 23 and 78 minutes. Focus groups were carried out in German, to ensure all participants could share their experiences, and were then transcribed and translated into

English. The focus group guide was piloted in a tabletop exercise in April 2022; see Supplementary Materials for further information about the pilot.

2.1.2. Observations

During the exercise, four evaluators collected observational data at three different locations: 1) at the incident site (prior to decontamination); 2) in the Disrobe Area (one observer stationed inside the Disrobe Area of the Decontamination Unit); 3) in the decontamination shower (one evaluator observed decontamination processes in each side of the Decontamination Unit). To facilitate observational data collection, an observation framework including behaviours of interest was developed. Start and finish times of decontamination were also recorded.

2.2 **Participants**

In total, 18 participants took part in the exercise, 5 men and 13 women ranging from 21 to 66 years old (M=39.33, SD=15.30). A priori power calculation was not possible due to restrictions on the number of participants able to attend. A sensitivity power analysis was conducted on G*Power (Faul et al., 2009) that indicates our obtained sample provides 80% power to detect a large effect in a one-sample t-test (d=0.61) and a large effect size for a regression with four predictors (f^2=0.95), both with alpha at 0.05. Nine participants had vulnerabilities including: visual impairments (n=4), hearing impairments (n=2), older age (n=1), physical impairments (n=1), anxiety (n=1), and asthma (n=1). Participants were recruited through advertisements in local newspapers, universities, and sports clubs as well as through social media.

2.3. Materials

All materials are included in the Supplementary Materials.

2.3.1. Pre-Incident Information

Participants were provided with pre-incident information (based on information developed previously by Nicholson et al. 2021, but with the addition of pictograms) two weeks before the exercise. Prior to the exercise the pre-incident information, including pictograms, was assessed through Patient and Public Involvement focus groups which led to some modifications; see Supplementary Materials for the pre-incident information.

2.3.2. Pre-Exercise Questionnaire

The pre-exercise questionnaire contained measures of participants': confidence and knowledge in actions to take during this type of incident; perceived responder legitimacy; expectations of help from other participants; willingness to help others; identification with other participants; identification with responders; level of anxiety about the exercise. Participants were asked "Did you read the pre-incident information for CBRNe incidents?" if they responded "yes" they then answered six questions on their perceptions of pre-incident information (efficacy of information, ease of taking recommended actions, willingness to take recommended actions, comfort in taking recommended actions, embarrassment associated with taking recommended actions, and desire to seek further treatment), if they answered "no" they did not answer these six questions. All items were rated on a scale from 1 (Strongly agree) to 7 (Strongly disagree) and all measures had high reliability (α=0.77-0.97). See Table 1 for details about measures.

2.3.3. Post-Exercise Questionnaire

The post-exercise questionnaire contained measures in the following order: confidence and knowledge in actions to take during this type of incident; accessibility; perceived responder legitimacy; expectancy of help from other participants; willingness to help others; levels of anxiety; identification with other participants; identification with responders; pre-incident information (effective, comfortable, embarrassed, easy, willing, seek further treatment); collective agency; perceptions of responder communication; perceptions

of communication messages; perceptions of practical information; perceived responder competence; perceptions of privacy; perceptions of co-operative behaviour among participants; engagement in the exercise; and expectations of compliance. All items were rated on a scale from 1 (Strongly agree) to 7 (Strongly disagree) and all measures had high reliability (α=0.64-0.98). See Table 1 for details of the measures used. The questionnaire also included three yes or no questions in the post-exercise questionnaire ("I went through decontamination in the exercise"; "Did you use the pre-incident information during the exercise?" and "Did you discuss the pre-incident information with other volunteers during the exercise?"). It also included a series of open-ended questions covering accessibility, levels of anxiety, perceptions of the pre-incident information, perceptions of responder communication, and compliance.

2.3.4. Focus Group Guide

The focus group guide contained questions relating to participants' experiences and perceptions during the exercise, including: perceptions of the pre-incident information; perceptions of responders' ability to understand and respond to vulnerabilities; perceptions of responders' ability to manage the decontamination process; perceptions of responders' interactions with participants; and experiences of the decontamination process in general.

2.4.5.Observational Framework

The observational framework captured all behaviours of interest, including a) responder to participant interactions (physical assistance, manhandling, interaction between responders and participants, and identification and assistance of vulnerable people) and b) participant to participant interactions (physical assistance to and/or from other participants, interaction between participants, washing behaviour, non-compliance, identification, and assistance to vulnerable people). These behaviours were recorded by evaluators at each exercise location. The framework enabled behaviours of interest to be captured in a more

standardised way by the evaluators who were capturing observational data. The observational data was collected in English so no notes were gathered on the content of communication.

2.4. Procedure

Ethical approval was gained before the day of the exercise through UK Health Security Agency's Research Ethics and Governance Group (R&D 504). Individuals who were interested in participating in the exercise emailed the exercise registration email. After a basic selection process, which considered, among other things, the distance to the exercise location, everyone received a registration email. The exercise information as well as the pre-incident information was sent to participants approximately two weeks before the exercise. Participants were given a brief about what would happen during the exercise, signed consent forms, and then completed the pre-exercise questionnaire. Participants were then led onto the exercise site by exercise organisers. At the start of the exercise disco fog was released from a freight train to simulate the release of a chemical contaminant. Participants then took part in the exercise, including undressing except for swimwear and undergoing decontamination. After participants had been through decontamination they were approached by a responder who handed them towels and conducted an assessment, following this the exercise ended and participants were then taken to an area where they could change out of their swimwear. As each participant completed the exercise, they were assigned to a focus group. At that point, each participant completed the post-exercise questionnaire before taking part in a focus group discussion. Participants were given a €30 voucher for local shops in exchange for their participation.

2.6. Data Analysis

The quantitative data from the questionnaires were analysed using descriptive statistics and one-sample t-tests to explore perceptions of the pre-incident information, perceptions of responder communication, and the impact of participants' vulnerabilities.

Paired sample t-tests were then conducted to assess any differences in participants' perceptions, understanding, and identification with other participants and emergency responders from before to after the exercise. We then ran Linear regressions to identify predictors of compliance and a Pearsons correlation to assess relationships between variables. The open-ended questionnaire responses, observational data, and focus groups were analysed using framework analysis, a qualitative thematic approach that is often used in research that has implications for policy (Pope et al. 2000; Ritchie & Spencer 1994). Five steps of framework analysis were conducted (Ritchie & Lewis 2003): familiarisation with the data; identifying initial codes relevant to the research; indexing broad themes; charting the data into an analytic framework; and defining and clarifying themes in relation to other themes. The first author (AD) conducted the analysis for open-ended questionnaire responses, observational data, and focus groups. The focus groups were also coded by HC to ensure consistency and reliability. After data analysis, some of the team then met to discuss any discrepancies between coders and the framework. Data saturation of themes was not achieved in the three focus groups, data saturation was measured by group (e.g., Hancock et al., 2019). There were limits on the number of participants in the exercise, therefore, we were unable to recruit more participants and conduct more focus groups. However, due to the topic of the focus groups centring around experiences it is possible that data saturation may not have been reached with more participants (Braun & Clark, 2021), particularly in the case of vulnerable populations as there may be vulnerabilities that differ from those in our sample that may have different experiences. Vulnerability saturation was also not achieved as we were not able to recruit all vulnerabilities (e.g., children, pregnant people) or even number of all vulnerabilities.

3. Results

3.1. Quantitative Data

3.1.1. Descriptive Statistics. In the pre-exercise questionnaire, seven participants (43.8%) reported that they had read the pre-incident information while nine participants (56.3%) reported that they had not read the pre-incident information. In the post-exercise questionnaire 6 participants (33.3%) reported that they discussed the pre-incident information with other participants during the exercise and 12 participants (66.7%) reported that they did not discuss the pre-incident information during the exercise. Of the participants that had read the pre-incident information, we ran a one-sample t-test to assess whether each item relating to pre-incident information was significantly different to the scale midpoint (see Table 2). The results showed that five out of six items (willingness, comfort, efficacy, ability, and desire to seek further treatment) were significantly higher than the scale midpoint. Therefore, participants who had read the pre-incident information indicated that they would be comfortable, willing, and able to take the actions in the pre-incident information and perceived the actions in the pre-incident information to be an effective way to decontaminate, though they would still want to seek further treatment.

In the post-exercise questionnaire, all 18 participants reported that they went through the decontamination shower. We used one-sample t-tests to examine whether the following variables were significantly higher than the scale-midpoint of 4: the two accessibility questions (accessibility impacted interactions with first responders; accessibility impacted ability to undergo the decontamination shower), responder communication, perceptions of practical information, identification with participants, emotional engagement in the exercise, seriousness with which participants took the exercise, identification with responders, expected compliance with responders' instructions, expected compliance with decontamination, perceptions of privacy, perceived responder legitimacy, and perceived responder competence. The results are shown in Table 2. The results showed that the following variables were significantly higher than the scale midpoint: impact of

vulnerabilities on interactions with emergency responders, perceptions of practical information, seriousness with which participants took the exercise, identification with other participants, expected compliance with responders' instructions, expected compliance with undergoing a decontamination shower in a real incident, perceived responder legitimacy, and perceived responder competence. Whereas the following variables were non-significantly different to the scale midpoint: impact of vulnerabilities on ability to undergo a decontamination shower, perceptions of responder communication, emotional engagement in the exercise, identification with responders, and perceptions of privacy.

3.1.2. Difference between Pre-Exercise and Post-Exercise. Paired samples t-tests were conducted to assess the impact of the exercise (pre-exercise vs. post-exercise) on the six pre-incident information items, participants' confidence and knowledge, perceived responder legitimacy, expectancy of help, helping others, identification with responders, and identification with other participants. See Table 3 for the results.

The results showed that there were significant differences between pre-exercise and post-exercise questionnaires for confidence, knowledge, and identification with responders, and marginal significance for perceived responder legitimacy. At post-exercise, participants reported significantly higher confidence and knowledge, significantly lower identification with responders, and marginally lower perceptions of responder legitimacy compared to pre-exercise. There were non-significant differences for all six pre-incident information items, expectancy of receiving help, helping others, and identification with other participants. Therefore, the exercise increased confidence and knowledge of actions to take and reduced identification with responders and perceived responder legitimacy. The exercise did not impact perceptions of the pre-incident information, identification with participants, or expectancy of helping others or receiving help.

3.1.3. Predictors of Compliance. Two regressions assessed whether responder legitimacy, responder communication, practical information, and identification with responders predicted compliance with responders' instructions and compliance with decontamination, respectively. The results (see Table 4) for both models were non-significant showing that perceived responder competence, responder communication, practical information, and identification with responders did not predict expected compliance with responders' instructions or with undergoing a decontamination shower.

3.1.4. Correlation between Variables. To assess relationships between communication, identification, and compliance during the exercise a Pearson's correlation was run between confidence and knowledge, perceived responder legitimacy, expectancy of help, helping others during the exercise, identification with participants, identification with responders, anxiety, expected compliance, collective agency, perceptions of privacy, perceptions of responder communication, perceptions of practical information, and perceived responder legitimacy. All variables were from the post-exercise questionnaire.

The findings showed (see Table 5) that expecting help from members of the public was positively correlated with helping others during the exercise but negatively correlated with anxiety. Perceived responder legitimacy was positively correlated with perceptions of privacy and confidence and knowledge.

In terms of identity, identification with participants positively correlated with expectancy of help and collective agency but negatively correlated with anxiety. Identification with responders positively correlated with confidence and knowledge, expectancy of help, and collective agency, and negatively correlated with anxiety. Additionally, collective agency positively correlated with perceptions of privacy.

3.1.5. Quantitative Summary. Participants reported high confidence, willingness, and ability to take the actions in the pre-incident information. Taking part in the exercise had

no impact on perceptions of the pre-incident information but did increase participants' confidence and knowledge of actions to take. Taking part in the exercise also reduced participants' perceptions of responder legitimacy and identification with responders. Identification with other participants and responders was related to high expectancy of help from members of the public, higher collective agency, and lower anxiety. Last, perceptions of practical information were related to perceptions of responder communication.

3.2. Qualitative analysis

3.2.1. Open-ended Questionnaire Responses. Six open-ended questions were analysed that revolved around accessibility, levels of anxiety, pre-incident information, communication from responders, improvements to decontamination process, and compliance. See Table 6 for quotes associated with the themes.

For *accessibility*, participants were asked "please describe any ways in which accessibility impacted your ability to undergo a decontamination shower?" to which seven participants provided a response. The answers revolved around the ways in which accessibility impacted both ability to communicate during decontamination and ability to physically undergo decontamination. Communication with responders impacted accessibility due to vulnerabilities (e.g., hearing impairments) impacting communication with responders. It was also reported that emergency responders' failure to communicate effectively impacted accessibility. Some participants reported that their increased sensory needs generally impacted their ability to go through the decontamination process.

The next open-ended question focused on the underlying reasons behind participants' *levels of anxiety* during the exercise ("If you felt anxious, stressed or scared during this exercise, please describe what the main reason for this was") to which 10 participants answered. Several participants reported that they were scared because of their increased sensory needs, with this making it harder for them to know what was happening

around them. Another reason participants reported feeling anxious, scared, or stressed was due to the lack of communication by the first responders. Participants reported that a lack of information from the first responders led to discomfort, not knowing what to do, and feeling like no one cared. One participant reported experiencing a panic attack because of eye irritation and a lack of explanation about the cause of this.

Participants were asked if the *pre-incident information* would be useful to members of the public before an incident ("Do you think the pre-incident information would be helpful to the public if it was provided to people before this type of incident occurred?"). Nine participants answered, and all said that the pre-incident information would be helpful if provided prior to an incident. Five answered with just the word "Yes" and the other four said "Yes" and explained why. The reasons for why it would be helpful included knowing what to do in that situation and in case of a lack of communication from responders during an incident.

Participants were asked how *communication from responders* could be improved ("Please explain any ways in which you feel communication from emergency responders during the decontamination process could have been improved."). Nine participants responded with answers revolving around three areas for improvement: improved support for those with vulnerabilities, improved clarity of communication, and more information. Regarding vulnerabilities, it was reported that responders could have made adjustments to communicate with people with vulnerabilities better that included allocating one responder to a person with impairments for the whole exercise as each time the responder changed, they had to adjust to the participant's vulnerability. Second, improvements should be made to ensure that communication is clear and audible, with participants stating that it was difficult to hear the first responders over background noise. Third, participants stated responders needed to give more information about what would happen and why this would be

happening. Relatedly, participants reported that it was difficult to accept what responders said as they appeared to not know what was going on.

Participants were also asked about how responders could have made *improvements to the decontamination process* ("Please describe any ways in which emergency responders could have dealt with the decontamination process better."). Eleven participants responded with responses covering two areas for improvement: communication and general behaviour from first responders. Regarding communication, participants wanted better communication and more information from first responders. Regarding general behaviour, participants stated that first responders' behaviour could have been improved as they appeared uncertain about what they were doing. One way in which participants reported that responder behaviour could have been improved was through faster initial treatment of those affected.

In the final open-ended question around *compliance*, participants were asked "If you would not be willing to undergo a decontamination shower during a real incident or would not be willing to be naked inside the decontamination showers in a real incident, please explain why.". Four participants responded with two reasons for not wanting to undergo a decontamination shower: a lack of understanding about what would be involved and shame associated with undergoing the shower.

3.2.2. Observations. Three main themes were identified from the observational data: responder interactions with vulnerable individuals, communication from responders, and participant to participant interaction. For a description of the exercise from observational data see Supplementary Materials.

3.2.2.1. ***Responder Interactions with vulnerable individuals.*** Responders' behaviours towards vulnerable individuals are centred around three sub-themes: support, issues with support, and decontamination of mobility aids.

In terms of *support*, responders provided physical support to vulnerable individuals during the exercise. For example, a responder physically supported one of the blind participants to move away from the incident site. Furthermore, at the decontamination shower, multiple responders led the two blind participants to the ambulant showers first. Responders led these participants by hand through the decontamination showers and appeared to be communicating with them throughout. At re-robing, one participant appeared to be in distress sitting on the bench and one responder crouched down next to her holding her hand, appearing to be providing support. Another two responders stood around her while the first responder was holding her hand, then she was led out of the disrobing tent by the responder holding her hand.

However, despite the provision of support, there were some *issues with support* provided to vulnerable people. First, when responders led the blind participant through the ambulant shower she tripped over the ramp and started to appear distressed, possibly due to responders leading her too quickly. Indeed, both blind individuals appeared to tell the responders how to assist them in and out of the shower. Second, the first time the wheelchair user went through the decontamination shower, she was wheeled straight through, fully clothed and with the showers turned off. At re-robing she pretended to towel off, as if she was wet. The responders then took her through the non-ambulant shower properly, with her clothes off and the showers on. Third, one participant was hesitant with the responder physically assisting her in the first shower. The participant reacted with lots of headshaking, but the responder appeared to give a lot of explanation and she then allowed the responder to sponge wash her. In the second shower, she did not allow the responder to touch her and was instead given the sponge to use herself. At dis-robing, another responder tried to place a lanyard over her head, but she resisted and kept standing back. The responder tried two more times to put the lanyard over the participant's head and then gave her the lanyard to put over

her head. Additionally, during dis-robing, another responder tried to talk to the participant by touching her at which point she immediately leant away and then jumped further away from the responder. The responder then kept trying to get closer to the participant, as she continued to jump and step further away. This only stopped when the responder appeared to be told by another responder to stop trying to touch her. When being assessed in dis-robing, the responder got her to sit down by inviting her to sit down at a distance. Finally, before leaving dis-robing a responder tried to help her put on footwear by nearly touching her which caused her to move back.

Last, in terms of *decontamination of mobility aids*, it was also noted that the responders did not decontaminate vulnerable individuals' mobility aids. First, before the decontamination shower, a responder took away the sight stick from a vulnerable individual and this was not decontaminated. Second, the wheelchair was wheeled through last and was not decontaminated. These items were therefore returned to participants without having been decontaminated.

3.2.2.2. *Communication from Responders.* At the incident site, the firefighter that stood with the participants did not appear to communicate with them. The participants frequently approached responders whilst waiting at the initial incident site, but responders just held up their hands gesturing for participants to go back; communication at this stage therefore appeared to be very limited.

At dis-robing, responders appeared to guide participants on how to remove clothing. Furthermore, at dis-robing, there was at least one responder (up to three responders) to one participant. The responders appeared to be engaged and provided assistance, thus there were lots of responder to participant discussions and responders appeared to be joking and laughing with the participants. When dis-robing non-ambulant participants, responders appeared to display good engagement and communication. When non-ambulant participants

were waiting to be moved to the decontamination shower there was always one responder with them. Towards the end of the exercise there was less engagement and assistance from responders. Some responders had walked through the shower to re-robing. At one point there was one responder to six ambulant participants and after participants had been dis-robed and were waiting for the showers there were nine responders in dis-robing with none of them interacting with the participants. In the ambulant shower, there were in-depth discussions between responders and participants that included hand movements and pointing; responders appeared to be outlining how to shower. Responders washing participants appeared to interact calmly and patiently.

In the non-ambulant shower, responders were in constant discussion with the participants. When there was a wait, this was communicated by responders, for example, one non-ambulant participant had to wait for a second responder to become available so they could be lifted from the conveyor belt to the bench, the first responder kept communicating with the participant waiting to be lifted.

Overall, communication between responders and participants was very limited at the incident site, but responders appeared to be in continual communication with participants during disrobing and showering.

3.2.2.3. ***Participant to participant interactions.*** At the incident site, participants who were waiting to be taken to the decontamination shower were stood in a group and talked to each other. Participants also provided other participants with support at the incident site. This included physical support, such as participants helping another participant who was on the ground, one participant's wheelchair being pushed by another participant, and a wheelchair user giving her wheelchair to another participant. Participants also provided emotional support to each other, including holding hands, hugging each other, and calling to responders for help for another participant. While waiting to go into the shower, participants

talked and laughed with each other, and when in the shower, participants occasionally talked to each other. However, no participant-to-participant assistance was observed during showering. At re-robe, one participant attempted to reassure another participant by trying to put a hand on her shoulder, but she leaned away when touched.

3.2.3. Focus Groups. Five main themes were identified: accessibility, communication, responder management, participants helping other participants, and exercise artificiality.

3.2.3.1. Accessibility and Vulnerabilities. Participants discussed the impact of accessibilities, vulnerabilities, and impairments during the exercise. This revolved around four sub-themes: lack of support for different functional needs, neglect of those who were not vulnerable, functional aids, and suggestions for improvement.

Lack of support for different functional needs. Participants discussed a lack of support from responders, which revolved around: physical support, communication support, support for those with different social or cultural needs; and support for those with additional mental and physical health needs. First, in terms of physical support, participants stated that at points vulnerabilities were not identified: “And no matter if I simulate it or not, when I say I need water urgently, I need it. So at the end I did no longer feel taken care of. The vulnerability wasn't realized well.” FG1. Some felt that vulnerabilities were identified, but adequate physical support was not provided, for example when guiding a blind participant: “I was pushed again, the ramp up to the showers, someone came from the front and pulled me up. None of the fire fighters knew how to guide a blind person and that is shocking for me, honestly.” FG2; providing a stretcher for a wheelchair user: “One would have expected that the woman would be put on the stretcher, but no, the stretcher was there, [the] woman on the ground, the wheelchair, and nobody was doing anything.” FG1; or ensuring that the

decontamination shower was physically accessible for all: “It was narrow in some places, only for the slim people.” FG3.

Second, participants mentioned a lack of communication support and modification for participants with vulnerabilities. Participants mentioned that a lot of communication was given verbally and was not accessible to everyone: “But verbally they have given a lot of instructions. It was a lot of verbal communication and that is difficult for some people.” FG1; and that responders were not able to adapt communication: “Yes, you said a hundred times I can't hear anything, I am deaf and sometimes they haven't been very quick to find a different approach how to deal with people.” FG1. However, some felt that responders had made attempts to modify communication for those with different functional needs: “During the decontamination process one had the idea to write it down, which was a great idea.” FG1; though these were not always successful: “the other tried hand signs, which was a good approach but it wasn't clear what he meant.” FG1.

Third, participants discussed support for different social and cultural needs, including identifying that it is intimidating for female participants to be decontaminated by male responders: “My problem was also that as a woman, you get from one man to the next in a room with only men and there is not psychological support and they tell me there is no reason to be fearful. […] Of course, they are fire fighters but I was intimidated” FG1. One participant noted that they would have felt safer with female firefighters: “if just some women or psychologists were present I would have felt a bit safer.” FG1. Other social and cultural factors that participants felt needed further consideration included religious factors, particularly around undressing: “I imagine I am a Muslim woman of the same age, I don't know whether I would have undressed.” FG3.

Participants were more positive when reflecting on responders’ ability to manage different health needs, with one participant feeling that their physical health needs had been

addressed: “They could deal with respiratory problems. I told them that my eyes are burning and someone came with a bottle to help me.” FG1; and another highlighting the mental health support they had received: “During the shower I was hyperventilating and in that moment I felt very well taken care of.” FG1.

Neglect of those who were not vulnerable. Participants that were not vulnerable reported feeling neglected as responders focused more on vulnerable individuals: “I felt a bit neglected because it was clear that the emergency forces would focus more on the handicapped person.” FG3; and felt that everyone was affected during the incident: “Like we said before, when the focus is on a handicapped person or has other problems, the focus shifts away from those that are only "normally" affected.” FG3. One way in which participants that were not vulnerable reported feeling neglected is due to queues for ambulant showers: “What was strange, we were standing in queue and parallel there was nobody and I asked if we can move over as there is nobody waiting and they said no. When you are in a panicking situation and need a shower, I don't care what they have, whether I am handicapped or not.” FG2.

Functional Aids. Participants discussed several issues related to the use of functional aids during the exercise. First, it was noted that not all functional aids were returned after decontamination: “They took away my white stick and asked whether I absolutely need it. I said, when you help me, I don't need it. But then I thought I would get it back after decontamination, but it was gone.” FG2; others also shared concerns about not being given their functional aids back after decontamination: “I wouldn't recognize the person I would have given it to and to trust that we get technology back is difficult when there was the obvious problem with the wheelchair. I mean glasses are small, I don't know how the 2 blind people with their sticks, how that was going, but in a real emergency I would have feared for my technology.” FG1. Second, participants reported that the removal of functional aids led to them feeling concerned: “the moment the decontamination process had started, I took off

my devices and couldn't hear anything, I was really deaf and that has made me unsure a bit because I didn't hear what they were talking, what they were doing. I had to take off my glasses too and I couldn't see so well and I had the impression that the forces haven't had it factored in that it could be like that, i.e. that as participants we are extremely unsettled." FG1; "As hearing impaired the situation was absolutely a problem. What you said, during decontamination, without technology, in a real emergency situation I would have felt absolutely helpless." FG1. Last, participants questioned how responders would have managed other functional aids such as guide dogs that were not included in the exercise: "Until recently I had a guide dog, and if I had my guide dog with me, how was it supposed to work, to decontaminate the dog in the shower. My dog would have panicked in the shower." FG2.

Suggestions for Improvements. Participants suggested ways in which responders could have provided greater support to individuals with vulnerabilities, including: improved training, and buddy systems (in which a member of the public with vulnerabilities is supported through the decontamination process by another member of the public). Participants suggested that responders should receive more training on how to support vulnerable individuals: "Therefore, the fire fighters need training for people with handicaps." FG2; in order to respond effectively: "I would have wished that they had expected there is a deaf person and had developed ideas prior to the training about how to deal with it." FG1.

Second, participants suggested it would be beneficial to have one responder leading them through the exercise: "But in general the process in the shower, we were lead from one [responder] to the next. I think it would have been better, not only for the handicapped but for all, if the same person would have led us through the complete process." FG1. Participants suggested that having the same responder throughout the exercise so that they could more easily ask questions: "maybe one person should have the focus on one or two people, so that you have someone you could approach and ask" FG2; and so that they would not have to

repeatedly explain their vulnerability: “We were led from one to the other, so we had to explain it again and again. If we would have had just one contact person, we could have spared that.” FG1; “There are these different stations of the emergency forces and they transfer the person from one colleague to the next and I don't know whether they passed on the information about the handicaps.” FG3.

3.2.3.2. Communication. Participants’ perceptions of responder communication revolved around five sub-themes: poor responder communication, practical communication issues, good responder communication, impact of communication strategy, and improvements for communication.

Poor Responder Communication. Participants reported poor communication from the responders: “the communication between the fire brigades and those who participated in the exercise, I would have expected that it would be better” Focus Group (FG) 1; “The communication in the tent wasn't so good for me” FG3. Participants explained the communication from responders was poor because they did not provide any information: “We haven't had any information, we were only told to go into the corner, nobody paid attention to people who weren't doing well.” FG1; “the information was a bit rare.” FG3. Participants reported the information lacked in three key areas. First, responders did not explain what was happening in terms of the incident: “There was also no information about what had happened and what dangerous substance it is. At least I haven't realized it.” FG1; “And nobody explained anything, what is happening, none of the fire fighters” FG2. Second, that responders did not provide an explanation about why decontamination was needed: “It was just like you have to be decontaminated, but why and what contamination is wasn't explained.” FG1. Third, responder communication lacked practical information on the actions to take: “They just gave me the sponge and he only asked me whether I need help for the back and then he cleaned my back. But before I was just alone and he didn't explain

anything.” FG2; “The process, they didn't talk, I suddenly had the sponge on thighs and calves but very hesitant. There was no information and when they use the sponge it should be done more targeted, not only just like this. I didn't know what happened, there was not communication.” FG3. Participants stated that in order to get information from responders they had to ask for the information: “I have to ask for information. No problem, I can ask […] But at the same time I thought this is not my task.” FG1; “I have asked and then I got information and it was helpful. But I had to ask actively.” FG3.

Practical Communication Issues. Participants raised practical issues associated with communication from responders. Due to the responder’s gas masks, participants found it hard to understand what the responders were saying: “with the mask it was difficult to understand” (FG2). Additionally, participants also reported the responder masks made it difficult to know if responders were talking to them: “And then the problem with the communication started, because the problem gas mask, oxygen device, is he talking to me or not.” (FG1)

Good Responder Communication. Although participants largely reported poor responder communication, participants did note some positive aspects of responder communication during the exercise, focusing on two key areas. First, participants mentioned the positive tone of communication from responders, which included eye contact and clarity: “the fire fighters always made eye contact with me, spoke clearly, at least to me, and that was very good.” FG1; being empathetic “The fire fighter who got me at the location of the accident was very empathic, he was a bit younger and friendly, he told me that they are here, they will help us and nothing will happen to us.” FG1; and reassuring: “They told me they put me on the stretcher and he also calmed me down, made small talk” FG3. Second, participants stated that responders provided good communication during the decontamination process, including explaining what would happen and the actions participants should take: “When I was in the shower [it] was explained very well, what they are doing, washing my face, asked

me where I was mostly affected. The communication was very good." FG3.

Impact of Communication Strategy. Participants discussed the impact of the responders' communication strategies. Participants stated that the lack of information from responders would have caused stress and fear in a real situation: "Because people get hectic and stressed when they don't have information. If you explain it in the beginning nobody needs to be stressed." FG1; "in a real situation it would have been fear as there was no communication at all what had happened. I would have had fear as there was no information." FG1; however, this could have been avoided through responders providing better information: "I think an announcement would have calmed down the situation and the people." FG2. Participants suggested that poor communication would result in people leaving the incident site and not complying with responders' instructions: "Right, there was no communication. We were standing there and didn't know anything. If I were in panic, I would run away or go home." FG3. Conversely, it was suggested that greater communication from the responders would have fostered trust, which would have increased compliance: "[Responders] just arrived, pushed us to the side, encircled us as if we had done something wrong. […] when communication occurs it creates a basis for trust. That we feel perceived as humans. And not just get away." FG1.

Suggestion for Communication Improvements. Participants also discussed ways responders could improve communication. In general participants wanted more communication from responders: "I would have wished for more communication." FG3. In terms of practical improvements to communication, participants suggested the use of a megaphone to combat the difficulty of hearing responders through their mask: "with the mask it was difficult to understand. Therefore, someone with a megaphone outside the dangerous area would have been useful." FG2; and the use of visual cues: "I think in such a situation it wouldn't hurt if there were any signs or arrows." FG3. Participants also discussed

understanding the information and suggested that responders should explain what is happening and why: “In general, communication step-by-step, what is happening, what are we doing and why are we doing it.” FG2; and use simple language for example, not using terms like decontamination as people may not understand what it means: “to use simple language.” FG3; “would be easier if we wouldn't speak about contamination and decontamination. I don't know whether everyone knows what it meant.” FG3.

3.2.3.3. Responder Management. Participants’ views of the responders’ management of the incident included three sub-themes: coordination and organisation; competence; and legitimacy.

Coordination and organisation. Some participants felt that there was a lack of co-ordination and organisation among responders: “The coordination between the rescue forces was missing.” FG2, with some responders not appearing to have an active role: “I was surprised, there was this one guy from the fire brigades who pushed us back all the time and 4 people are standing at the fire brigades truck and do nothing. They haven't done anything and were just standing there.” FG1; “Many fire fighters were just standing around and were observers. They were just standing everywhere and not just at a central location.” FG3. However, other participants felt that responders were well-organised: “For me the general organization at the tent was well-organized. The decontamination process, the bracelets, taking off the clothes, in the tent it seemed well organized for me.” FG1.

Competence. Some participants suggested that responders didn’t appear to be competent in managing the incident: “a young guy from the fire brigades, he didn't know what he should do.” FG1; “In the beginning they have been very helpless in regard to the undressing. It took forever and I had the feeling they don't really know what to do.” FG3. Sometimes this incompetence resulted in negative consequences for participants: “Therefore they almost forgot to fix me on the spine board. I almost dropped.” FG3. However, other

participants suggested that they thought responders had behaved competently during the exercise: “I would have tried to escape. I tried to do that but the emergency forces had been very motivated to keep me there. It was rather good. They did know what to do.” FG3.

Legitimacy. As well as perceiving responders to be incompetent, several participants also felt that responders behaved in an unfair or illegitimate way and didn’t take care of their needs: “I didn't really [feel] taken care of.” FG1; “We are the victims and you could help us instead of shouting at us.” FG1. Participants reported that this perceived illegitimacy led to them being non-compliant: “Then we wouldn't try to escape. It is done out of desperation because you have the feeling you can't do anything in this situation. FG1. Participants also reported this illegitimacy led to experiencing negative emotions: “I was also strongly annoyed because I asked them several times and they just send me away. I didn't feel understood and eventually I was a bit annoyed because I go there, ask them questions, those are the people who are supposed to help and they just send me back.” FG1, and negative emotions that encompass a lack of shared identity with responders: “you felt excluded. It wasn't help, it was like we did something wrong, and we were just encircled, like encircled by the police force” FG1. However, other participants felt that responders treated them well during the exercise: “I was told that he is doing my back and the thighs, the legs and he told me that I have to clean under my arms. He paid attention. I felt clean.” FG3

3.2.3.4. Participants Helping Other Participants. Participants mentioned that other participants had helped them, or other participants, during the exercise: “Yes, even [participant] was providing help. Even she tried to help others.” FG3. It was also reported that participants behaved respectfully towards each other: “And mostly people are friendly with each other or respectful. I haven't observed anything negative.” FG3. Participant to participant help had a positive impact; one participant reported that without the help of another participant they would have felt alone: “If the nice woman, who was also affected,

wouldn't have been with me, I would have felt very lost at some points. As she was with me, she was my companion only by chance." FG3.

Participants suggested that other participants provided help because they were the majority compared to responders: "I think during the first situation we also provided help to each other. [It] worked well. We have been the majority compared to the 4 fire fighters." FG1; and because they acted well as a group: "In the area of the dangerous situation I also felt that we acted as a group." FG1.

3.2.3.5. Exercise Artificiality. Participants discussed the artificiality of the exercise and comparisons to behaviour during a real incident, and there were three sub-themes: artificial responder behaviour; unrealistic levels of compliance, and reduced emotion.

Artificial Responder Behaviour. Participants felt that there may be discrepancies between how the responders behaved in the exercise and how they would behave in a real incident. The first related to a perceived lack of urgency in responder behaviour: "Nobody was in a hurry. Would they be in a real emergency also so calm and relaxed?" FG2.

The second was that responders were too well-organised prior to the exercise, with the decontamination tent already set up: "the first emergency forces arrived and had to block the area, while everything else was ready and available. The question is what would have happened if we had to start from zero? What would have happened then? […] We have to be aware of that, the second part was well-organized because it was already prepared." FG1. However, another participant suggested responders may be more effective as in the exercise they are aware it is artificial, whereas during a real incident they will work more effectively: "I can imagine that due to the seriousness they will work even more targeted" FG3.

The last point relating to responder behaviour was that responders may have exerted more control if the incident was real as they would have worked harder to stop participants

getting through barriers: “I think in a real situation they wouldn't let us get through the barriers and would stop us more actively.” FG3.

Unrealistic levels of Compliance. Participants mentioned that if the incident had been real, they would not have complied with the responders and would have tried to leave the incident site before decontamination: “In a real situation you don't stay there, you don't go into the building. I would have tried to escape.” (FG3). Participants gave different reasons for wanting to leave the scene including fear: “I could imagine that someone would panic and run away before decontamination.” FG3; and not wanting to wait for the decontamination tent to be set up: “I would have escaped earlier because there would have been time enough to disappear. It would have been wrong as I wouldn't have been decontaminated. But whether I would wait for half an hour until such a tent would be set up, probably not.” FG3.

Reduced Emotion. Participants stated that their emotions would be different in a real incident. In particular, participants felt that anxiety was reduced because it was an exercise: “I didn't panic because I knew it is an exercise” FG3; and that a real incident would result in greater anxiety: “In a real situation I would have been very nervous because nothing happened, but here it was clear it is an exercise and I have to wait a moment, which is probably the difference between exercise and reality.” FG3.

4.Discussion

This study evaluated a field exercise involving a hypothetical chemical leak, and we had four aims. The first aim was to understand the experiences of members of vulnerable groups, including evaluating responders’ ability to identify and assist those with additional needs. The second aim was to assess participants’ perceptions of the previously developed pre-incident information. The third aim was to identify and examine the ways that responders communicate with the public and the public’s perception of responder communication. The fourth and last aim was to assess if perceptions of responder communication, practical

information, identification with responders, and responder legitimacy predict compliance during the decontamination process.

4.1. Assistance Of Individuals with Additional Needs

We assessed the effectiveness of first responders at identifying, supporting, and assisting vulnerable individuals through the exercise. Through the observations it was noted that in some instances, responders failed to understand vulnerabilities; however, other responders appeared able to identify vulnerable individuals. At times we observed issues with the support provided by responders, and this was in line with focus group results in which participants mentioned various issues related to support, including poor physical support, poor communication support, and the need for greater consideration of social and cultural needs. The predominately negative perception of responders' ability to support those with vulnerabilities suggests that while responders were largely able to identify those with vulnerabilities, they were often unable to effectively support them throughout the exercise. In addition, questionnaire data showed that participants' vulnerabilities impacted their interactions with first responders, with participants reporting that responders typically did not effectively modify their communication for people with vulnerabilities. This supports previous research that shows CBRNe practitioners rarely modify their communication for vulnerable individuals (Carbon et al., 2022a), and that more training is needed for supporting vulnerable individuals (Havarneanu et al., 2022). However, some participants reported that responders did effectively modify their communication, through the use of written instructions and hand signs. A key way in which participants suggested that support for those with vulnerabilities could be improved would be to have each participant be led through the exercise by the same responder. This would avoid participants having to explain their vulnerability and appropriate adaptions to multiple different responders. Whilst limited numbers of responders may make this difficult, it may be possible to create a buddy system

(Carter et al., 2016). Hignett et al. (2019) recommends the use of information media that can accommodate a range of vulnerabilities.

The observational and focus group results also demonstrate that the use of functional aids was not effectively managed. Functional aids were not decontaminated, and some participants had delays in getting their functional aids back after the decontamination shower. It has been suggested that aids be removed at dis-robing and given back at re-robing, after having been decontaminated (Braue et al., 2009). Taylor et al. (2008) suggest that decontamination may be more efficient and quicker if individuals are allowed to keep their functional aids.

4.2. Perceptions of Pre-Incident Information

The second aim was to assess the effectiveness of the pre-incident information. The pre-exercise questionnaire showed that participants who had read the pre-incident information reported that they would feel comfortable, willing, and able to take the actions in the pre-incident information. Participants also felt that the actions in the pre-incident information would be an effective way to decontaminate themselves, though they would still want to seek further treatment. In open-ended responses, participants reported that the pre-incident information would be useful to members of the public as it would enable them to know what to do in that situation, noting that this would be particularly useful if there was a lack of communication from responders during an incident. Overall, the pre-incident information was perceived as effective as participants reported positive perceptions of the actions in the pre-incident information and felt that it would be helpful to members of the public. This finding is in line with results from previous research which shows that members of the public want to receive this type of information prior to an incident involving hazardous materials, and that they would find it useful (Carter et al., 2019; Carter et al., 2020a; Nicholson et al., 2021).

4.3. Responder Communication

The third aim was to examine the ways that responders communicate with the public and the public's perception of responder communication. In the post-exercise questionnaire, participants reported positive perceptions of practical information though not of overall communication strategy. In open-ended questionnaire items and focus groups, participants reported that communication could be improved by providing more explanation about what actions members of the public could take to help themselves, and why such actions are effective, as well as simplifying the language used. This is in line with previous research, which shows that casualties report a lack of communication (Currie & Heslop, 2018), that casualties want to receive more information during decontamination (Carter et al., 2013b) and that providing this information improves the speed and efficiency of decontamination (Carter et al., 2014). Participants also suggested that practical aspects of communication should be improved, as background noise and personal protective equipment (PPE) made it difficult for participants to hear responders. Practical suggestions included the use of a megaphone, written instructions, and provision of instructions in different languages. This is also in line with previous research which demonstrates that practical issues associated with communication need to be addressed during decontamination (Carter et al., 2012) and that the provision of written or pictorial instructions, as well as the use of megaphones, may help to improve communication (Carter & Amlôt, 2016).

4.4. Compliance

The last aim was to assess if responder communication, perceptions of practical information, identification with responders, and responder competence predict compliance during the decontamination process. Results from the quantitative questionnaire data showed that participants' perceptions of responder legitimacy, responder communication, practical information, and identification with responders did not predict expected compliance as well

as no associations with compliance for any variables. This is in contrast to previous research which has demonstrated that lack of shared identity, low perceived responder legitimacy and poor responder communication reduce public compliance during decontamination (Carter et al. 2013b; Carter et al. 2015a). In the current study, expected compliance during a real incident was high, which may have made it difficult to establish relationships between key variables and compliance. However, in focus group discussions, participants reported that ineffective communication from emergency responders resulted in reduced perceptions of responder competence and legitimacy, which would be likely to result in increased non-compliance, with participants stating that poor communication would be likely to result in them leaving the incident site prior to decontamination. This is in line with previous research which has shown that effective communication leads to increased trust and perceived legitimacy of responders (Carter et al., 2013b; Carter et al., 2014; Rogers & Pearce, 2013), which in turn leads to increased compliance with decontamination (Carter et al., 2014; Carter et al., 2015a).

We also found a relationship between shared social identity and other key variables which may affect public willingness and ability to comply with responders' instructions, with identification with other participants being associated with increased expectancy of help, increased collective agency, and reduced anxiety, while increased identification with responders was associated with increased confidence and knowledge of actions to take, increased expectancy of help, and reduced anxiety. This is in line with previous research which has demonstrated that shared identity results in increased collective agency (Carter et al., 2014), increased helping behaviour (Carter et al., 2013b), and reduced anxiety (Carter et al., 2015a) during decontamination. While we did not find a direct relationship between these variables and compliance in the current study, this may be due to the high levels of expected compliance among our participant sample.

4.5.Recommendations and Implications

As part of the PROACTIVE project, we aim to implement the recommendations from this exercise by working with practitioners across Europe. Based on the findings from this study, there are several recommendations that can be made. The first recommendation revolves around communication, responders should address practical issues with communication caused by PPE, way to address this issue include using a megaphone and sign language. Responders should also work to improve communication by giving clear explanations and instructions to casualties on what actions they should take but also in using different ways of communication with vulnerable individuals. Second, responders should be trained in how to assist vulnerable individuals through decontamination this could include one responder leading a vulnerable casualty through the decontamination (so less explanation is needed as they are passed to another responder) and clear guidelines for how to decontaminate functional aids. Third, at the incident site, as participants were waiting to be taken to the decontamination tents, the responder could have advised participants to take protective actions. For example, outer layers of clothing could have been removed at the incident site. In addition, there could have been better management of the contaminated clothing. For ambulant participants, contaminated clothing was removed overhead rather than being cut off, and for both ambulant and non-ambulant participants contaminated clothes were placed into sealed bags, with the bags then left inside the tent. Another key area for improvement would be decontamination. The first decontamination recommendation is to use different sponges for different participants during showering, along with the use of detergent. The use of the same sponges for all participants is problematic because it results in the potential for cross-contamination. The second recommendation to decontamination is to decontaminate vulnerable individual mobility aids such as wheelchairs and walking canes; these mobility aids were not decontaminated during the exercise which may lead to

secondary contamination. Finally, at both dis-robe and re-robe, queues were building up. At disrobe, participants had to wait to get into the shower, while at re-robe they had to wait to be assessed. Given that there were lots of responders present for the response, and that some did not appear to have an active role, these processes could be made faster and more efficient.

As well as recommendations for policy, our study also has implications for future research. Firstly, future research could experimentally manipulate the communication that vulnerable individuals receive in decontamination exercises, replicating Carter et al. (2015a) manipulation of responder communication strategies but applied to vulnerable individuals to assess the most effective ways that responders can communicate. Secondly, future research can also experimentally test the effectiveness of pre-incident information in instigating decontamination among casualties to assess whether pre-incident information would be suitable as a public health campaign.

4.6. Limitations

There were several limitations within the current research. First, field exercises attempt to replicate real emergencies however there are differences between field exercises and real emergencies. Specifically, participants are likely to experience less anxiety during an exercise. There are also artificialities inherent to exercise scenarios (e.g., the decontamination unit being set up prior to the exercise) which may affect the way in which responders and members of the public behave. Although there are differences between real emergencies and field exercises, casualties' needs for communication are likely to be similar (Vogt & Sorensen, 2002). A second limitation of the current study is the small sample size which led to data saturation not being met in the focus groups. Another limitation is the use of one-item measures (e.g., expectancy of helping others), future research should use multi-item measures to assess these constructs. One strength of the current study is the inclusion of vulnerable individuals. It is key to assess the experiences of vulnerable individuals during

decontamination as a review of responder guidance documents showed that while some documents discuss vulnerable individuals, none of the guidance documents reviewed mention strategies for managing vulnerable individuals (Davidson et al., 2021). In addition, limited research has explored the experiences of vulnerable individuals during decontamination, therefore by including vulnerable individuals in our study future research and guidance documents can build upon this to address the gaps in the response to vulnerable individuals. By addressing the gaps in responding to vulnerable individuals it can aid the speed of decontamination and help prevent further injuries. However, we could not capture all vulnerabilities. For example, we did not recruit children in the current study, therefore, future field exercises should assess the needs of children. Although there is a recruitment bias in the inclusion of vulnerable individuals in research given that participants need to provide consent that may be limited by some vulnerabilities. There is also a more general selection bias as only those willing to be involved in a decontamination exercise and go through a decontamination shower will come forward to participate. Overall, future studies can address these issues by recruiting larger sample sizes in CBRNe exercises with the inclusion of vulnerable individuals and a wide range of vulnerabilities.

5.Conclusions

The findings from the current study support previous findings suggesting responders need greater training in how to meet the needs of vulnerable individuals during a CBRNe incident. First responders, in some cases, failed to meet the needs of vulnerable individuals due to poor physical support, poor communication support, and not decontaminating functional aids. We found positive perceptions of the pre-incident information, which supports previous research demonstrating the benefits of providing the public with this type of information. Last, the current study adds to the literature on responder communication, with participants suggesting improvements relating to practical aspects of communication and

the provision of greater explanation. Overall, this research demonstrates the importance of effective communication with the public, both before and during a CBRNe incident, and the need to better understand prepare for decontamination of members of vulnerable groups.

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Table 1

Questions in the Pre-Exercise and Post-Exercise Questionnaires

Scale	Example Question	Number of Items	Cronbach's Alpha	Source
Pre-Exercise Questionnaire				
Confidence and Knowledge	"If a real incident of this type were to occur, I would know what actions to take to protect myself."	4-items	α=0.97	Carter et al. (2019)
Perceived Responder Legitimacy	"I think that the emergency services will behave in a respectful way during the decontamination process today."	2-items	α=0.77	Carter et al. (2019)
Expectancy of Help	"If a real incident of this type were to occur, I would expect emotional support from other members of the public who were involved."	2-items,	α=0.89	Carter et al. (2019)
Expectancy of Helping Others	"If a real incident of this type were to occur, I would be willing to help other members of the public."	1-item		Carter et al. (2019)
Identification with Other Participants	"I feel a sense of unity with the other participants who are taking part in the exercise today."	2-items	α=0.92	Carter et al. (2013a)
Identification with Emergency Responders	"I feel a sense of unity with the emergency responders who will be taking part in the exercise today."	2-items	α=0.77	Carter et al. (2013a)
Levels of Anxiety	"If a real incident of this type were to occur, I would feel nervous."	3-items	α=0.90	Carter et al. (2013a)
Pre-Incident Information: Effective	"If a real incident of this type were to occur, I think that taking the actions recommended in the pre-incident information sheet would be an effective way to remove a contaminant from my skin."	1-item		Nicholson et al. (2021)
Pre-Incident Information: Comfortable	"If a real incident of this type were to occur, I would feel comfortable taking the actions recommended in the pre-incident information sheet."	1-item		Nicholson et al. (2021)

Pre-Incident Information: Embarrassed	"If a real incident of this type were to occur, I would feel embarrassed taking the actions recommended in the pre-incident information sheet."	1-item		Nicholson et al. (2021)
Pre-Incident Information: Easy	"If a real incident of this type were to occur, I think I would find it easy to take the actions recommended in the pre-incident information sheet."	1-item		Nicholson et al. (2021)
Pre-Incident Information: Willing	"If a real incident of this type were to occur, I would be willing to take the actions recommended in the pre-incident information sheet."	1-item		Nicholson et al. (2021)
Pre-Incident Information: Seek Further Treatment	"If a real incident of this type were to occur, I would feel the need to seek further treatment after taking the actions recommended in the pre-incident information sheet."	1-item		Nicholson et al. (2021)
Post-Exercise Questionnaire				
Confidence and Knowledge	Same as in pre-exercise questionnaire	4-items	α=0.98	Carter et al. (2019)
Expectancy of Help	Same as in pre-exercise questionnaire	2-items	α=0.80	Carter et al. (2019)
Perceived Responder Legitimacy	Adapted to past tense from pre-exercise questionnaire e.g., "I think that the emergency services behaved in a fair way during the decontamination process."	2-items	α=0.96	Carter et al. (2019)
Identifications with Participants	Adapted to past tense from pre-exercise questionnaire e.g., "I identified with the other volunteers who took part in the exercise today."	2-items	α=0.68	Carter et al. (2013a)
Identification with Responders	Adapted to past tense from pre-exercise questionnaire e.g., "I felt a sense of unity with the emergency responders who took part in the exercise today."	2-items	α=0.94	Carter et al. (2013a)
Levels of Anxiety	Measured levels of anxiety during decontamination and exercise e.g., "I felt nervous during the decontamination	3-items	α=0.94	Carter et al. (2014)

	process."; "I felt nervous during the exercise.").			
Pre-Incident Information: Effective	Same as in pre-exercise questionnaire	1-item		Nicholson et al. (2021)
Pre-Incident Information: Comfortable	Same as in pre-exercise questionnaire	1-item		Nicholson et al. (2021)
Pre-Incident Information: Embarrassed	Same as in pre-exercise questionnaire	1-item		Nicholson et al. (2021)
Pre-Incident Information: Easy	Same as in pre-exercise questionnaire	1-item		Nicholson et al. (2021)
Pre-Incident Information: Willing	Same as in pre-exercise questionnaire	1-item		Nicholson et al. (2021)
Pre-Incident Information: Seek Further Treatment	Same as in pre-exercise questionnaire	1-item		Nicholson et al. (2021)
Vulnerabilities Impacted Interactions with Responders	"My disability/condition/vulnerability impacted my interaction with the first responders").	1-item		
Vulnerabilities Impacted Decontamination	"My disability/condition/vulnerability impacted my ability to undergo a decontamination shower"	1-item		
Collective Agency	"If this situation had been real, I would have felt able to work with others to take appropriate actions to reduce the danger we were in."	1-item		Carter et al. (2014)
Perceptions of Privacy	"I had sufficient privacy during the decontamination process";	1-item		Carter et al. (2014)
Cooperation Among Participants	"I saw volunteers cooperating with each other during the decontamination process."	1-item		Carter et al. (2014)
Courteousness Among Participants	"Volunteers were courteous to each other during the decontamination process."	1-item		Carter et al. (2014)

Participants Needing Help	"Sometimes volunteers needed other volunteers to help during the decontamination process."	1-item		Carter et al. (2014)
Emotional Engagement	"I felt emotionally engaged during this exercise."	1-item		Carter et al. (2014)
Seriousness With Which Participants Took the Exercise	"I took this exercise seriously."	1-item		Carter et al. (2014)
Perceptions of Responder Communication	"Emergency responders explained clearly what was happening during the decontamination process."	5-items,	α=0.91	Carter et al. (2013a; 2014)
Perceptions of Practical Information	"Emergency responders provided sufficient practical information about what we were supposed to do during the decontamination process."	2-items	α=0.95	Carter et al. (2013a)
Perceived Responder Competence	"Emergency responders took appropriate actions to manage this incident."	2-items	α=0.64	Carter et al. (2013a)
Expectations of Compliance	"If this situation had been real, I would have complied with the instructions of the emergency responders"	2-items	α=0.62	Carter et al. (2015a)

Table 2

Comparisons between the Means and the Scale Midpoint

	M	SD	*T*	p	df	Cohen's d
If a real incident of this type were to occur, I think that taking the actions recommended in the pre-incident information sheet would be an effective way to remove a contaminant from my skin.	5.38	1.41	2.75	.014	7	0.98
If a real incident of this type were to occur, I would feel comfortable taking the actions recommended in the pre-incident information sheet.	5.38	1.19	3.27	.007	7	1.16
If a real incident of this type were to occur, I would feel embarrassed taking the actions recommended in the pre-incident information sheet.	3.63	2.50	0.42	.658	7	0.15
If a real incident of this type were to occur, I think I would find it easy to take the actions recommended in the pre-incident information sheet.	5.00	1.31	2.16	.034	7	0.76
If a real incident of this type were to occur, I would be willing to take the actions recommended in the pre-incident information sheet.	5.88	1.36	3.91	.003	7	1.38
If a real incident of this type were to occur, I would feel the need to seek further treatment after taking the actions recommended in the pre-incident information sheet.	5.88	1.36	3.91	.003	7	1.38
My disability/condition/vulnerability impacted my interaction with the first responders.	5.67	1.37	5.15	<.001	17	1.21
My disability/condition/vulnerability impacted my ability to undergo a decontamination shower.	3.94	2.58	0.09	.928	17	0.02
Emotional engagement in exercise	4.65	1.77	1.51	.075	16	0.37
Seriousness of exercise	5.76	1.25	5.81	<.001	16	1.41
Perceptions of responder communication	4.22	1.87	0.48	.319	15	0.12
Perceptions of practical information	4.92	1.97	1.97	.033	17	0.47
Expected compliance with responder	6.29	0.92	10.27	<.001	16	2.50
Expected compliance with decontamination shower	6.76	0.56	20.37	<.001	16	4.92
Identification with participants	6.25	0.97	9.80	<.001	17	2.31
Identification with responders	4.00	2.01	0.00	.500	17	0.00

Perceptions of privacy	4.00	2.00	0.00	.500	16	0.00
Perceived responder legitimacy	5.78	1.52	4.97	<.001	17	1.17
Perceived responder competence	5.50	1.29	4.81	<.001	16	1.17

Table 3

Pre- and Post-exercise Questionnaires

	Pre-		**Post-**		***t***	**df**	***p***	**Cohen's d**
	M	SD	M	SD				
Confidence and Knowledge	2.82	1.66	4.09	1.91	3.80	16	.002	0.92
Perceived responder legitimacy	6.58	0.69	5.78	1.52	2.04	17	.057	0.48
Identification with responders	5.14	1.63	4.00	2.00	3.77	17	.002	0.89
Expectancy of receiving help	5.08	1.19	4.92	1.65	0.43	17	.671	0.10
Helping others	6.82	0.39	6.59	0.62	1.73	16	.104	0.42
Identification with participants	6.25	1.24	6.25	0.97	0.00	17	1.00	0.00

Table 4
Regression for Compliance

	Compliance 1		Compliance 2	
	β	**95% CI**	***β***	**95% CI**
Perceived Responder Competence	0.09	(-0.44, 0.57)	-0.13	(-0.36, 0.24)
Responder Communication	0.23	(-0.45, 0.68)	0.33	(-0.24, 0.44)
Practical Information	0.01	(-0.49, 0.50)	-0.02	(-0.30, 0.29)
Identification with Responders	0.05	(-0.33, 0.37)	0.17	(-0.16, 0.26)
Adjusted R2	-0.28		-0.17	
P	.910		.734	
F	0.24		0.50	

Table 5

Correlation between Variables

	1	2	3	4	5	6	7	8	9	10	11	12
1. Confidence and Knowledge	-											
2. Perceived responder legitimacy	0.50*	-										
3. Helping others in the exercise	0.04	0.08	-									
4. Expectancy of help	0.41	0.20	0.66**	-								
5. Anxiety	-0.41	-0.35	-0.19	-0.63**	-							
6. Identification with participants	0.40	0.44	0.20	0.67**	-0.58*	-						
7. Identification with responders	0.74***	0.43	0.21	0.48*	-0.72**	0.35	-					
8. Expected compliance	-0.02	-0.21	0.04	0.44	0.37	0.36	0.20	-				
9. Perceptions of practical information	0.24	0.12	-0.13	0.06	0.25	-0.07	0.09	0.29	-			
10. Perceptions of responder communication	0.24	0.49	0.16	0.39	-0.18	0.27	0.45	0.36	0.69**	-		
11. Perceived responder competence	0.22	0.06	0.08	0.02	0.13	-0.11	0.19	0.15	0.20	0.17	-	
12. Collective agency	0.68**	0.55	0.10	0.45	-0.47	0.51*	0.61*	0.02	0.14	0.32	-0.29	-
13. Perceptions of privacy	0.23	0.59*	-0.20	-0.04	0.16	0.25	0.03	-0.14	0.36	0.59*	-0.22	0.48*

Note. * $p < 0.05$ **p<0.01, ***p<0.001

Table 6

Quotes for the Themes and Sub-Themes of the Open-Ended Questionnaire Responses

Accessibility	
Communication with responders	018: “The fire department didn't explain to me what was happening. I had an uncertain feeling.” 021: “Deafness. Communication with the emergency services was difficult - due to gas masks, etc. Mouth field not recognizable. Gestures / signs on the part of the emergency forces too little used. Not always clear instructions.” 017: “I could not hear because I am deaf without my speech processors. In addition, I had limited sight because I had to take off my glasses. This made it very difficult for the helpers to make me understand what they expected of me.”
Impaired Senses	022: “Decreased vision.” 016: “I could hardly see. Had a headache.”
Levels of Anxiety	
Impact on their senses	017: “I was a bit unsettled by my impairment, as I couldn't see exactly or hear what was going on around me.” 011: “I put myself in the situation of having a panic attack and was scared because my eyes were burning, and no one could tell me why.”
Lack of communication from responders	005: “The reason for my discomfort was the lack of communication from the emergency personnel at the point of communication.” 025: “I was parked with another person and told to wait. Nothing happened for a very long time. No info. Nobody cared.”
Pre-Incident Information	007: “Yes, then they might know what to do in such a situation.” 005: “Yes, definitely. If task forces continue to fail to communicate on-site, old information in advance would be helpful.”
Communication from responders	
Improved support for those with vulnerabilities	017: “The safety personnel could have written down what they wanted to say to me. One person should have been at my side - changing people had to adjust to my impairment each time.”
Improved accessibility of communication	025: “Speak loudly and clearly. There is a lot of background noise + nervousness.”

	011: “It was difficult to understand the emergency services acoustically and to accept them, because even they did not know what was going on.”
More information about the process	016: “More talk about the process, what exactly happened. Give reasons for action, for example: Why weren't people helped at the beginning of the exercise when injured people were on the floor.”
Improvements to Decontamination Process	
Communication	022: “Better communication.” 006: “Better information (perhaps using a megaphone) at the beginning of the accident. After all, we were only held back by the firefighters and pushed into a corner. In the real case, a small disaster within the disaster.”
General behaviour from first responders	005: “The decontamination process was not the problem, but the behaviour of the rescue staff before the decontamination.” 016: “More paramedics to provide care. Faster initial treatment of the injured at the beginning.” 012: “Some seemed very uncertain about the exact procedure and had to ask more often.”
Compliance	010: “Lack of understanding of the process.” 007: “There is a certain sense of shame.”