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Deliverable D1.2

Findings from systematic review of current policy for mitigation and management of CBRNe terrorism

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Consortium – List of partners

Partner no.	Short name	Name	Country
1	UIC	UNION INTERNATIONALE DES CHEMINS DE FER (COORDINATOR)	France
2	CBRNE	CBRNE LTD	UK
3	PPI	POPULATION PROTECTION INSTITUTE (MINISTRY OF THE INTERIOR OF THE CZECH REPUBLIC)	Czech Republic
4	DB	DEUTSCHE BAHN AG	Germany
6	UMU	UMEA UNIVERSITET	Sweden
7	DHPOL	DEUTSCHE HOCHSCHULE DER POLIZEI	Germany
8	RINISOFT	RINISOFT LTD	Bulgaria
9	WMP	WEST MIDLANDS POLICE AND CRIME COMMISSIONER	UK
10	ETICAS	ETICAS RESEARCH AND CONSULTING SL	Spain
11	SESU	STATE EMERGENCY SERVICE OF UKRAINE	Ukraine
12	PHE	DEPARTMENT OF HEALTH	UK
13	SPL	STATE POLICE OF LATVIA	Latvia
14	AGS	AN GARDA SÍOCHÁNA – NATIONAL POLICE FORCE IRELAND	Ireland
15	FFI	FORSVARETS FORSKNINGSINSTITUTT	Norway
16	NPH	KOMENDA GŁÓWNA POLICJI	Poland

List of acronyms

Acronym	Definition
EU	European Union
CBRNe	Chemical, Biological, Radiological, Nuclear, and explosive
T	Task
M	Month
D	Deliverable
WP	Work Package
SOP	Standard Operating Procedure
NATO	National Atlantic Treaty Organisation
JESIP	Joint Emergency Services Interoperability Programme
UK	United Kingdom
US	United States
NHS	National Health Service

Executive summary

The following deliverable is the second of the three set out for the PROACTIVE project for WP1 – Human factors analysis of preparedness and response. It reviews guidance documents relating to CBRNe incident management and aims to understand: (i) current policy and practice in the preparation for and management of CBRNe terrorism in different organisations and across different countries; (ii) current guidance and strategies for communicating with members of the public about CBRNe preparation and management; and (iii) the potential impact of current policy and practice in the preparation for and management of CBRNe terrorism on members of vulnerable groups.

This report presents the findings of current tools, SOPs and guidance documents, in order to identify current policy and practice for mitigation of CBRNe terrorism, across different countries and organisation. Findings show that across guidance documents, there seems to be a heavy reliance on practical and physical aspects of CBRNe management, yet documents tend to lack recognition for psychosocial aspects. In addition, there seem to be discrepancies in the information that is provided in guidance documents both within and between countries. There are several specific recommendations that can be drawn from this review: 1) Guidance and policy would benefit from incorporating up-do-date evidence-based advice on how members of the public are likely to respond in a CBRNe incident; 2) Guidance and policy should be updated to incorporate a detailed communication strategy for how emergency responders should communicate with casualties and members of the public during a CBRNe incident; 3) Guidance and policy should include a clear strategy on how to manage vulnerable groups in a CBRNe incident; and 4) Any discrepancies in documents should be reviewed both within and between countries to ensure consistency in recommendations on how emergency response organisations should respond to a CBRNe incident.

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1: DHPol, 2: SPL, 3: UIC, 4: UMU, 5: PPI

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1. INTRODUCTION

Incidents involving chemical, biological, radiological, nuclear, and explosive (CBRNe) threats can have a significant impact on society, and the likelihood of these incidents occurring has increased in recent years due to technological advances and an increased willingness for terrorists to use more unconventional weapons (Schneidmiller, 2012). Whether they are accidental or intentional, CBRNe threats can be hard to detect, or even invisible. The immediate consequences of exposure to a CBRNe incident are often unknown as effects can be delayed for hours or even days. Because of this, the risks are often defined by a lack of perceived control with catastrophic potential and fatal consequences (Slovic, 1987; 2002; 2004), which consequently can increase public anxiety towards these kinds of incidents.

The way in which members of the public behave during CBRNe incidents will have a crucial impact on the outcomes from the incident. It is therefore important to understand the way in which members of the public are likely to behave during such incidents, and the factors that are likely to affect public behaviour. Traditional theories of crowd behaviour during emergencies suggest that members of the public are likely to 'panic' and behave in a disorderly way (e.g. La Piere, 1938; Le Bon, 1895; Smelser, 1963). However, these traditional theories have now been discredited and more recent research suggests that crowd behaviour in disasters is likely to be calm and orderly and that panic is in fact rare (e.g. Aguirre et al., 2011; Carter et al., 2012; Carter et al., 2015; Cornwell, 2001; Johnson, 1987; Quarantelli, 1954).

Despite the fact that traditional theories of crowd behaviour have now largely been discredited, guidance and training for emergency responders often continues to endorse outdated and discredited assumptions about crowd behaviour (e.g. mass panic, public disorder) (Carter et al., 2013a; Carter & Amlôt, 2016). The reliance on such assumptions has led to the development of crowd management strategies that focus on controlling members of the public (e.g. withholding information, disregarding public needs etc) during CBRNe incidents, rather than communicating with them. However, rather than mitigating against public disorder, these types of control management strategies may actually create public disorder, by reducing public trust in responders and increasing non-compliance with responder instructions (e.g. Carter et al., 2014).

In recent years, there has been an increased focus on research aiming to understand the psychosocial aspects of the management of mass emergencies (including those involving CBRNe agents), specifically the nature of the relationship between responders and members of the public and how different responder management strategies can affect public behaviour during mass emergencies (e.g. Carter et al., 2012; Carter at al., 2013b; Carter et al., 2015; Drury et al., 2009). This research shows that the way in which emergency responders manage a CBRNe incident will affect the way in which members of the public

behave and will therefore affect the outcomes of the incident (Carter & Amlôt, 2016; Carter et al., 2014; Carter et al., 2013a). It is essential to understand how responder management strategies can impact on public behaviour during CBRNe incidents, and to use this understanding to enhance guidance and training for CBRNe incident management.

Research indicates that the key psychosocial aspects that will impact on public behaviour during CBRNe incidents include: responders' understanding of the way in which their management of an incident can affect public behaviour; how effectively responders communicate with members of the public; and how well the needs of vulnerable groups are understood and prepared for. The aim of this research was to review current CBRNe management guidance documents to understand to what extent these key psychosocial aspects are embedded into current guidance. This review will identify and synthesise the state of the art concerning CBRNe preparedness and response to CBRNe terrorist incidents. The three key aims of this review are:

(1) To understand current policy and practice in the preparation for and management of CBRNe terrorism in different organisation across different countries.
(2) To understand current guidance and strategies for communicating with members of the public about CBRNe preparation and management.
(3) To understand the potential impact of current policy and practice in the preparation for and management of CBRNe terrorism on members of vulnerable groups.

2. METHOD

A search of open literature was conducted to identify any publicly available guidance documents relating to the management of CBRNe incidents. Documents were included if they:

a) Were publicly available;
b) Described guidance, practice or standard operating procedures in relation to preparedness and/ or management of CBRNe terrorist or non-terrorist incidents;
c) Were produced by a health, emergency service, or Government organisation and were designed for use by policy makers and/ or emergency responders;
d) Were available in English or able to be translated into English;
e) Were produced within the last 5 years (with the exception of translated documents which were not imposed a time limit).

The search was carried out between July and September 2019 using four different search strategies: (2.1) *advanced Google search*, (2.2) *target website search*, (2.3) *consultation with project partners*, and (2.4) *grey literature database search*. An additional advanced Google search (2.5) was carried out between January and March 2021 to identify any publicly available information communication tools (e.g. apps) that enabled either: 1)

communication from first responders to members of the public during CBRNe incidents; 2) communication from members of the public to first responders during CBRNe incidents. To understand the current state of the art, and to inform interpretation of findings from the guidance review, a separate search of EU projects (2.6) was carried out, focusing on optimising situational awareness, common operational picture, and standardisation.

2.1. Advanced Google search

The search strategy began with an advanced Google search. Search terms were generated under three main categories: (1) type of management (e.g. decontamination, lockdown); (2) type of incident (e.g. chemical, radiological); and (3) type of guidance (e.g. standard operating procedure, report). The phrases in these categories were then combined to create 38 separate search terms, for example “decontamination AND chemical AND (standard operating procedure OR guidance OR policy document OR report)”, “operational response AND radiological AND (standard operating procedure OR guidance OR policy document OR report)” (see Appendix 1 for a full list of search terms). Due to the large number of results generated (up to 27,600,000 results on some searches), the search was limited to the first 200 documents from each set of results. Duplicate documents were highlighted and removed. The results were scanned for relevance and any relevant documents were flagged for later screening. In total, 53 relevant documents were identified and selected for further analysis from the advanced Google search.

2.2. Target website search

Websites of 17 relevant organisations were searched: National Fire Chiefs Council; National Police Chiefs Council; National Ambulance Resilience Unit; World Health Organisation; North Atlantic Treaty Organisation (NATO); Centers for Disease Prevention and Control; European Centre for Disease Prevention and Control; Pan American Health Organisation; International Atomic Energy Agency; NHS England; Government UK; Joint Emergency Services Interoperability Programme; Counter Terrorism Policing; Federal Emergency Management Agency; National Operational Guidance; Public Health Wales; Public Safety Canada.

These websites were chosen based on previous reviews that have completed target website searches in similar areas (see Carter et al., 2013a; Carter et al., 2016). The websites were initially searched using the search terms: “CBR”, “CBRN”, “Chemical”, “Biological”, “Radiological”, and “Nuclear”. When these search terms generated a large number of results, they were then separately searched with “policy” and “guidance” (e.g. “CBR AND policy”, “Biological AND guidance”). For any search that generated over 200 results, only the first 200 results were searched. One website (Counter Terrorism Policing) did not have a search box on the website therefore the website was manually searched for any relevant documents. Duplicate documents were highlighted and removed. The results were scanned for relevance and any relevant documents were flagged for later screening. In total, 17

relevant documents were identified and selected for further analysis from this target website search.

2.3. Consultation with project partners

Project partners were contacted asking them to identify any relevant documents from their country and provide a summary in English. Twenty-five documents were returned from France (n = 6), Czech Republic (n = 1), Latvia (n = 1), Austria (n = 1), Sweden (n = 1) and Germany (n = 15).

2.4. Grey literature database search

Three grey literature databases were searched: Toxnet (https://toxnet.nlm.nih.gov/); International Nuclear Information System (https://inis.iaea.org/search/); and Open Grey (http://www.opengrey.eu/). These databases were chosen based on their relevance to the overall aim of the review. Five search terms were used within each of these databases: "CBRN AND (guidance OR policy)", "Chemical AND (guidance OR policy)", "Biological AND (guidance OR policy)", "Radiological AND (guidance OR policy)", and "Nuclear AND (guidance OR policy)". For any search that generated over 200 results, only the first 200 results were reviewed. No additional relevant documents were identified using this search strategy.

In total, 95 relevant guidance documents were identified from 18 different countries (see Appendix 2 for a full list of countries) during the search and these were reviewed to identify: (i) whether a strategy for responding to a CBRNe incident is discussed, (ii) whether a strategy for communicating with members of the public during a CBRNe incident is specified, (iii) if there is guidance on how members of the public are likely to behave in a CBRNe incident, and (iv) whether there is a strategy for managing the impact of CBRNe incidents on vulnerable groups (see Appendix 2 for a full list of guidance documents identified).

2.5. Advanced Google Search for Communication Apps

A review of public and responder communication tools was conducted through an advanced Google search. Search terms were generated under three main categories: type of communication tool (e.g., app, social media); type of incident (e.g. chemical, radiological); and type of communication (e.g. information, communication). The phrases in these categories were then combined to create 12 separate search terms, for example "app AND chemical AND (standard operating procedure OR guidance OR policy document OR report)", "operational response AND radiological AND (information OR communication OR preparedness OR response)" (see Appendix 3 for a full list of search terms). The search was limited to the first 100 results from each search term. The results were scanned for relevance and any relevant communication tools were flagged for later screening. In total, three relevant communication tools were identified for further analysis (see Appendix 4).

2.6. Review of EU projects on situational awareness, common operational picture and standardisation

A targeted search of EU projects was carried out to identify projects that related to situational awareness, common operational picture, and standardisation. For each project, the website was reviewed to identify: any information on project aims or outcomes relating to situational awareness; any information on project aims or outcomes relating to common operational picture; any information on project aims or outcomes relating to standardisation; any references to other relevant EU projects, the websites of which were then included in the search. This review identified 17 relevant projects. A summary of findings and a full list of projects reviewed is presented in Appendix 5.

2.7. Data Analysis

Each document was analysed using *the Framework Approach*, which is a commonly used method for analysing qualitative research. Originally used for large-scale social policy research, it is now becoming increasingly used in medical and health research (Gale et al. 2013). The Framework Approach is useful for identifying commonalities and differences in qualitative data and has a focus on identifying relationships between different parts of the data (Gale et al., 2013). This approach was chosen for the current research due to the research aim of identifying commonalities and differences between guidance documents for CBRNe incidents across different countries.

Three key stages of data analysis were carried out:

(1) Framework identification – an analytical framework was identified based on themes derived from existing research which outline important aspects of managing a response to CBRNe incidents (see Carter & Amlôt, 2016; Carter et al., 2013). Four themes were identified to be incorporated into the framework for analysis (see Appendix 6 for an overview of the analytical framework and description of themes). The first theme was *response strategy*, and this incorporated any guidance that was provided in the documents which related to the overall way emergency responders manage a CBRNe incident and any actions recommended that the responder and/or casualty should carry out. The second theme identified was *communication strategy*, and this incorporated any guidance provided for responders within the document on how to communicate with members of the public during a CBRNe incident, for example, what information should be provided to those at the incident site, what information should be provided to members of the general public, and how should this information be provided. The third theme was *public response* and incorporated any information that the documents provided on how members of the public are likely to behave during a CBRNe incident, for example, are people likely to panic, or are they likely to behave in a calm manner. The final theme was *vulnerable groups* and incorporated any guidance provided on how emergency responders should manage vulnerable groups, for example those with a disability, non-native speakers, children, or any other individuals who might be more vulnerable during a CBRNe incident.

(2) Data coding - documents were read by a researcher with the analytical framework in mind. For each document, a code (also known as a descriptive or conceptual label) was applied to any part of the document that provided information in line with the four pre-identified themes. The code describes what the researcher has interpreted from the text. For example, under the theme 'response strategy', one code used was 'disrobe' to describe the section of text "victims should remove outer clothing". The aim of coding data is to classify the data so that it can be compared systematically with other parts of the data set (Gale et al., 2013).

(3) Data interpretation - codes within each theme were compared with each other. This enabled commonly arising themes, and any relationships between the themes, to be identified. Further, any differences between themes across documents were also able to be identified. For example, all documents which included the code 'disrobe' were able to be compared to identify whether documents provided the same, or different information about how people should disrobe.

3. RESULTS

Of the 95 documents identified, eight were written by a single emergency response organisation (e.g. Fire and Rescue Service, UK FRS, 2018; Police Service, Police Scotland, 2018) and so for the purpose of this report are considered single-agency. The rest were written by national government organisations (e.g. Australian Government Department of Health, 2018; US Department of Homeland Security, 2014), voluntary organisations (e.g. International Committee of the Red Cross, 2014), or health services (e.g. NHS England, 2019). Where there were either multiple contributors to the document from different organisations, or the document was written in consultation with members from other organisations, for the purpose of this report are considered multi-agency. In 18 of the translated documents it was not possible to determine authorship.

Nineteen documents specify that the response shared there within is for the intentional release of a CBRNe substance (e.g. Australian Government Department of Health, 2015), and five provide guidance for an unintentional release of a CBRNe substance (e.g. Secretariat-General for National Defence and Security, 2014). Two of the 19 documents that specify that the document is aimed at the intentional release of a CBRNe substance, also note that the response to an unintentional release would be similar. For example, "From an FRS and Ambulance perspective, the broad response to a hazardous materials release utilises most of the same resources and follows broadly similar processes as would be followed for a CBRNe event" (JESIP, 2016). This document goes onto explain the main difference is that the Police will take the lead in an intentional incident which may trigger additional specialist personnel to arrive at the scene.

30 documents specify that the guidance provided is for both the intentional and unintentional release of a CBRNe substance (e.g. Centres for Disease Control and Prevention, 2019). Of these, 11 documents specify a difference in response between the intentional and unintentional release, with the main difference in required response provided being in the event of an intentional release of a CBRN(e) substance, Police will take overall control of the incident. For example, the Government of Western Australia (2018) states that in a terrorist or criminal act, additional strategies may need to be implemented and that Police will take overall command and control of the response. Furthermore, four documents explicitly outline the difference between a CBRN(e) incident (intentional) and a HAZMAT incident (unintentional) (e.g. “This may be as a result of either a deliberate (CBRNe) or accidental (HAZMAT) release of chemical, biological, radiological or nuclear material which presents a hazard”, NHS Foundation Trust, 2017).

In a further 30 documents the nature of the incident (i.e. whether it has been caused intentionally or unintentionally) has not been specified (e.g. Department of Homeland Security, 2018). In four of these documents, the terminology “CBRNe” and “HAZMAT” has been used (NATO, 2014; NHS 2019; Office of Preparedness and Emergency Management, 2014; UK FRS, 2018), yet definitions of these phrases have not been provided, therefore the reader is unable to determine whether they are aimed at the intentional, or unintentional release of a CBRNe substance .

Details on the nature of the incident were unable to be determined in 11 of the translated documents.

Findings from the guidance documents are described under four headings based on the framework used when analysing the documents (see Appendix 4): 3.1. Guidance on the overall response strategy; 3.2. Guidance on how to communicate with members of the public; 3.3. Guidance on likely public behaviour; and 3.4. Guidance on how to deal with vulnerable groups. A summary results table can be found in Appendix 2.

3.1. Guidance on the overall response strategy during a CBRNe incident

Across the documents, seven different management strategies are recommended to enable responders to manage CBRNe incidents: evacuation (removing one-self from the incident site to a place of safety); disrobe (removing clothing); wet decontamination (using water to conduct decontamination either through improvised, interim, or mass methods); dry decontamination (using dry absorbent material to conduct decontamination; re-robing (putting clothes on); commencing life-saving treatment prior to decontamination; shelter in place (a person remaining where they are and taking self-protection measures if they cannot move to a place of safety). These are described in more detail under the relevant sub-headings below.

Of the 95 documents identified, 36 discuss the process of triaging patients. Yet, the detail in which it is discussed varies between documents. In 19 documents the triaging process is only discussed very briefly (e.g. “Those affected will be taken to the triage area”, Akola District Disaster Management Authority, 2017; "Responders and receivers will need to prioritise patients for decontamination as well as triage for medical care", US Department of Homeland Security, 2014). One document provides a definition in its glossary of what triage is, but does not provide any guidance on how to implement it in an incident: “A dynamic method by which people are 'sieved and sorted' in order of medical priority", Home Office (2015).

On the other hand, just four documents provide more detailed guidance outlining the different stages of triage, such as p1 (severe), p2 (moderate), p3 (mild) (Government of Western Australia, 2018; NHS England, 2018; NHS Shetland, 2014; Oak Ridge Institute for Science and Education). Further, two documents provide a detailed yes/no pictogram to support the triaging process (NHS England, 2018; World Health organisation, 2014).

In 11 documents it is recommended that the Ambulance or Health Service should take the lead in triaging patients. For example, Norfolk Resilience Forum (2016) state that it is the role of the ambulance service to: "Establish an effective triage sieve and triage sort system to determine the priority evacuation needs of those injured and to establish a safe location for casualty holding and casualty clearing areas".

Ten documents recognise that triage is a dynamic process and re-triaging should take place following the initial triaging process as casualties may develop symptoms later on, for example: "Casualties should undergo dynamic re-triage in the event of any significant delay as symptoms may have developed during the waiting period" (NHS England, 2015); "Triage is an on-going and dynamic process, triage priorities can change. Once the casualty has been decontaminated a further assessment may be carried out and casualties re-prioritised as required" (NHS Foundation Trust, 2017).

One document specifies triaging should take place before decontamination or medical interventions (Law, 2011). However, two documents state that triage should be conducted in sequence with decontamination: “Decontamination may need to be accompanied by other activities such as triage and medical resuscitation" (World Health Organisation, 2018); "Patient decontamination should occur in combination with triage and the provision of life-saving interventions" (World Health Organisation, 2014).

Two documents specify a difference between triaging a paediatric patient and an adult patient. For example, "In children, if positioning the airway does not restart ventilation, then give a trial of ventilation, as this may restart spontaneous ventilation. In adults, there is no trial of ventilation and the adult casualty is tagged expectant or dead; In children, only peripheral pulses should be used to assess circulation; In children, AVPU is used to assess mental status, not ability to follow commands." (NHS England, 2018).

The Oak Ridge Institute for Science and Education (2017) provides specific guidance for triaging in a radiation incident: "multi-parameter triage (i.e., time to vomiting, lymphocyte depletion kinetics, and other biodosimetry and biochemical indicators) as the current best early biodosimetric assessment of a victim's absorbed dose", and "early, rapid deployment, high-throughput cytogenetic dosimetry utilizing the internet is expected to be very valuable in triage of large numbers of people."

Thirty-eight documents did not discuss triage in their guidance and specific triaging guidance could not be established in 21 of the translated documents.

3.1.1. Evacuation

Thirty-three documents recommend evacuating the scene of the incident, for example "where appropriate, the public should be evacuated" (NATO, 2014); "public protection actions include evacuation" (Secretariat general de la defense et de la securite nationale, 2014). A time scale of when to evacuate was provided in six of these documents, ranging from immediately (Secretariat general de la defense et de la securite nationale, 2014 & Department of Homeland Security, no date b) to within 15 minutes of the incident taking place (Home Office, 2015). Further to this, two documents recommend that evacuation is either "as soon as possible" (Vigipirate, 2016) or "prompt" (Department of Homeland Security, no date c). The World Health Organisation recommends that people evacuate when they "feel safe" (World Health Organisation, 2017).

3.1.2. Disrobe

Sixty documents recommend that disrobe is the first stage of decontamination and should be carried out by removing either just the outer layers of clothing (e.g. "contaminated casualties should disrobe down to their underwear", NHS England, 2015; "take off outer layer of clothing", Centers for Disease Control and Prevention, 2018a), just contaminated clothing (e.g. "contaminated clothing should be removed as soon as possible", Office of Preparedness and Emergency Management, 2014), or all clothing (e.g. "patients should undress completely", Australian Government Department of Health, 2015). Twenty-three documents just state to "disrobe" or "remove clothing" but do not provide guidance on how much to disrobe. For example, "decontaminate if necessary using disrobe" (Public Health England, 2018); "clothing should be removed as soon as possible" (Queensland Government, 2015).

3.1.3. Wet decontamination (improvised, interim, mass)

Thirty-eight documents recommend that affected persons should undergo wet decontamination. Across these documents, wet decontamination is described in varying levels of detail from "washing" ("decontamination can be achieved through washing", West Yorkshire Police, 2016) to "taking a shower" ("decontamination can involve taking multiple showers", Centres for Disease Control and Prevention, 2018). Seven documents recommend using a wet towel or moist cloth if water facilities are not readily available (e.g.

"if running water is not available people should decontaminate exposed skin with moist wipes or damp towels", Centres for Disease Control and Prevention, 2015; "if you cannot wash or shower, use a wipe or clean wet cloth to wipe any hair or skin that was not covered", Department of Homeland Security, 2018). Twenty out of the 38 documents that recommend wet decontamination recommended using soap to aid decontamination (e.g. "patients should wash using soap", Australian Government Department of Health, 2015; "affected areas should be gently rinsed or washed with soapy water", World Health Organisation, 2018). Four of these 20 documents recommend using soap only when it is available and not to delay decontamination to wait for its arrival (e.g. "Soap should be used if available", NHS Shetland, 2014; "wash whole body, including hair, with soap and tepid water (or water alone if soap not available)", World Health Organisation, 2017).

Four documents recommend that interim decontamination should be conducted, however the guidance on this is limited, with one document suggesting "patients are guided through a decontamination corridor" (US Department of Homeland Security, 2014) and another document stating there is no national standard for how interim decontamination is carried out, but it should last between 45-60 seconds and use any available source of water (NHS England, 2015). Two documents just state that decontamination will be either improvised, interim, or mass, but do not provide any guidance on how or when interim decontamination should be carried out (JESIP, 2016; US Department of Homeland Security, 2014).

Thirteen documents recommend that decontamination is conducted in a CBRNe incident, but do not advise how decontamination is carried out (e.g. "initial skin decontamination should be completed", Joint Chiefs of Staff, 2016; "decontamination should be administered as appropriate", NATO, 2014).

3.1.4. Dry decontamination

Twenty-nine documents recommend that dry decontamination may be necessary, depending on the scenario. Twelve documents recommend using dry decontamination as the default decontamination method e.g. "dry decontamination is the default method in the UK for non-caustic substances" (Public Health England, 2019) and wet decontamination should only be used when the substance is "corrosive" or "itchy" (e.g. "if there are signs of caustic chemical, use water from any available source to dilute and flush the contaminant", Home Office, 2015). Nine documents recommend that dry decontamination should always be followed by wet decontamination, regardless of what the substance is (e.g. "decontamination should be conducted by first absorbing the liquid on the skin, then decontaminate by showering and using soap", Swedish Civil Contingencies Agency, 2014/2019). Kirklees Council (2017) recommend that although dry decontamination may be carried out alone at the scene of the incident, casualties must undergo a full wet decontamination before admission to hospital. Furthermore, there are four documents that discuss decontamination of hair and these recommend that wet decontamination is always used when hair is suspected to be contaminated (e.g. "those with long or thick matted hair should wash their hair in running water leaning forward", NHS England, 2015).

3.1.5. Re-robing

Although 60 documents recommend disrobing following a CBRNe incident, only ten documents recommend re-robing following an incident. All of the documents that recommend re-robing recommend the casualty putting on fresh clothes (e.g. “Wet wipes may also be used on exposed skin before re-robing with clean clothing”, Public Health England, 2019), however the Centre for Disease Control and Prevention recommends if fresh clothes are not available, casualties should “shake or brush off clothes and put them back on, then rewash hands and face” (Centres for Disease Control and Prevention, 2018).

3.1.6. Commencing life-saving treatment prior to beginning decontamination

Twenty documents recommend completing any life-saving first aid treatment prior to initiating decontamination (e.g. “Everyone nearby or in contact with a suspicious item is separated from non-contaminated people and held by the police until the public health officer comes. This does not include life-threatening situations requiring immediate medical treatment”, Federal Office of Civil Protection and Disaster Assistance (BBK) and Robert Koch Institute, 2007; “patients should be decontaminated before treatment, unless their condition is life threatening”, NHS Shetland, 2014). The World Health Organisation recommend that patients should be decontaminated prior to entry to health care facilities, however decontamination should occur in parallel with triage and the provision of life-saving interventions (World Health Organisation, 2014).

3.1.7. Shelter in place

Eighteen documents recommend that the public shelter in place, rather than evacuating or moving away from the incident. Advice for sheltering in place seems to be given for four main reasons: (i) when evacuation is not immediately necessary (e.g. United States Environmental Protection Agency, 2017); (ii) when it is too dangerous to leave the immediate area (e.g. Centres for Disease Control and Prevention, 2019); if already in a safe location at the time of the incident (e.g. New South Wales Government, 2016). Furthermore, for nuclear disasters, the Department of Homeland Security (2018) recommend staying inside for 24 hours following the incident, unless otherwise instructed. Four of the documents that recommend sheltering-in-place state that the public will be advised by authorities when it is safe to exit their sheltering location (e.g. Centres for Disease Control and Prevention, 2019).

3.2. Guidance on how to communicate with members of the public.

Fifty four of the 95 documents acknowledge the importance of providing a strategy to emergency responders for communicating with members of the public. Twenty two of these documents outline a communication strategy for those at the incident site, 19 are aimed at the general public, 6 are aimed at who have self-evacuated away from the scene (four specifically for those who self-present at hospitals, and one for those who turn up at a shelter), two are aimed at the person reporting an incident to the emergency services, one

document provides a strategy both for those at the scene and for people reporting the incident to emergency services, one document provides a strategy for those at the incident scene and those who have evacuated, and two documents provide a strategy both for those at the incident site, and members of the general population.

However, the documents vary in the amount of detail that is provided around how to communicate. For communication strategies at the incident site, the level of detail provided in recommendations ranges across the documents from a few words (e.g. “give immediate medical advice and reassurance that help is on its way”, Police Scotland, 2018) to detailed paragraphs describing how information should be communicated and what information should be communicated (e.g. “First responders should communicate: what they know of the nature of the incident, what the emergency services are doing and how these actions will help, medical assistance is coming and they should not leave the scene, advice and instructions from the emergency services should be followed, those that are capable should assist others who are injured or less able to carry out tasks, why and how casualties need to be disrobed and decontaminated, do not eat, drink, smoke or touch your face”, Home Office, 2015).

Three documents state that information provided to the public in an incident should start from the very first call to the emergency services, and it is the job of the call holder to provide this information (“response starts from the very first call to the emergency services and it is the role of the call handler/supervisor is to provide correct advice to the caller”, Home Office, 2015; “Fire control room staff and first responders should give members of the public advice on what actions to take”, National Operational Guidance Programme, 2018b).

Two documents recommend that communication should be pre-planned. One of these documents is aimed at those who have evacuated away from the incident scene and self-presented at hospital: “pre-recorded messages should be considered” (Office of Preparedness and Emergency Management, 2014). The other document is aimed at members of the general public who are away from the incident scene: “pre-prepared messaged should focus on radiation response activities for state and local public health, hospitals, businesses, individuals and families, community organizations and schools” (Akola District Disaster Management Authority, 2017). Whilst one document recommends that information provided to the general public should be pre-scripted as far as is practicable, it also recognises that messages may need to be prepared or revised as the incident progresses (Ministry of Community Safety and Correctional Services, 2017). Two further documents recommend that in addition to pre-planned messages, information should also be provided to the general public through pre-agreed communication channels (“a pre-agreed communication plan for the public should be implemented via pre-agreed communication channels/methods” (NATO, 2014); “Pre-scripted and printed follow up information should be provided to patients before they leave the scene” (US Department of Homeland Security, 2014)). One document recommends that pre-recorded messages should be used at the incident scene, and these should be provided in the most frequently used languages (US Department of Homeland Security, 2014).

Within the documents, the communication strategy can be separated into three distinct sub-categories: 1) general communication and explanation (includes explanations about the nature of the incident, explanations about why certain actions are necessary, and principles of effective communication strategies); 2) practical information (includes recommendations about what practical instructions people need to be given); and 3) communication channel (includes recommendations about how best to provide people with information).

3.2.1. General communication and explanation

A key emphasis on communication highlighted in several documents is on clear, precise and true information that is conveyed to people at the incident site, those who have evacuated, and the general public, in an empathetic and sensitive way. For example, at the incident site: “it should be clearly explained to patients what is expected of them in the self-decontamination process” (Queensland Government, 2015). The Secretariat General de la Defense et de la Securite Nationale (2014) describe the communication of transparent and clear information about accidents and their development to the general public as “a basic right of citizens”. The Australian Government Department of Health (2018) suggest that communication to the general public should follow a key principle of “openness and transparency”. A central focus for NHS England is that communication to those who have evacuated and self-presented at a nearby hospital or health facility should be “centred around showing respect, treating people as individuals and respecting the public’s needs” (NHS England, 2019).

Two documents recommend that information is provided to the general public at regular intervals. For example, Bundesministerium des Innern (2016) describe the provision of regular updated messages as important to ensure that people are able to take the appropriate measures to protect themselves. Two documents specify that all information should permanently be available to members of the public (e.g. “This information should be permanently available to the public”, Ministry of Defence, 2017).

One document provides specific information that should be provided for those not present at the immediate scene of an incident: “who is likely to be affected (based on geographical proximity to the incident, wind speed and direction, health and age vulnerability and other factors), actions necessary to prevent or mitigate the effects of exposure, availability and location of treatment, and the numbers of confirmed illnesses or deaths” (Akola District Disaster Management Authority, 2017). For a nuclear incident, Portsmouth and Southampton City Council (2016) recommend that members of the general public are provided with “basic facts about radioactivity and its effects on people and the environment” as well as “information on the actions to be taken in a radiation incident”. The document specifies that it is essential that this information is distributed wider than the immediate emergency zone to provide assurance to the public. Other documents provide more vague advice for communicating with members of the general public, for example “public information releases should be issued covering urgent protective actions” (The Scottish

Government, 2015), “warn people who are close to the affected area” (Swedish Civil Contingencies Agency, 2014/19).

Whilst five documents provide advice for communicating with those who have evacuated and self-presented either at a hospital or at a shelter, two documents provide advice for communicating with people that have evacuated away from the incident scene and who do not self-present at a nearby hospital or shelter. One document recommends that messages provided to these people must “convey specific advice (at home: undressing, bagging clothing, showering), and encourage the population likely to have been in contact with the contaminant to go as quickly as possible to designated reception centres.” (Law, 2011). The other document does not specify any actions people who self-evacuate must take, but just emphasises that information should be provided to them: “Guidance should be given to this population through multiple communication methods (television, radio, internet and social media) on what actions to take and how to decontaminate themselves” (National Center for Environmental Health, 2014).

3.2.2. Practical information

Eight documents discuss that practical information to do with the incident should be provided to those at the scene of the incident or to those who have evacuated and self-presented at a nearby hospital. This information ranges in detail from a basic, generic message (e.g. “The procedure should be explained to the patient”, Permanent Conference on Disaster Preparedness and Population Protection, 2008), to more detailed explanations of the actions they should take to help themselves and others (e.g. “it should be communicated: why and how casualties need to disrobe and decontaminate, those who are capable should assist others who are less able, more help is coming and don't leave, don't eat, drink or smoke and avoid touching face”, NHS England, 2019). Only one document provides specific details on what someone should do if they have been exposed to a hazardous substance (NARU, 2018). This document recommends to tell those affected to:

> “remove themselves from the immediate area to avoid further exposure to the substance. Fresh air is important. If the skin is itchy or painful, find a water source. Remove outer clothing if affected by the substance. Try to avoid pulling clothes over the head if possible. Do not smoke, eat or drink. Do not pull off clothing stuck to skin. Remove the substance from skin using a dry absorbent material to either soak it up or brush it off. Rinse continually with water if the skin is itch or painful” (NARU, 2018).

All other documents that discuss providing advice on the actions people should take only provide more generic advice, for example “the disrobe and decontamination procedure should be explained to the patient” (NHS Foundation Trust, 2016).

3.2.3. Communication channel

Seven documents discuss the best way to communicate information to members of the general public, and those who have evacuated during CBRNe incidents. For example, the National Center for Environmental Health (2014) recommends that messages should be communicated to members of the general public through television, radio, internet, and social media. It is emphasised in several documents that messages should be consistent across communication channels (e.g. “guidance should be given to people who self-evacuate through communications methods e.g. tv, radio, internet, social media etc. on what actions to take and how to decontaminate themselves. Messages should be consistent across these platforms”, National Center for Environmental Health, 2014). NATO (2014) states that this mode of communication should be pre-planned but does not offer any advice on what mode it should be.

Four documents recommend using a public address system to communicate with people at the incident site. For example, Association of Chief Police Officers (2014) recommend using a public-address system, a hand-held radio, or another standalone system and emphasises that mobile phones should not be relied on.

Four documents state that certain instructions (e.g. disrobe) should be demonstrated by emergency responders to the people at the incident site to aid understanding (e.g. “Demonstrations of how to disrobe and decontaminate should be considered”, NHS England, 2019; “the decontamination team encouraged to act out key decontamination functions”, Office of Preparedness and Emergency Management, 2014).

The US Department of Homeland Security recommends that people at the incident site should be provided with pre-scripted and printed follow up instructions to take away with them before they leave the scene of the incident (US Department of Homeland Security, 2014) and the Office of Preparedness and Emergency Management recommends that debrief sessions should be conducted with all patients following decontamination to allay fears and provide information and resources regarding follow-up care (Office of Preparedness and Emergency Management, 2014).

3.2.3.1. Communication Apps

The review of communication tools identified three apps that could be used to facilitate communication between first responders as well as law enforcement agents and members of the public during CBRNe emergencies. These included the Be-Alert app, which can be used to send emergency alerts to individuals signed up to the app, the S.O.S. Emergencias app, which allows civilians to send their location to emergency services and communicate with emergency services, and the FEMA app, which allows users to receive alerts, send disaster pictures to authorities and call the FEMA hotline. However, only two of these apps allow for bidirectional communication between authorities and members of the public. Further, neither of these apps were designed to meet the needs of members of vulnerable groups. The low number of communication tools identified in this search is in-line with findings from a survey of 223 first responders and law enforcement agents from 23

countries, which revealed that only 11% of respondents indicated that their organisation uses an App to communicate with the public (Arnold et al., 2020). The two apps that were specifically mentioned by responders in this study were BE-ALERT and SOS Emergencias. It is therefore clear that there is a need to develop an App that allows for authorities and the public to communicate with each other, and which is specifically designed to meet the needs of members of vulnerable groups.

3.3. Guidance on how members of the public are likely to behave in a CBRNe incident

Twenty-three documents discuss how the public are likely to respond in a CBRNe incident. These documents vary in their approach to likely public behaviour, with some suggesting public behaviour will be broadly negative (e.g. panic, disorder), and others suggesting it will be broadly positive (e.g. orderly, no panic). One guidance document highlights that everybody will respond differently to a CBRNe incident, with behaviour ranging from calm to panic and violence (Bundesamt für Bevölkerungsschutz und katastrophenhilfe, 2009).

One of the 23 documents states that people who are involved in a CBRNe incident will be anxious: “CBRN incidents would cause heightened public anxiety and result in substantial disruption to citizens lives and the economy” (Secured Urban Transportation - European Demonstration, 2014), while another states that people will be afraid: “the general population will not have a detailed knowledge of radiation and its effects on both the environment and humans. There is likely to be fear and suspicion about anything connected to radiation” (The Scottish Government, 2015). In addition, two documents suggest that people are likely to panic either due to a lack of confidence in local authorities: “migrants from southern countries, at least in the first generation of migration, will react anxiously in some cases, possibly even panic, when events occur that threaten them because they have no confidence that the local organisations involved in security are up to the task” (Bundesamt für Bevölkerungsschutz und katastrophenhilfe, 2010), or because the protective clothing worn by responders in a CBRNe incident can cause “panic and hysteria to members of the public” (Federal Office of Civil Protection and Disaster Assistance (BBK) and Robert Koch Institute, 2007). Two documents suggest that members of the public may behave in unpredictable (“affected people react self-centred and unpredictable”, Sudhoff, 2016) or unresponsive (“Casualties are likely to be traumatised and therefore may act in an unexpected way e.g. they may be completely unresponsive to commands or unaware of danger”, National Operational Guidance Programme, 2015) ways. In addition, five documents suggest that members of the public involved in a CBRNe incident may experience strong feelings of stress. Stress in a CBRNe incident can be caused by: “loss of privacy and personal vulnerability as well as ethical and moral problems” (Bundesamt für Bevölkerungsschutz und katastrophenhilfe, 2009), decontamination (Queensland Government, 2015; NHS Foundation Trust), radiation incidents (Centres for Disease Control and Prevention, 2015), and acute anxiety caused by the incident (“symptoms of radiation illness can produce devastating psychological effects on an entire community. Acute anxiety

may lead to emotional stress and poor performance", Oak Ridge Institute for Science and Education, 2017).

On the other hand, three documents state that public behaviour will be orderly and with no panic (e.g. "evidence suggests public behaviour will be orderly and there will be no panic", NHS England, 2019). NHS (2019) suggests that this "is determined by how the incident is managed" and explains that "ineffective management may result in reduced compliance". Bundesamt für Bevölkerungsschutz und Katastrophenhilfe (2008) suggest that most members of the public are likely to behave "normally" and "pro-actively".

The US Department of Homeland Security (2014) suggest that most patients will need instructions on how to behave. For example, "a perceptive patient, or one experiencing distress, may execute self-decontamination before responders arrive, however most patients will need instruction" (US Department of Homeland Security, 2014). However, four documents suggest that people might not respond in appropriate ways to advice and may not carry out protective actions recommended. Schneider (2015) suggests "Many people do not respond appropriately to warning messages or do not immediately take the recommended protective measures following the warning message". People may be reluctant to follow instructions due to patients being "reluctant to remove clothing in cold weather environments (Office of Preparedness and Emergency Management, 2014) and responders "failing to respect privacy needs of patients" (NHS England, 2019).

It is suggested within two documents that the public (particularly children) might find the situation uncomfortable (US Department of Homeland Security, 2014; American Academy of Pediatrics, 2015). One document states: "a survivor, who is left alone without hope of recognizable help, may experience a strong sense of powerlessness" and then goes onto state "survivors have a strong need of regaining control over the situation" (Federal Office of Civil Protection and Disaster Assistance (BBK) and Robert Koch Institute, 2007).

Six documents suggest that people may self-evacuate. For example, "patients may self-decontaminate themselves and leave the scene" (US Department of Homeland Security, 2014), "there is a possibility of self-evacuation of patients from the scene (Office of Preparedness and Emergency Management, 2014). Five of these documents suggest that people will evacuate to the nearest treatment centre or hospital, for example "members of the public may leave the scene and subsequently seek assistance at a nearby health facility" (NHS England, 2019).

One document suggests that people will want to trace family members who may have been involved ("people will travel to the scene or other focal points if they believe that their family or friends may have been involved", Norfolk Resilience Forum, 2016) and will want reassurance that family members and friends are accounted for and safe ("people will be anxious to trace family members and friends who live, work, visit or attend school in the affected area. People sheltering in the affected area will wish to be reassured that displaced

family members are accounted for and safe", Portsmouth and Southampton City Council, 2016).

3.4. Guidance on strategies for managing vulnerable populations during a CBRNe incident

Thirty-three documents discuss strategies for managing vulnerable groups during a CBRNe incident. Six documents only provide short sentences in relation to the management of vulnerable groups, for example "care must be taken to adjust for religious, cultural and social customs" (Oak Ridge Institute for Science and Education, 2017), "consideration should be given to issues such as language barriers" (NHS, 2019), "considerations should be given to cultural and religious sensitives and also learning disabilities or mental health issues (NHS, 2019).

Three documents give more detailed paragraphs stating a specific strategy for managing vulnerable populations. For example,

> "Care should be taken to ensure patients suffering from very high levels of emotional distress are provided adequate access to appropriate interventions, such as crisis counselling. Patients should be provided privacy during the process. Patients should ideally be separated individually, but if not possible then by gender. Same gender staff should ideally be used, but this is not always possible. Re-robing should occur as soon as possible post-decontamination. There may be a role for mental health professionals in the post-decontamination process in dealing with psychological distress amongst patients. Effort should be made to keep children with parents or carer. If children are alone they should be assisted through the decontamination process. Children should be closely observed during decontamination due to their greater vulnerability to hypothermia. Laundry baskets/infant baths could be used to carry and decontaminate infants" (Queensland Government, 2015).

Queensland Government (2015) recommends that patients suffering from very high levels of emotional distress should be provided with access to appropriate interventions, such as crisis counselling (Queensland Government, 2015).

Three documents highlight the need to consider gender when managing a CBRNe incident. Two of these documents state that patients should be separated by gender and have a member of staff of the same sex, where possible: "staff should deal with patients of the same sex and patients of different sexes should not be mixed, where possible" (NHS Foundation Trust, 2016). However, one document recommends that separating patients by their sex should always be possible "a sex separation (and if only by a privacy shield) should always be possible" (Federal Office of Civil Protection and Disaster Assistance (BBK) and Robert Koch Institute, 2007).

Four documents discuss issues around the management of children during CBRNe incidents. Two of these documents state that children should be allowed to remain with their parent or caregiver (e.g. “families, including caretakers, should be permitted to remain together during the decontamination process”, US Department of Homeland Security, 2014). Recommendations for if a child is alone when a CBRNe incident takes place include to provide assistance and to observe them for hypothermia (see Queensland Government, 2015), and “the responder should make eye contact and try to explain what is happening and assist the child through decontamination” (US Department of Homeland Security, 2014). To aid in helping a young child through the decontamination process, both Queensland Government and the US Department of Homeland Security recommend that a laundry basket or infant bath could be used to carry the child. Two documents recommend that children should be prioritised for decontamination before adults, with Office of Preparedness and Emergency Management (2014) clarifying this is in both ambulatory and non-ambulatory groups.

Eight documents highlight the need for recognition of cultural and religious issues. Five of these documents provide a brief sentence mentioning that consideration needs to be given to cultural and religious issues, for example “cultural and gender needs must be taken into account” (Scottish Government, 2016); “cultural and religious practices should be taken into consideration” (US Department of Homeland Security, 2014). One document provides a detailed strategy of how to decontaminate Muslim citizens:

> “If it’s necessary to decontaminate Muslim citizens, this can become difficult due to cultural-religious commandments: They are prohibited from undressing in public. There are several possible courses of action: (1) They can refer to the central legal principle of Islam "necessity breaks commandment": in emergency situations Muslims are allowed to take actions that are not otherwise permitted; (2) Secure the support and the permission to undress by male escorts of the Muslim woman. Preferably turn to a respect person of the family or the group (e.g. the family elder); (3) If possible, ensure that a religious respected person (Imam) is called in in the cordoned-off area by the psychosocial acute helpers (emergency pastors, KIT) there” (Bundesamt für Bevölkerungsschutz und katastrophenhilfe, 2009).

Although this document highlights the importance of taking into account religious needs, it specifies that accommodating religious needs “must not be at the expense of those who are willing to decontaminate”. Norfolk Resilience Forum (2016) also provides some detailed recommendations for dealing with patients with cultural and religious needs, such as “requirements may relate to a place for prayer” and “it is important to engage appropriate faith, religious and ethnic community leaders at an early stage”. How to deal with fatalities in a religious context is also discussed in this document: “where there are fatalities, responders should be aware of customs in respect of dealing with the deceased. Hospital Chaplains are conversant with these customs and could be asked to assist”.

Six documents recognise that language barriers between patients and responders can cause difficulties in patients following instructions. One document provides a short sentence acknowledging this issue: “consideration should be given to issues such as language barriers” (NHS, 2019). The other documents provide more detail, for example Scottish Government (2016) recommend that interpreters and printed instructions are provided and the US Department of Homeland Security (2014) specify these instructions should be provided in the most commonly used languages. One document recommends that information that is “comparable in content and detail” should be provided to “all patients who have a disability or limited English proficiency” (Office of Preparedness and Emergency Management, 2014). Two documents recommend that instructions should also be provided in pictographic forms (US Department of Homeland Security, 2014) or with universal sign language or videos (National Center for Environmental Health, 2014).

It has been recognised across three documents that those with mobility issues (either pre-existing or as a result of the incident) may require additional support during the decontamination process. NHS (2019) recommend that “in those who struggle undergoing decontamination, responders should make provisions of assisting these individuals whilst maintaining no physical contact”. Another document specifies that non-ambulatory of mobility impaired patients may not be able to perform self-care and will need personnel to assist them through the process with specialised equipment (US Department of Homeland Security, 2014). Office of Preparedness and Emergency Management (2014) state that “extra care should be taken when decontaminating with water for those with walkers, canes, wheelchairs, paediatrics, geriatrics, service animals and non-ambulatory patients” and goes on to recommend that “if equipment or devices can’t be decontaminated, a procedure should be in place to replace them after decontamination”. In addition, US Department of Homeland Security (2014) recommend that “a plan should be in place for service animals and where possible they should be kept with the patient”.

4. DISCUSSION

The purpose of this research was to review guidance documents relating to CBRNe incident management. It is clear from the documents identified that there is a heavy focus in guidance on the practical and physical aspects of CBRNe incident management (e.g. decontamination, disrobe, evacuate etc.), yet there seems to be a lack of detailed recognition for psychosocial aspects (psychological and social factors associated with human behaviour). Research looking at the impact of psychosocial aspects of public behaviour in a CBRNe incident suggests that the ways emergency responders manage it can have a substantial effect on the ways that the public behave (e.g. Carter & Amlôt, 2016; Carter et al., 2014; Carter et al., 2013a). Therefore, although it is important to provide practical and physical recommendations to responders to enable them to manage the

incident, ensuring that they also consider psychosocial aspects and interactions with the public should not be overlooked.

4.1. Discrepancies in recommended behaviour within and between countries

To our knowledge, this review is the first guidance review to encompass guidance documents relating to CBRNe management across different countries and languages, with the review incorporating 95 guidance documents from 18 different countries. What is clear from this review is that there is inconsistency in the information that is provided in the documents *between* countries. For example, there are clear discrepancies in the recommendations for conducting wet decontamination between countries. One UK document states that decontamination should last between 45-90 seconds (NHS England, 2015), whereas a Canadian document recommends washing with soap and water for 15 minutes following exposure to hazardous materials (Kingston Health Sciences Centre, 2018) and an Australian document recommends that wet decontamination should last no longer than three minutes (Queensland Government, 2015). Interestingly, there also seems to be inconsistency in guidance documents *within* a country, for example in another document from the UK, it is specified that decontamination should be delivered for a minimum of 90 seconds (NHS England, 2019) as compared to the previously stated 90 second maximum (NHS England, 2015). Both of these documents are from the same organisation (The NHS), yet they provide conflicting information. As they are from different years (2019 and 2015, respectively) it is likely that the later document is an updated version, yet this should be made clear in the older document to prevent outdated information being used. Another discrepancy arises both *within* and *between* countries as one UK document recommends first showering with clothes on, then undressing and re-showering without clothes (Newman University, Birmingham, 2014), whereas all other documents recommend removing clothes prior to showering or decontamination. These discrepancies are worrisome and can lead to confusion in how to respond to a CBRNe incident.

Another interesting observation across the documents is that there seems to be no standardised method of response to a CBRNe incident both within and between countries. Most documents recommend decontamination of some form (i.e. dry, wet, showering, interim), yet there does not seem to be any consistency in how documents recommend these procedures are carried out. For example, some documents recommend taking a shower (e.g. Centres for Disease Control and Prevention, 2018) whilst others recommend using a moist cloth (e.g. Division of Homeland Security and Emergency Management, 2019). The only consistencies in decontamination method across all documents, regardless of country seem to be in relation to hair contamination (e.g. Swedish Civil Contingencies Agency, 2014/2019) or when the contaminant is caustic (e.g. Scottish Government, 2016), in both cases washing with copious amounts of water is recommended.

Whilst eight out of the nine documents that recommend re-robing following decontamination recommend putting on clean, un-contaminated clothes, a worrying recommendation from

one document is that casualties should put back on contaminated clothing if clean clothes are not available (Centres for Disease Control and Prevention, 2018). Although the document states that casualties should shake or brush the clothes to remove the contaminant before putting them back on, there is no guarantee that this will remove all the contaminant from the clothes and the casualty risks re-contaminating themselves with a harmful substance, causing a potential for significant harm to the casualty.

Across 15 documents from ten countries (United Kingdom, Czech Republic, Germany, Australia, England, Scotland, Latvia, France, America and Sweden) and in a document from the World Health Organisation, there seemed to be a consensus that life-saving medical treatment should take priority over decontamination. Although it is positive there is consensus across these countries, this guidance is covered in only approximately 15% of documents. In the 79 documents that do not recommend that life-saving actions should take priority, this important advice might be overlooked.

4.2. Specific communication strategies are lacking in guidance documents

In terms of communication strategy, there seems to be about a 50/50 split in documents as to whether communication is mentioned. However, when it is mentioned, there does not seem to be any consistency across documents in how much information is provided. Documents that only provide short sentences would benefit greatly from providing more details about what to communicate to the public and also how to communicate this information, whether this is through media channels, loud speakers, etc.

Two UK documents (Home Office, 2015; National Operational Guidance Programme, 2018b) provide an interesting recommendation that a communication strategy to the public should be implemented from the very first phone call to the emergency services. In the UK, it is estimated that emergency responders will arrive at the scene of a CBRNe incident and be able to begin implementing decontamination and other procedures within 15 minutes of an incident being reported. The ability for call handlers to be able to start offering advice to casualties about actions they should be taking in those initial stages of an incident before emergency services arrive could potentially save lives.

Clear, precise and truthful communication is emphasised across documents with the provision of regular updates to the public being recommended (e.g. Bundesministerium des Innern, 2016). However interestingly, a French document describes clear and honest communication as a basic human right (Secretariat General de la Defense et de la Securite Nationale, 2014) suggesting that this communication is not just recommended, but instead that it must be carried out.

Across the documents that discuss a communication strategy, eight of these documents discuss practical information that should be provided to those at the scene of the incident, for example communicating why and how people should decontaminate (NHS England,

2019). However, the practical information that is provided seems to be very generic and there is no clear practical communication strategy across any document. For example, there is no information that is suggested to be communicated to the public about how they should disrobe (e.g. cut clothes/do not remove over the head) or how decontamination will be carried out (e.g. blot and rub using dry absorbent material). Guidance documents would benefit from having a clear strategy for communicating this information to the public to prevent confusion, build trust and reduce non-compliant behaviour.

Although five documents do discuss communicating with members of the public who are not at the scene of the incident, or whom may have self-evacuated, these two groups (those at the scene vs. those not at the scene) should be clearly distinguished in communication strategies.

Furthermore, this review shows that countries seem to have an understanding of the importance of utilising different media channels to communicate with members of the public with documents from America, Australia, Austria, France, Germany and Latvia recommending that messages are conveyed to members of the public through television, radio, internet and social media. However, there seems to be less consistency in the recommended modalities for communicating with people at the scene of the incident. Four documents recommend using some form of public address system to convey information to the public. Four further documents recommend that certain information should be demonstrated to the public to aid in understanding. Although additional modalities of communicating with people at the scene may not always be necessary depending on the size of the incident scene and the number of casualties, it is important that responders are aware that there might be a need to use additional modalities and are aware of what these are.

4.3. Likely public behaviour should be addressed in guidance documents

Approximately one quarter of documents mention how the public are likely to respond in a CBRNe incident. There is inconsistency across these documents in how members of the public are likely to respond. Four of these documents are in line with the common myths around disasters and suggest that members of the public are likely to panic (e.g. The Scottish Government, 2015). A further four documents suggest that members of the public are likely to be non-compliant with instructions from responders (e.g. US Department of Homeland Security, 2014). On the other hand, three documents explicitly state that public behaviour will be orderly with no panic (e.g. NHS, 2019). Guidance documents need to be updated to reflect current evidence relating to likely public behaviour during mass emergencies which suggests that, far from panic and mass disorder being common, people will actually behave in a helpful and cooperative way (e.g. Aguirre et al., 2011; Carter et al., 2012; Carter et al., 2015; Cornwell, 2001; Johnson, 1987; Quarantelli, 1954). A reliance on common myths about public behaviour during mass emergencies (e.g. mass panic and

public disorder) may result in control management strategies that involve withholding information and disregarding public needs (Carter et al., 2013a; Carter & Amlôt, 2016).

Nearly 40% of documents discuss vulnerable groups, and across these documents, the discussions seem to be split into four main groups of vulnerability: gender and privacy issues; children; mobility issues (e.g. ambulant casualties, blind people, people who require walking aids etc.) cultural and religious issues; and challenges with communicating. The amount of guidance provided for these groups ranges from a short sentence mentioning that consideration should be given to them with no guidance on how to meet their additional functional needs (e.g. Australian Government Department of Health, 2018) to detailed paragraphs describing a strategy for managing them and meeting their functional needs (e.g. Bundesamt für Bevölkerungsschutz und katastrophenhilfe, 2009). It is clear from this review that there needs to be a greater focus placed on managing the needs of vulnerable groups in guidance documents to ensure that the needs of these individuals are met.

4.4. Limitations

The main limitation of this review was that it was not possible to carry out an exhaustive search of all guidance documents. Due to the large number of results that were generated by each search and the lack of feasibility in reviewing all results, the search was limited to the first 200 results of each search term. As a result, there is a possibility that not all relevant documents were identified. However, a comprehensive method for conducting the search was developed, utilising four separate search options (advanced Google search, target website search, grey literature database search, and consultation with project partners), therefore missing results should be kept to a minimum. A second limitation is that only documents that were available in open literature were used for this review. A final limitation is that although non-English documents were able to be utilised for this review, it is possible that some information may have been missed through translation.

5. CONCLUSION

This systematic review of guidance, SOPs and tools for CBRNe mitigation and management identified 95 relevant documents, from 18 different countries across Europe and beyond. Data relating to various key aspects of incident response was extracted, including: perceptions of likely public behaviour during CBRNe incidents, strategies for communicating with members of the public during CBRNe incidents, and procedures for the management of members of vulnerable groups during CBRNe incidents. Extracting this data enabled common themes to be identified from the tools, SOPs and guidance documents to generate an understanding of current policy and procedures for CBRNe management across different organisations and countries.

Although evidence shows that it is important to be mindful of the psychosocial aspects of CBRNe management, this review of guidance, SOPs and policy documents shows that this is rarely reflected when planning for these kinds of incidents. There is a need for guidance and policy to be updated across Europe to reflect the importance of recognising psychosocial aspects of CBRNe response. In addition, there are worrying discrepancies in advice in guidance documents both within and between countries, therefore highlighting a need for these discrepancies to be reviewed and updated to ensure consistency in response.

On the basis of these outcomes, four provisional recommendations are detailed. These recommendations are as followed:

> **Recommendation 1**: Incorporate up-do-date evidence-based advice in guidance and policy on how members of the public are likely to respond in a CBRNe incident.
>
> **Recommendation 2**: Update guidance and policy to incorporate a detailed communication strategy for how emergency responders should communicate with casualties and members of the public during a CBRNe incident.
>
> **Recommendation 3**: Ensure guidance and policy have a clear strategy on how to manage vulnerable groups in a CBRNe incident.
>
> **Recommendation 4**: Review any discrepancies in documents both within and between countries to ensure consistency in recommendations on how emergency response organisations should respond to a CBRNe incident.

These recommendations will be further explored and developed when the outcomes from D1.2 are synthesised with the findings from D1.1 for presentation within D1.3.

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Documents were sent to the researcher from project partners with a transcription of a summary key points in English.

7. APPENDICES

Appendix 1. Search terms used for the advanced Google search, target website search and grey literature database search.

Type of management	Type of incident	Type of guidance
Decontamination	CBRN(e)	Standard operating procedure
Lockdown	CBRN	Guidance
Quarantine	Chemical	Policy document
Airport security	Biological	Report
Operational response	Radiological	
Evacuation	Nuclear	
Vulnerable		
Tools		

Appendix 2. Guidance documents relating to CBRNe management.

Organisation	Year	Country	Single/ multi-agency	Incident type	Nature of incident	Management strategy	Communication strategy	Public behaviour	Vulnerable groups
Akola District Disaster Management Authority	2017	India	Multi-agency	CBRN	Intentional	Dry decontamination Wet decontamination	incident site General public	N	Y
American Academy of Pediatrics	2015	America	Multi-agency	Chemical	Intentional and unintentional	Wet decontamination	N	Y	Y
Association of Chief Police Officers	2014	United Kingdom	Multi-agency	Hazardous materials	Intentional	Evacuation	General public	N	N
Ausschuss Feuerwehrangelegenheiten, Katastrophenschutz und zivile Verteidigung	2012	Germany	*	Hazardous materials	*	Disrobe Wet decontamination	Incident site	N	N
Australian Government Department of Health	2015	Australia	Multi-agency	Chemical	Intentional	Disrobe Re-robe Wet decontamination	N	N	N
Australian Government Department of Health	2018	Australia	Multi-agency	CBRN	Intentional	N	General public	N	Y
Bundesamt für Bevölkerungsschutz und Katastrophenhilfe	2008	Germany	*	Hazardous materials	*	N	General public	Y	N
Bundesamt für Bevölkerungsschutz	2009	Germany	*	CBRN	*	Decontamination Disrobe	General public	Y	Y

Organisation	Year	Country	Single/ multi-agency	Incident type	Nature of incident	Management strategy	Communication strategy	Public behaviour	Vulnerable groups
und katastrophenhilfe						Evacuation Life-saving treatment			
Bundesamt für Bevölkerungsschutz und katastrophenhilfe	2010	Germany	*	Hazardous materials	*	N	Incident site	Y	Y
Bundesamt für Bevölkerungsschutz und katastrophenhilfe	2018	Germany	*	Hazardous materials	*	N	Incident site	N	N
Bundesministerium des Innern	2016	Germany	Multi-agency	Hazardous materials	Intentional and unintentional	Wet decontamination	General public	N	N
Centers for Disease Control and Prevention	2015	America	Multi-agency	Radiological	Doesn't specify	Disrobe Dry decontamination Life-saving treatment Wet decontamination	Evacuated to shelters	Y	N
Centers for Disease Control and Prevention	2018a	America	Multi-agency	Dirty bomb	Intentional	Disrobe Shelter in place Wet decontamination	Incident site	N	N
Centres for Disease Control and Prevention	2018b	America	Multi-agency	Radiological	Doesn't specify	Disrobe Re-robe Wet decontamination	N	N	N
Centres for Disease Control and Prevention	2018c	America	Multi-agency	CBRN	Doesn't specify	Disrobe Dry decontamination Wet decontamination	N	N	N

Organisation	Year	Country	Single/ multi-agency	Incident type	Nature of incident	Management strategy	Communication strategy	Public behaviour	Vulnerable groups
Centres for Disease Control and Prevention	2018d	America	Multi-agency	Radiological	Doesn't specify	Evacuation	Incident site	N	N
Centers for Disease Control and Prevention	2019	America	Multi-agency	Chemical	Intentional and unintentional	Disrobe Evacuation Shelter in place Wet decontamination	N	N	Y
Centers for Disease Control and Prevention	No date	America	Multi-agency	Radiological	Doesn't specify	Disrobe Re-robe Wet decontamination	N	N	N
Centre for the Protection of National Infrastructure	2016	United Kingdom	Multi-agency	CBRN	Intentional	Evacuation	N	N	N
Civil Defence Association Austria	No date	Austria	*	Radiological	Unintentional	Disrobe Shelter in place Wet decontamination	Incident site	N	N
Department of Fire and Emergency Services, Western Australia	2016	Australia	Multi-agency	Hazardous materials	Unintentional	Evacuation Shelter in place	General public	N	N
US Department of Homeland Security	2014	America	Multi-agency	Chemical	Not specified	Disrobe Evacuation Life-saving treatment Wet decontamination	Incident site	Y	Y

Organisation	Year	Country	Single/ multi-agency	Incident type	Nature of incident	Management strategy	Communication strategy	Public behaviour	Vulnerable groups
Department of Homeland Security	2018	America	Multi-agency	Nuclear	Not specified	Disrobe Evacuation Shelter in place Wet decontamination	General public	N	N
Department of Homeland Security	No date a	America	Multi-agency	Hazardous materials	Intentional	Evacuation Shelter in place	N	N	N
Department of Homeland Security	No date b	America	Multi-agency	Chemical		Disrobe Evacuation Shelter in place Wet decontamination	N	N	N
Department of Homeland Security	No date c	America	Multi-agency	Biological	Not specified	Disrobe Wet decontamination	Incident site	N	N
Division of Homeland Security & Emergency Management	2019	America	Multi-agency	Hazardous materials	Intentional and unintentional	Evacuation Shelter in place Wet decontamination	N	N	N
Federal office of civil protection and disaster assistance	2018a	Germany	*	CBRN	*	Disrobe Evacuation Wet decontamination	Incident site	N	Y
Federal office of civil protection and disaster assistance	2018b	Germany	*	CBRN	*	Disrobe Shelter in place Re-robe Wet decontamination	General public	N	N

Organisation	Year	Country	Single/ multi-agency	Incident type	Nature of incident	Management strategy	Communication strategy	Public behaviour	Vulnerable groups
Federal Office of Civil Protection and Disaster Assistance	No date	Germany	Multi-agency	CBRN	Not specified	Disrobe Evacuation Wet decontamination	N	N	N
Federal Office of Civil Protection and Disaster Assistance (BBK) and Robert Koch Institute	2007	Germany	*	Biological	*	Disrobe Evacuation Life-saving treatment Wet decontamination	Incident site	Y	Y
Government of Czech Republic	No date	Czech Republic	Multi-agency	Dirty bomb	Intentional	Decontamination Life-saving treatment	N	N	N
Government of Western Australia	2018	Australia	Multi-agency	Hazardous materials	Intentional and unintentional	Decontamination Life-saving treatment	N	N	N
Home Office	2015	United Kingdom	Multi-agency	CBRN	Intentional	Disrobe Dry decontamination Evacuation Wet decontamination	Incident scene	Y	Y
Homeland Security	2017	America	Multi-agency	Biological	Intentional and unintentional	Disrobe Shelter in place Wet decontamination	General public	N	N
Instruction of Cabinet Ministers No.12	2012	Latvia	Multi-agency	CBRNe	Intentional and unintentional	Decontamination	General public	N	N
International Committee of the Red Cross	2014	Switzerland	Multi-agency	CBRN	Intentional and unintentional	Dry decontamination Evacuation Wet decontamination	N	N	Y

Organisation	Year	Country	Single/ multi-agency	Incident type	Nature of incident	Management strategy	Communication strategy	Public behaviour	Vulnerable groups
Joint Chiefs of Staff	2016	America	Multi-agency	CBRN	Intentional and unintentional	Decontamination Disrobe	N	N	Y
Joint Emergency Services Interoperability Programme (JESIP)	2016	United Kingdom	Multi-agency	CBRNe	Intentional	Disrobe Dry decontamination Life-saving treatment Wet decontamination	N	N	Y
Kingston Health Sciences Centre	2018	Canada	Single-agency	Hazardous materials	Not specified	Disrobe Re-robe Wet decontamination	N	N	N
Kirklees Council	2017	England	Multi-agency	CBRNe and Hazardous materials	Intentional and unintentional	Disrobe Dry decontamination Re-robe Wet decontamination	N	N	N
Law	2018	France	*	Chemical	Intentional	Decontamination Shelter in place	General public	Y	N
Law	2011	France	*	Radiological	Intentional	Disrobe Life-saving treatment Wet decontamination	General public Evacuated	N	N
Ministry of Community Safety and Correctional Services	2017	Canada	Multi-agency	Nuclear	Intentional and unintentional	Decontamination	General public	N	N
Ministry of Defence	2017	United Kingdom	Multi-agency	Radiological	Not specified	Decontamination	Incident site	N	N

Organisation	Year	Country	Single/ multi-agency	Incident type	Nature of incident	Management strategy	Communication strategy	Public behaviour	Vulnerable groups
National Ambulance Resilience Unit (NARU)	2018	United Kingdom	Multi-agency	Hazardous materials	Not specified	Disrobe Dry decontamination Evacuation Wet decontamination	N	N	N
National Ambulance Resilience Unit (NARU)	2017	United Kingdom	Multi-agency	Chemical	Not specified	Dry decontamination Disrobe Wet decontamination	N	N	N
National Center for Environmental Health	2014	America	Multi-agency	Radiological	Intentional	Disrobe Wet decontamination	Incident site Self evacuate	N	Y
National Operational Guidance Programme	2018a	United Kingdom	Single agency	Hazardous materials	Not specified	Disrobe Dry decontamination Wet decontamination	N	N	N
National Operational Guidance Programme	2018b	United Kingdom	Single agency	Hazardous materials	Not specified	Disrobe Decontamination Evacuation	Incident site	N	N
National Operational Guidance Programme	2015	United Kingdom	Single agency	CBRNe	Intentional	Disrobe Dry decontamination Evacuation Wet decontamination	Incident site	Y	Y
NATO	2014	North America/Europe	Multi-agency	CBRN	Not specified	Decontamination Evacuation	General public	N	N

Organisation	Year	Country	Single/ multi-agency	Incident type	Nature of incident	Management strategy	Communication strategy	Public behaviour	Vulnerable groups
New South Wales Government	2016	Australia	Multi-agency	CBRN/hazardous materials	Intentional and unintentional	Evacuation Shelter in place	General public	N	Y
Newman University, Birmingham	2014	England	Singlea gency	Hazardous materials	Not specified	Disrobe Re-robe Wet decontamination	N	N	N
NHS	2019	United Kingdom	Multi-agency	CBRNe	Not specified	Disrobe Dry decontamination Evacuation Wet decontamination	Self-evacuated	Y	Y
NHS England	2019	England	Multi-agency	Hazardous materials	Not specified	Disrobe Dry decontamination Wet decontamination	Self-evacuated	Y	Y
NHS England	2018	England	Multi-agency	CBRN	Not specified	Decontamination Disrobe Evacuation Life-saving treatment	N	N	Y
NHS England	2015	England	Multi-agency	Chemical	Intentional and unintentional	Disrobe Dry decontamination Wet decontamination	N	Y	Y
NHS Foundation Trust	2017	United Kingdom	Multi-agency	CBRN/hazardous materials	Intentional and unintentional	Disrobe Dry decontamination Wet decontamination	N	N	N

Organisation	Year	Country	Single/ multi-agency	Incident type	Nature of incident	Management strategy	Communication strategy	Public behaviour	Vulnerable groups
NHS Foundation Trust	2016	United Kingdom	Multi-agency	CBRNe/hazardous materials	Not specified	Disrobe Dry decontamination Life-saving treatment Wet decontamination	Self-evacuated	Y	Y
NHS Shetland	2014	Scotland	Multi-agency	Chemical and Biological	Intentional and unintentional	Disrobe Life-saving treatment Wet decontamination	N	N	N
No author named	2006	Germany	*	CBRN	*	Evacuation Life-saving treatment Shelter in place	N	N	N
Norfolk Resilience Forum	2016	England	Multi-agency	Hazardous materials	Intentional and unintentional	N	General public	Y	Y
Oak Ridge Institute for Science and Education	2017	America	Multi-agency	Radiological	Intentional and unintentional	Disrobe Life-saving treatment Wet decontamination	Incident site Self-evacuated	Y	Y
Office of Preparedness and Emergency Management	2014	America	Multi-agency	Hazardous materials	Not specified	Disrobe Dry decontamination Wet decontamination	Self-evacuated	Y	Y
Permanent conference on disaster preparedness and population protection	2008	Germany	*	Hazardous materials	*	Decontamination Disrobe Life-saving treatment	Incident site	N	N
Police Scotland	2018	Scotland	Single-agency	Hazardous materials	Unintentional	Disrobe Dry decontamination	Incident site	N	N

Organisation	Year	Country	Single/ multi-agency	Incident type	Nature of incident	Management strategy	Communication strategy	Public behaviour	Vulnerable groups
Portsmouth and Southampton City Council	2016	England	Multi-agency	Nuclear	Not specified	Evacuation Wet decontamination Decontamination Evacuation Life-saving treatment Shelter in place	General public	Y	Y
Public Health England	2019	England	Multi-agency	Radiological	Not specified	Disrobe Dry decontamination Evacuation Shelter in place Wet decontamination	N	N	Y
Public Health England	2018	England	Multi-agency	CBRN	Intentional and unintentional	Disrobe Dry decontamination Life-saving treatment Wet decontamination	N	N	N
Public Health Wales	2016	Wales	Multi-agency	Chemical	Intentional and unintentional	Disrobe Dry decontamination Wet decontamination	N	N	N
Queensland Government	2015	Australia	Multi-agency	Chemical, biological, radiological	Intentional and unintentional	Disrobe Re-robe Wet decontamination	Incident site	Y	Y
Schneider	2015	Germany	*	Hazardous materials	*	N	Incident site	Y	N

Organisation	Year	Country	Single/ multi-agency	Incident type	Nature of incident	Management strategy	Communication strategy	Public behaviour	Vulnerable groups
Scottish Government	2016	Scotland	Multi-agency	Chemical, biological, radiological	Intentional and unintentional	Disrobe Dry decontamination Wet decontamination	N	N	Y
Scottish Government	2015	Scotland	Multi-agency	Nuclear	Intentional and unintentional	N	Incident site	Y	N
Secretariat General de la Defense et de la Securite Nationale	2014	France	*	Nuclear	Intentional and unintentional	Evacuation Shelter in place Wet decontamination	General public	N	Y
Secretariat-General for National Defence and Security	2014	France	*	Biological	Unintentional	N	General public	N	Y
Secretariat-General for National Defence and Security	2011	France	*	Biological	Unintentional	N	General public	N	N
Secured Urban Transportation	2014	Europe	Multi-agency	CBRNe	Intentional	Disrobe Dry decontamination Wet decontamination	General public	Y	Y
Sudhoff	2016	Germany	*	CBRN	*	Wet decontamination	Incident site	Y	N
Swedish Civil Contingencies Agency	2019	Sweden	Multi-agency	CBRNe/hazardous materials	Intentional and unintentional	Disrobe Dry decontamination Evacuation Life-saving treatment Wet decontamination	Caller	N	N

Organisation	Year	Country	Single/ multi-agency	Incident type	Nature of incident	Management strategy	Communication strategy	Public behaviour	Vulnerable groups
Swedish Civil Contingencies Agency	2014	Sweden	Multi-agency	CBRNe/hazardous materials	Intentional and unintentional	Disrobe Dry decontamination Evacuation Life-saving treatment Wet decontamination	Caller	N	N
THW	2014	Germany	*	CBRN	*	Disrobe Wet decontamination	N	N	N
UK Fire and Rescue Service (UK FRS)	2018	United Kingdom	Single-agency	Hazardous materials	Not specified	Disrobe Dry decontamination Wet decontamination	N	N	N
United States Environmental Protection Agency	2017	America	Multi-agency	Radiological	Intentional and unintentional	Disrobe Evacuation Life-saving treatment Shelter in place Wet decontamination	General public Self-evacuated	N	Y
United States Department of Labor	2019	America	Multi-agency	Radiological	Intentional and unintentional	Disrobe Re-robe Wet decontamination	N	N	N
US Department of Health and Human Sciences	2019	America	Multi-agency	Radiological	Not specified	Disrobe Wet decontamination	N	N	N

Organisation	Year	Country	Single/ multi-agency	Incident type	Nature of incident	Management strategy	Communication strategy	Public behaviour	Vulnerable groups
Vigipirate	2016	France	Multi-agency	Toxic product	Intentional	Disrobe Evacuation Wet decontamination	General public	N	N
West Virginia Board of Education	2018	America	Multi-agency	Hazardous materials	Intentional and unintentional	Evacuation	N	N	N
West Yorkshire Police	2016	England	Single-agency	CBRN	Intentional	Disrobe Life-saving treatment Wet decontamination	N	N	N
World Health Organisation	2018	World	Multi-agency	CBRN	Intentional and unintentional	Disrobe Dry decontamination Wet decontamination	N	N	N
World Health Organisation	2017	World	Multi-agency	Chemical	Not specified	Disrobe Evacuation Re-robe Shelter in place Wet decontamination	N	N	N
World Health Organisation	2014	World	Multi-agency	Chemical	Intentional	Disrobe Dry decontamination Life-saving treatment Wet decontamination	Incident site	N	Y
World Health Organisation	No date	World	Multi-agency	Chemical	Not specified	Dry decontamination Wet decontamination	N	N	N

* Details were unable to be determined in some translated documents.

Appendix 3. Search terms used for the advanced Google search for communication tools.

Type of platform	Type of incident	Type of communication
App	CBRN(e)	Information
Social Media	CBRN	Communication
	Chemical	Preparedness
	Biological	Response
	Radiological	
	Nuclear	

Appendix 4. Relevant communication apps

App name	Country	Incident type	Allows communication from authorities to public	Allows communication from public to authorities
FEMA	USA	Any emergency	X	X
BE-Alert	Belgium	Any emergency	X	
S.O.S. Emergencias	Spain	Any emergency	X	X

Appendix 5. Review of EU projects relating to situational awareness, common operational picture and standardisation

To ensure effective management of CBRNe incidents, it is essential to understand concepts such as shared situational awareness, common operational picture, and standardisation. Guidance and SOPs designed to inform the management of such incidents should therefore incorporate information relating to the development of shared situational awareness, the building of a common operational picture, and the standardisation of key concepts.

A number of EU projects s aim to optimise situational awareness, common operational picture, and standardisation. Current understanding around optimisation of each of these key concepts is presented below and the full list of included projects is presented in Table 1.

Situational awareness

Situational awareness is "the perception of the elements in the environment within a volume of time and space, comprehension of their meaning, and the projection of their status in the near future" (Endsley, 2016, pg. 13). Situational awareness relies on gathering relevant information and filtering out irrelevant information. Situational awareness can be facilitated by multiple agencies working together in order to gather sufficient information and understanding about a situation. However, the development of situational awareness can be hampered by inefficient multi-agency communication, particularly where not all agencies have the same information (e.g., traffic data), and where different agencies use different technologies that can make compiling this information difficult. Research is exploring the role that local communities and machine learning can play in aiding information gathering to facilitate shared situational awareness during emergencies.

Common operational picture

A common operational picture can facilitate efficient situational awareness systems. Common operational picture is an information system that allows information to be formed and shared across agencies as soon as possible. Common operational picture relies on compatible technology across different agencies so that information from different sources can be easily and efficiently compiled. Additionally, in order to create an accurate common operational picture, first responders need to be able to communicate accurate information of the emergency. Therefore, commanders need to gain as much information as possible about the situation, but this information needs to be integrated, accurate, and up to date; once this is done different agencies can respond in a coordinated manner with better decision making.

Standardisation

The communication between agencies that can build situational awareness and a common operational picture can also enhance a standardised emergency response. In this review we found discrepancies between guidance policies for emergency response. A standardised emergency response can enhance collaboration and reduce confusion in emergencies which involve a multi-agency response. However, it has also been suggested that in fast-

paced multi-agency emergency response a flexible rather than standardised procedure may be better to allow responders to make timely decisions based on the current situation. Standardisation also relates directly to situational awareness and common operational picture as different agencies can have different standards for the information they gather relating to the emergency. Additionally, where specific systems have been developed for one agency this can cause confusion when working with other agencies.

Table 1. EU Projects relating to situational awareness, common operational picture and standardisation

Project	Author (year)	Situational Awareness	Common Operational Picture	Standardisation	Project Summary
SAYSO	Steinhäusler (2019)	X	X		An adequate multi-stakeholder SA serves to both, (1) filter out information that is not goal-related, and (2) help people to understand how and why they should provide relevant information to crisis managers The typical process of SA: a. Observation: Initially FRs seek and scan for critical clues. This observation phase consists of taking and noting observations. It places observations in context and assists in understanding the situation as a whole. b. Assessment: Subsequently, these clues are used to assess (1) what will happen, if no action is taken by them, as compared to (2) the benefits by taking an appropriate action; c. Decision: On the basis of this prediction a decision is taken by the crisis management and acted upon; d. Communication & Coordination: The last step in this SA-based process is to communicate and coordinate with other FRs on scene and with all other organisations involved.

					SA tools need to correspond to the special working environment of FRs on scene and in their attempt to regain control over a crisis situation, jointly with crisis managers, safely, quickly and cost effectively. FRs are multitasking experts. In order to create adequate SA, they use the available data and combine them with the extensive know-how from their working methods, competencies and their tacit knowledge. SA enables them to assess what is going on, respectively predict what might happen next. Therefore, SA functionalities and tools have to create an information profile for them that enables them to successfully manage four roles, i.e., (a) situation follower, (b) analyzer, (c) planner and (d) decision maker.
					SAYSO addresses both the technical and human aspects of technology implementation to define specifications of multi-stakeholders situational awareness systems to support the integration of various data into a common operational picture.
ARCSAR	Halonen (2019)	X	X	X	Some agencies receive differing levels of information (e.g., regular traffic data) which decreases situational awareness and makes potential risks more difficult to predict

					More information about neighbouring rescue teams with specialised equipment so these can be called on quickly Receiving health status of recued people so that triage skilled personal can be deployed to the scene Operatives not receiving all necessary info of objects relating to the accident – Lack of standardisation of communication – recommendation is to create a communication platform between agencies so data can be shared easily. When multiple agencies operate in the same situation via different technologies it makes it difficult to build an operational picture Different requirement for information from different agencies
EU-HYBNET	Cullen et al. (2021)	X			Intelligence provides decision-makers with situational awareness, a must for strategic and security-related decisions. Therefore, intelligence activities need to be designed and implemented to meet the need identified by decision-makers or implied by their policy guidance.

					Intelligence in the modern world is derived from several disciplines, including Open-Source Intelligence (OSINT), Signals Intelligence (SIGNIT), Geospatial or Imagery Intelligence (GEOINT or IMINT), Measurement And Signature Intelligence (MASINT), Cyber Intelligence (CYBINT) and Human Intelligence (HUMINT). An actor using Hybrid Threats may use intelligence in two principal ways. They will usually employ their own intelligence capabilities to support planned or ongoing hybrid threat activities, or they may attempt to affect the target state's intelligence operations. In both cases, the actor seeks to undermine the target state's capability to develop and maintain situational awareness. To the extent that intelligence can support and has been used to support a wide range of hybrid threat activities, it can be understood to be related to all other domains. Nevertheless, it has a strong connection to the information domain (section 4.1.13), mainly because disinformation campaigns can be orchestrated or facilitated by intelligence agencies. By the same token, CYBINT and MASINT play an increasingly important role in intelligence gathering. Therefore, this domain is strongly related to the cyber and space domains as well (sections 4.1.2 and 4.1.3). In addition, the purpose of intelligence support for hybrid threat activities, whether it is used to implement clandestine operations in support of hybrid

					threat activities or to blur the target state's situational awareness and/or create deception, is to undermine the decision-making capabilities at the political level and the ability of public administration to implement policy (sections 4.1.8 and 4.1.12). There may also be de- escalation, meaning that the activity can also move backwards, confusing situational awareness and disguising the real aims of the action. This is distinctive of the landscape of Hybrid Threats. The escalation and de-escalation can be horizontal and vertical, meaning that the combination of tools and how they are used, is adjusted to the situation and need. As the MCDC countering hybrid warfare report "Understanding hybrid warfare" observes, "synchronization allows the hybrid warfare actor to `escalate or `de-escalate' horizontally rather than just vertically, thus providing further options for the attacker" (Cullen and Reichborn-Kjennerud 2017).
NEXES	Puisa et al., (2020)			X	These safety systems are developed in isolation from a wider operational context and, when integrated, can lead to confusion and surprises (Ahsan et al., 2019). The way to deal with this is to build safety management on the systems approach (top-down) rather than on reductionism (bottom-up) as commonly done (Leveson, 2015).

ENGAGE	ENGAGE (2020)	X			Natural and man-made disasters remind us how the ability of societies to adapt and prosper depends on the collective action of the whole society. But the significant role citizens and communities can play at the grassroots level has been overlooked in research. ENGAGE will turn this around, showing how individuals and local practices can interrelate effectively with planned preparedness and response, practitioners and technology. To achieve this bold goal ENGAGE will start with the knowledge, strategies, methods, tools and practices used by real world practitioners and citizens, and mature results from earlier projects. It will combine and extend these to create innovative solutions to disaster management and new ways of fostering trans-disciplinary collaboration and learning across disciplines. A model for assessing and methods for improving societal resilience will be complemented by an evolving knowledge platform providing actionable solutions meeting the diverse needs of authorities, first responders and citizens. ENGAGE will use empirical data on individual and collective contributions to societal resilience and take into account contextual aspects such as socio-economic conditions, digital literacy, culture, gender, social capital, trust and diversity. It will focus on aspects that can be directly enhanced such as risk awareness, communication, social media, citizens' as well as authorities' and first responders' involvement. Real world field validations will be used to demonstrate

					and validate ENGAGE solutions and their transferability to diverse contexts across Europe. The consortium is complemented by a Knowledge and Innovation Community of Practice that already has 37 members and will grow during the project. This team includes representatives from authorities, first responders, citizens associations, NGO´s, SMEs, industries, schools and academia. Together, they will propose validated solutions contributing to specific SENDAI actions.
Eurobiotox	Eurobiotox (n.d.)			X	After this project there will be a pan-European network of competence, certified reference materials, standard operating procedures and a common way of handling biotoxin incidents.
EU-Sense	EU-Sense (2021)	X			The EU-SENSE project will provide an innovative technical solution to deal with selected shortcomings in CBRNe protection indicated in the ENCIRCLE Catalogue of Technologies. The created system will be a step-forward in chemical detection by developing a novel network of sensors that exploits advanced machine-learning and modelling algorithms for improved performance. The salient objectives of the project include development of an adaptable and multipurpose threat detection system (network of sensors, comprising both stationary and person-worn sensor nodes supported by

					environmental noise learning algorithm for false alarm rate reduction) and tools for enhancing situational awareness based on the sensor data (threat source location estimation and hazard prediction solutions). In general, the developed system will improve the threat detection capabilities and will increase state-of-the-art sensors reliability by networking and novel algorithms.
ENCIRCLE	ENCIRCLE (2017)			X	Provide integration with platforms (systems, tools, services, products) by proposing standardised interfaces and future EU standards to integrate CBRN technologies and innovations developed from the Part b projects of the H2020-SEC-05-DRS CBRN Cluster call,
IMPROVER	Petersen et al. (2017)	X			Social media is used for both crisis communication and situational awareness.
FASTER	Chrysanthopoulos et al. (2020)	X	X	X	The Situational Awareness factor also includes the easy and extensive use of geolocation and on-site mapping services, which should be open-access and available also for offline use. It is imperative that the First Responder (FR) teams and the Communication & Coordination Center (C3) have the necessary resources to operate with safety, reliable

					information, concise operational view for the FRs and detailed Common Operational Picture (COP) for the team commanders. Continuous updates to the C3 of the team; integration of multiple sources for better COP; reliable communications and contacts with the authorities; strict operational protocols for safety and effectiveness in stressful and hazardous environments. In Communications, there is a clear need for resilient, high-capacity, cross-platform compatible and energy-efficient mobile technologies for the FR teams, especially for use inside closed spaces or under debris. The devices should be designed for personal safety, inter- and intra-team (C3) information exchange via voice or data (e.g. images, streaming video), as well as easy integration into information fusion platforms for enhancing COP.
COPE	COPE (n.d.)		**X**		support first responders by giving them: - the ability to share ground truth with the COP the ability to share ground truth with the COP
EFFECTOR	EFFECTOR (2020)	X			Specifically, EFFECTOR will unlock the full capabilities of maritime surveillance systems and data sharing at

					tactical and strategic level by introducing applied solutions for enhanced border and external security, including the implementation of a multilayered data lake platform for end-to-end interoperability and data exploitation, the exchange of enhanced situational awareness pictures
RESPOND-A	RESPOND-A (2020)	X	X		With the evolving threat of climate change and the consequences of industrial accidents to becoming more severe, there is an increasing need for First Responders to access reliable and agile information management systems that offer as higher Situational Awareness and better Common Operational Picture.
INGENIOUS	INGENIOUS (2020).		X		INGENIOUS enhances the common operational picture among FR teams and enables FRs to have to have better situational awareness and respond efficiently in a coordinated way. The NGIT (Next Generation Integrated Toolkit) will allow First Responders of different disciplines to combine their strengths and experience, enhancing their common operational picture in order to develop a common, integrated and coordinated operational plan of action
TERRIFFIC	Munro, (2019)		X		For the incident commander, it is vitally important to find out as much about the situation as possible and that situational awareness is updated dynamically, accurately and quickly. Improved situational awareness

					and a Common Operational Picture will ensure that the Incident Commander is able to make better-informed decisions.
STAIR4SECURITY	STAIR4SECURITY (n.d.)			X	A wide range of security threats including man-made and natural risks can result in disruptive events having serious consequences for societal and citizen security. Both, public and private stakeholders require adequate solutions in organisation, procedures, and technological capabilities to be able to respond timely and effectively. Thus, there is a need to develop specific standards to enable the various public and private organisations within Europe to be effectively coordinated ensuring as much as possible a smoothly cooperation before, during, and after a disruptive event. However, while standards are well-known and frequently used in many industrial sectors, practitioners in the field of security may not be familiar with this type of tools. Pre-standardisation deliverables, with a process that is both faster and less complex, can then be particularly relevant for them, provided they know about this option.
IN-PREP				X	The ACRIMAS project has identified two important organisational problems concerning harmonisation: dispersed responsibility (the existence of many actors engaged in various stages of crisis management) and institutional barriers against standardisation (meaning standardisation mainly takes place on an intra-agency,

					not cross-agency basis, thus requiring a top-down approach). As with other aspects, harmonisation relies heavily on a common terminology (Stolk et al. 2012). But technological standards also play their part. For example when it comes to communications between organisations, the use of different and often non-interoperable technologies presents a significant barrier to cooperation (Fischer et al. 2016). However, technologies are, as research suggests, only a symptom of organisational culture. Harmonisation and cooperation are thus only possible if a certain amount of trust exists among organisations (Kane 2018). Harmonisation requires agreed standards and guidelines of operation. In the absence of a central authority which can ensure a top-down harmonisation effort, coordination and an open dialogue based on a shared goal among organisations is necessary, also specifying the exact topics which should be addressed (Stolk et al. 2012). This makes harmonisation a cross-cutting issue, involving both organisations and policy making.

Appendix 6. An overview of the analytical framework and description of themes.

Theme	Description
Response strategy	The way an emergency responder manages a CBRNe incident.
	Recommended actions the responder and/or casualty should carry out.
Communication strategy	The way an emergency responder should communicate with people at the incident scene.
	Recommendations on how to provide information to members of the public.
Public response	The way members of the public are likely to respond to a CBRNe incident.
Vulnerable groups	The way emergency responders should manage vulnerable groups