

Self-care Decontamination within a Chemical Exposure Mass-casualty Incident

Raymond G. Monteith, MA; Laurie D. R. Pearce, PhD

Abstract

Growing awareness and concern for the increasing frequency of incidents involving hazardous materials (HazMat) across a broad spectrum of contaminants from chemical, biological, radiological, and nuclear (CBRN) sources indicates a clear need to refine the capability to respond successfully to mass-casualty contamination incidents. Best results for decontamination from a chemical agent will be achieved if done within minutes following exposure, and delays in decontamination will increase the length of time a casualty is in contact with the contaminate. The findings presented in this report indicate that casualties involved in a HazMat/CBRN mass-casualty incident (MCI) in a typical community would not receive sufficient on-scene care because of operational delays that are integral to a standard HazMat/CBRN first response. This delay in response will mean that casualty care will shift away from the incident scene into already over-tasked health care facilities as casualties seek aid on their own. The self-care decontamination protocols recommended here present a viable option to ensure decontamination is completed in the field, at the incident scene, and that casualties are cared for more quickly and less traumatically than they would be otherwise. Introducing self-care decontamination procedures as a standard first response within the response community will improve the level of care significantly and provide essential, self-care decontamination to casualties. The process involves three distinct stages which should not be delayed; these are summarized by the acronym MADE: Move/Assist, Disrobe/Decontaminate, Evaluate/Evacuate.

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There is growing awareness and concern for the increasing frequency of incidents involving hazardous materials (HazMat).¹ HazMat incidents encompass a broad spectrum of contaminants from chemical, biological, radiological, and nuclear (CBRN) sources.^{1,3} These incidents may result in exposure for a single individual, or they may result in mass-casualty events, such as the release of methyl isocyanate in Bhopal, India in 1984, which killed nearly 4,000 citizens and led to long-term health concerns for as many as 400,000 others.^{2,4}

Today, there are in excess of "80,000 potentially toxic substances produced, stored, and moved for manufacturing, agriculture, and service industries" across Canada and the United States.⁵ Hazardous goods "are shipped or received at more than 40,000 business sites across Canada."⁶ Many of these are toxic enough to be life-threatening for humans exposed to even limited quantities of these substances.⁵ In 2012, 398 accidents involving HazMat were reported to Transport Canada (Ottawa, Ontario, Canada); this represents an increase of 15% over the previous year and a nine percent increase over the previous five years' average.⁶ The Canadian Transportation Emergency Centre (CANUTEC; Ottawa, Ontario, Canada) provided assistance to first responders in 1,042 incidents and fielded 22,888 telephone inquiries in 2012.⁶

Along with the risk of an industrial or transportation accident involving toxic chemicals, there is cause for concern for the increased threat of exposure to civilians and responders resulting from the use of toxic chemicals in activities such as the hydrogen sulfide suicides currently popular in Japan and North America,⁷ the illegal production of methamphetamine in clandestine laboratories,⁸ and the frequent use of oleoresin capsicum spray as an offensive and defensive weapon.⁹ In addition to these concerns, the threat (both domestic and foreign) of CBRN-related terrorist events is perceived to be increasing.³ The release of sarin into the Tokyo (Japan) subway system in 1995 killed 12 commuters and injured hundreds more.¹⁰ Anthrax spores delivered through the United States Postal Service in 2001 resulted in five deaths and 22 injuries.¹⁰ The use of CBRN materials as weapons-and potentially as weapons of mass destruction, as evidenced by recent events in Syria-is considered a global threat by the Canadian government.³

Report

Significance of the Review

Given the Threats posed by HazMat and CBRN events, there is a clear need to identify and refine the capability to respond successfully. Contamination incidents require rapid and efficient responses from personnel from various first response agencies, including, but not limited to, specialized HazMat teams; police, fire, and paramedic departments; as well as first receivers from hospital facilities. Mass-decontamination capability is considered a critical aspect of a response to a CBRN event,¹⁰ and to be effective, it must be based upon sufficient capability to respond to a HazMat incident.¹¹

Experts agree that best results for decontamination from a chemical agent will be achieved if done within one minute following exposure,¹² and that delays in decontamination will increase the length of time a casualty remains contaminated.⁵ This suggests that first response activities will need to occur at the community level, and that a well-developed HazMat response capability at the community level is an essential component of a comprehensive emergency management system.³ A successful response

to a CBRN incident cannot be achieved without a well-established capacity to respond quickly and efficiently to a HazMat incident.¹¹ Such a rapid response capability is dependent upon validated HazMat decontamination protocols being available to first responders and first receivers, regardless of the size and sophistication of the community.¹³ A mass-casualty incident (MCI) requiring decontamination is resource intensive.¹⁰ Without sufficient training and resources, a significant event would be expected to overwhelm local responders and receivers quickly and render the response ineffective.^{3,14} Despite the increasing frequency of incidents involving HazMat,¹ and the acknowledged potential for a targeted terrorist attack using CBRN materials,³ a standardized, best practice, civilian MCI decontamination response protocol has not been identified.^{5,15,16} A significant number and variety of response guides are available; however, no single document provides sufficient guidance across the entire scope of a HazMat/CBRN MCI. Nevertheless, developing a well-established response protocol for a mass-casualty decontamination event should be an essential component of a comprehensive community response,^{16,17} especially in the face of the increasing frequency of HazMat events, the threat of a significant CBRN event, the likelihood of inadequate surge capacity,^{13,14} and the possibility of persistent under-preparation for such events.^{5,14} Speed is of the essence: the greater the delay in response, the greater the resulting damage.^{5,18}

Literature Review and Findings

Characteristically, incidents involving contamination by toxic chemicals or CBRN materials are chaotic and dangerous for victims and responders,¹⁹ and they require rapid, organized, and efficient intervention to minimize the consequences of the event.¹⁸

Nevertheless, while a number of best practices for response are mentioned, and while a consistent approach is encouraged, there are "no guidelines, standards, or regulations that specifically address patient decontamination."²⁰ However, while response protocols may be in place within some agencies and within some communities, response to incidents is often inadequate.¹⁴ Regardless of the community size, it has been noted that a significant lack of training and preparation is evident among responders and receivers.^{15,21}

Decontamination protocols that have been adopted widely for MCIs involving civilians are based upon techniques used by the military and HazMat first response agencies to decontaminate personnel wearing personal protective equipment (PPE) or in mission-forward military situations. There is insufficient evidence to support the effectiveness of these practices in civilian MCIs.^{12,16,22}

A literature review was completed in order to identify the commonalities and differences in existing HazMat/CBRN MCI response protocols and to evaluate the strengths and weaknesses across those protocols. The literature review identified 64 decontamination protocols or best practices currently or recently in use-written in English-from Canada, the United States, Great Britain, Australia, Israel, France, and Sweden. In order to identify these protocols, extensive research was undertaken using: peer-reviewed articles; computer-aided searches; field trips to local fire departments and HazMat teams; telephone interviews and email correspondence with organizational leaders; and reviews of presentations at HazMat and CBRN-related conferences.

The primary focus of the review was response protocols for use in a HazMat/CBRN MCI; however, literature that provided insights into particular concerns associated with MCI decontamination, such as crowd behavior and special considerations for the needs of at-risk populations, was also reviewed. The literature provides a broad overview of what is expected to occur during a HazMat/CBRN MCI response, as well as what may be the reality in that response. Additional criteria for review included: protocols that applied to multiple agents (eg, various chemicals); a publication date post-2007; application to civilian populations; consideration of different weather conditions; and first responders' (usually fire fighters or military personnel) or first receivers' involvement in the initial decontamination efforts.

Guiding Documents

Each of the 64 protocols was reviewed, and similarities and discrepancies were noted. As the review conducted, common themes and protocols emerged, significant gaps in generally accepted decontamination protocols were noted, and recommendations for best practices that, while not yet integrated fully into formal protocols, are beginning to influence response protocol development, were identified.¹⁶ A number of articles informed the need for, and method of, response, but it became clear that no one document provides guidance on the full scope of operations required for response to a HazMat/CBRN event involving multiple casualties.

Seven documents that provided the most comprehensive descriptions of response protocols were selected as guiding documents. In addition to the criteria listed above, to be included as a guiding document, the described response protocols had to be the latest edition and applicable to numerous situations and across multiple agencies. Thus, documents that solely were regional in focus,^{23,24} were excluded. Similarly, protocols solely developed for first receivers and receiving centers, such as hospitals,^{20,25,26} were also excluded.

In evaluating effective response protocols for the decontamination of civilians exposed to a toxic chemical, and particularly in situations involving multiple casualties, the seven documents were recognized widely and referenced in the literature as foundational guidance documents regarding a standardized approach to mass-casualty decontamination. All are objective-based documents, and, as will be discussed, the lack of integration between what should be achieved (objectives) and how it should be achieved (prescriptions) provides some particular challenges.

The following seven documents were selected as guiding documents:

1. *Guidelines for Cold Weather Mass Decontamination during a Terrorist Chemical Agent Incident*,²⁷ by the Edgewood Chemical. Biological Center of the US Army (Aberdeen, Maryland USA);
2. *Guidelines for Mass-casualty Decontamination during a HAZMAT/Weapon of Mass Destruction Incident (Volumes 1&2)*,¹⁰ also by the Edgewood Chemical Biological Center;
3. *Hazardous Materials for First Responders*,²⁸ from Oklahoma State University (Oklahoma USA) Fire Protection Publications;
4. *IHS Jane's CBRN Response Handbook (4th edition)*,²⁹ from the United Kingdom's IHS Global Ltd;
5. *Multiservice Tactics, Techniques, and Procedures for Chemical, Biological, Radiological, and Nuclear Consequence Management Operations (FM3-11.21/MCRP 3-37.2C/NTTP 3-11.24/ AFITP(I) 3-2.37)*,¹⁹ by the US Department of Defense (Washington, DC USA);
6. *National Fire Protection Association (NFPA; Quincy, Massachusetts USA) Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents (NFPA 472, 2013 edition)*,¹¹ from the NFPA; and
7. *Patient Decontamination in a Mass Chemical Exposure Incident: National Planning Guidance for Communities*,¹⁶ by the US Department of Homeland Security (Washington, DC USA).

Each of these documents is intended to guide response or to inform best practice. The current edition of NFPA 47211 was developed through extensive public and industry consultation and consensus building with relevant agency stakeholders throughout the United States and Canada. National Fire Protection Association 472 is revised in 5-year cycles and is recognized widely among civilian and military response agencies as the standard for first responders to a HazMat/CBRN event. The current edition of NFPA 47211 is cited in

recent protocol development documents,^{10 16} and the previous 2008 edition³⁰ is implemented in civilian training documents and by the military.^{19,28} Additionally military publications, such as US Army and Department of Defense guidelines,^{10,19,27,31} are recognized as best practices and guiding documents and are referenced frequently in the literature.¹⁶ Garcia, Rand, and Rinard²⁹ provide a perspective on protocols in use in the United Kingdom, and the US Department of Homeland Security¹⁶ guiding document is chosen because it provides a comprehensive review of response protocols currently in accepted practice and offers recommendations on best practices for response informed by current research data and subject matter expertise.

National Fire Protection Association 47211 is referenced extensively by the Department of Homeland Security¹⁶ in its analysis of mass-decontamination protocols following chemical exposure. The guiding documents reviewed affirm the objectives described by NFPA 472,¹¹ and each of the selected guidance documents provides additional supporting detail in describing various specific methods that should be adopted to achieve the required response objectives.

Limitations of Literature Review

As mentioned, focus was given only to those protocols written in English. Literature from non-English-speaking countries was not reviewed, and thus, valuable information may have been overlooked. Furthermore, given the large number of applicable documents focused on MCIs, manuals or protocols involving one person or small numbers of people may also have identified information which could have been useful when dealing with large populations; however, this information was not captured in the review. Finally, decontamination protocols for specific sites (eg, nuclear facilities) were not reviewed in depth; however, an initial analysis indicated that the cross-agent protocols appeared to incorporate key considerations.

Levels of Personnel Response

HazMat/CBRN response protocols are organized into: those for personnel who may encounter a HazMat/CBRN emergency in the course of their "normal duties [and are] expected to recognize [the danger], protect themselves, call for trained personnel, and secure the scene;"¹¹ and those for responders who are expected to respond to a HazMat/CBRN incident with the appropriate competencies, including mission-specific responsibilities, such as mass-casualty and technical decontamination. Protocols for the former are classified at an awareness level and those for the latter are classified at an operational level. These distinctions are important to understand within the context of HazMat/CBRN response protocols and particularly within the context of decontamination protocols.

Awareness-level Response--Awareness-level personnel must be able to evaluate the scene, identify the presence of HazMat, secure the scene, and initiate protective and notification processes.^{10,11,16,19,27-29} Implicit in the required competencies for awareness-level responders is the ability to initiate protective procedures, including decontamination procedures for contaminated casualties at the scene. However, the first personnel to arrive on scene may well be the least equipped and the least trained to initiate an appropriate decontamination response.

Operations-level Response--The focus of operations-level responders is the protection of casualties, the environment, and property, and the competencies include initiating emergency and mass-decontamination procedures, including gross or technical decontamination processes.¹¹ Responders at this level will be equipped with appropriate PPE enabling them to work

closely with contaminated casualties.

Protocol Development

While a uniform decontamination protocol does not exist,¹⁶ there is consensus on the desired outcomes to be achieved through an emergency decontamination process. The first objective is to reduce the amount of time a casualty is in contact with a contaminant in order to reduce the level of contamination to the lowest possible level to protect the casualty. The second objective is to limit the opportunity for secondary exposure of others the casualty may come into contact with.^{16,28,32} Limiting exposure time and diluting the contaminate concentration will reduce the impact upon the casualty.⁵

In a MCI, large numbers of people will need to be put through some form of decontamination process; however, the literature review identified a number of gaps in response standards and decontamination protocols for HazMat/CBRN MCI events. The following event timeline illustrates typical MCI response protocols as personnel trained to awareness level arrive on scene and are followed by responders trained to operations level¹¹ when responding to a chemical vapor or liquid chemical exposure event. Best practices are recommended as casualty-focused response protocols for mass-casualty decontamination.

Initial Arrival on Scene: Awareness-level Personnel-The scale of a HazMat/CBRN MCI is unpredictable; exposure may be limited to only a few individuals, or entire communities may be affected. The number of response personnel initially attending a civilian MCI will vary considerably depending on the circumstance; first-in personnel may be limited to a single police officer, a two person Emergency Medical Services (EMS) ambulance crew, a fire department engine company carrying four or five firefighters, or a single individual familiar with the HazMat typically in use at an industrial site. It is unlikely though, that a fully equipped hazardous response team will be the first to arrive on scene.

With the exception of possible bystanders who may attempt to render aid, and will, therefore, themselves become casualties, the first responding personnel to arrive on scene of a HazMat/CBRN MCI likely will be trained to awareness level as defined by NFPA 472¹¹ and will have limited response capability because of limitations in training and equipment. The US Department of Defense suggests that awareness-level personnel are limited to initiating "an emergency response sequence."¹⁹ Miller et al²⁸ suggest awareness-level personnel may initiate the evacuation of casualties from the hazard area to a minimum safe distance if they are able to do so without risking their personal safety.

These personnel will arrive on scene wearing civilian work clothing, police or EMS uniforms, or possibly, structural firefighting protective clothing (SFPC) with a positive pressure self-contained breathing apparatus (SCBA). General-duty work clothing, police, fire, and EMS uniforms are classified as Level D ensembles by the US Environmental Protection Agency (EPA; Washington, DC USA)²⁸ and are not considered chemical protective clothing. They will provide little, if any, protection against chemical contamination beyond what ordinary street clothing would. Structural firefighting protective clothing is also classed as Level D, and firefighters wearing SFPC and SCBA will have limited protection against chemical liquid and vapor contaminants. The lack of specialized chemical protective clothing will prohibit awareness-level personnel from being able to enter the hazard area to render aid to casualties.²⁸

Regardless of the limited resources available to awareness-level personnel, the guiding documents describe a series of complex activities that must be completed upon arrival at the scene of a HazMat/CBRN incident. Responding awareness-level personnel are required to:

- ensure their personal safety;
- secure and control the scene;
- identify the hazard;
- assess the site to determine wind direction and weather conditions;
- determine relevant terrain characteristics, including accessibility and drainage;
- determine who and what is at risk;
- determine available resources, including water, light, and electrical supply;
- determine what actions are possible immediately;
- initiate the external response sequence; and
- initiate a rescue response.²⁸

As mentioned, the first to arrive on scene may well be the least equipped and the least trained to initiate a rescue response, and are, therefore, unable to enter into a hazard area to render aid to casualties or begin rescue operations. Awareness-level personnel may be limited to initiating the evacuation of ambulatory casualties away from the hazard area while maintaining their own safety. Nevertheless, the guiding documents are unanimous and unequivocal in stating that emergency decontamination is considered essential first-aid and should occur without delay. In order to limit the potential for damage from exposure to a toxic chemical scantily, decontamination must occur within minutes of exposure.¹² The implication then is that, despite their minimal training and heavy initial task burden, awareness-level personnel should initiate protective procedures, including decontamination procedures, for contaminated casualties at the scene.

Initial Response Phase: Operations-level Response-The focus of operations-level responders is the protection of casualties, the

environment, and property. Their operational competencies include initiating emergency and mass-decontamination procedures, including gross or technical decontamination processes.¹¹ Operations-level responders will be trained to respond to a HazMat/CBRN incident; however, first responding crews may not be equipped with appropriate PPE and will be unable to enter the hazard zone without becoming contaminated themselves.

The arrival of properly equipped specialized HazMat teams, or mission-specific operational responders equipped with appropriate PPE, will often not be part of a first response.^{11,28} Scene assessment, the arrival of appropriately trained HazMat technicians, and donning of appropriate PPE (Level A or Level B chemical protective suits) is time consuming, as is the arrival and set-up of a specialized apparatus to enable gross or technical decontamination.

Technical decontamination typically will follow emergency gross decontamination procedures,¹¹ as technical decontamination facilities are labor intensive and time consuming to situate and assemble, and response delays are inevitable. Such delays are problematic in providing an immediate and appropriate medical countermeasure to contamination.¹⁶

The first objective to be met by operations-level first responders is to reduce the amount of time a casualty is in contact with a contaminant in order to reduce the level of contamination to the lowest possible level to protect the casualty; the second objective is to limit the opportunity for secondary exposure of others with whom the casualty may come into contact.^{16,28,32} Limiting exposure time and diluting the contaminate concentration will reduce the impact of exposure on the casualty.⁵ However, it is evident that considerable time will be lost during the initial response phase by responders who are not equipped adequately to initiate rescue activities. Operations-level responders are faced with a complex decision-making algorithm and must determine several important facts quickly:

- Is decontamination required immediately, or can casualties wait?
- Are conditions safe to conduct decontamination?
- What resources are required, and what resources are available?
- Are temperatures <18°C (64°F), and is wind chill a factor?
- Will casualties require protection from the cold?
- Are wet methods necessary, or will disrobing and dry methods suffice?
- Is it possible to conduct decontamination indoors?
- If decontamination is possible indoors, what transport options are available?
- If decontamination must be conducted outside, what options are available for managing cold or extreme weather conditions?

The response time to set up a mass-casualty technical decontamination facility can be significant, even in a large urban community equipped with such facilities and will not address the needs of non-ambulatory casualties immediately. Additionally, while responders are assessing the situation and initiating the external response sequence, considerable pressure will be placed on them by the concerns and demands of casualties on scene. That pressure will continue to be placed on operations-level responders as they continue to arrive.

Previous experience at actual and simulated incidents suggests that initial response personnel will be overwhelmed quickly by casualties seeking immediate assistance, or they will find that casualties are evacuating the scene quickly to seek medical assistance on their own. Following the March 1995 sarin attack in Tokyo, as many as 5,500 people presented to emergency rooms and clinics seeking medical aid.⁵ Exercises conducted in Adelaide, Australia found that casualties "swamped" aid personnel, quickly contaminating them or forcing them to don chemical PPE in their vehicles before disembarking to render aid.³³ In a study of treatment following a chlorine leak resulting from a train derailment in Graniteville, South Carolina (USA) in January 2005, Wenck et al.³⁴ determined that 63% of the casualties treated within the first 24 hours transported themselves to a medical facility for treatment. Additionally, findings from field exercises completed in the United Kingdom indicate that, when faced with any type of delay in response, casualties who are able will leave the scene quickly and either go home to care for themselves or go to a hospital to seek aid.³⁵

Therefore, immediate communication and aid to casualties is essential in order to secure their cooperation and assistance in controlling and containing the situation. It is paramount that casualties remain at the scene where they can be treated more efficiently and the risk of cross-contamination can be limited.

Best Practices Recommended by the Literature

Because first-arriving responders will seldom be equipped to begin a gross or technical decontamination response immediately, an effective HazMat/CBRN response protocol will have self-rescue procedures commence with the first personnel to arrive on scene. Self-rescue will include: (1) evacuation away from the hazard area to a safe location within the warm zone; (2) disrobing and self-care decontamination; and (3) re-robing and sheltering while awaiting further assessment or treatment and release.

Communications-Initiating self-rescue will require immediate communication to casualties by whatever means are available, including loud hailers or public address systems, hand signals, miming, signage, or other suitable means. Messaging should be developed prior to an incident and should be scripted clear so it remains consistent, regardless of who delivers it at the

scene.¹⁶ The following is a suggested framework script:

Stop. Listen. You may have been exposed to a hazardous substance. In order to help you and to protect your health and safety, and the health and safety of others, please follow our directions. You must be thoroughly cleaned before you can be safely treated by medical services.²³

Clearly, in order to penetrate the chaos and confusion that will surround a mass-casualty HazMat/CBRN incident, communication will need to be delivered in a strong and purposeful manner in order to calm casualties and allow them to focus their attention on the responder providing direction. "Information is an antidote to fear;"⁵ therefore, the more information communicated to casualties, the greater the likelihood they will comply with the instructions provided to them at the scene.^{35,36} Non-verbal instructions and active demonstrations of instructions are recommended to ensure that casualties who may not understand verbal instructions are able to understand what they need to do.¹⁶ Initial communication to victims is supported by the guiding documents;^{16,29} however, the guiding documents do not state specifically *what* should be communicated to the victims. Garcia et al²⁹ recommend first responders should:

- identify those requiring immediate first-aid;
- provide reassurance;
- inform victims that they will receive help shortly;
- calmly explain they will be helped more easily by following instructions;
- try to remain calm by being open and purposeful;
- explain to victims that if they try to leave, they will delay their own treatment and contaminate others;
- explain that decontamination procedures will begin as necessary; and
- lead the casualties away from, and upwind of, the hazard area to a casualty collection point located safely within the exclusion (warm) zone.

Research has demonstrated that communication strategies that include responders providing detailed information regarding the health-based need for decontamination, and the decontamination process itself, will increase the willingness and capacity of casualties to engage in the process.³⁶

Buddy System-There is substantial evidence to suggest that casualties will help each other in an emergency.^{16,35,37,38} Encouraging casualties to form into buddy pairs or teams will support mutual aid and help to quell anxiety.^{5,39} There is, however, little discussion in the literature of how non-ambulatory casualties are expected to move away from the hazard zone without assistance. If the option for non-ambulatory casualties is to either remain in the hazard zone until response personnel are available²⁸

| Priority | Function | Urgent Action |
|-----------------------|------------------------------|---|
| Move Assist | Self Rescue: | Casualties are directed to form Into mutually supportive buddy pairs or groups and to move together away from the source of contamination (a safe distance 100 meters upwind and uphill). |
| Disrobe/Decontaminate | Self-care Decontamination | Casualties are directed to remove as many layers of outer clothing as possible and to wipe down exposed hair and skin. |
| Evaluate | Triage and Shelter | Casualties must be provided with personal modesty coverings, sheltered from the weather, and triaged for further decontamination and medical needs immediately upon completing the self-care decontamination process. |

Table 1. Essential Stages of Self-care Decontamination MADE Simple

or to be assisted by ambulatory casualties, the latter option provides the best first-aid solution.¹⁶

Self-care-Kirk. and Deaton⁵ describe the period of uncertainty in developing an appropriate response to a chemical event as the "silent gap" and contend that the sooner the gap is closed, the better the patient outcome. As discussed, closing the gap quickly can be challenging for responders; nevertheless, minimizing the exposure time to a chemical contaminate will aid in reducing the dosage or severity of contamination.^{5,32} Initiating emergency self-care procedures by casualties is an essential first-aid measure and is consistent with the desired response outcomes for emergency decontamination expressed in the guiding documents.^{10,11,16,19,27-29}

Self-care can begin immediately, as it "can be conducted without equipment or supplies; it mainly depends on patients knowing what to do either on their own or through instructions provided by responders."¹⁶ Self-care actions that a casualty can perform include moving away from the hazard area, removing as much clothing as possible, and wiping contaminate off exposed skin.¹⁶ All of these actions can be completed before response personnel arrive on scene and while decontamination facilities are being established.¹⁶

Personal decontamination Kits-Protecting the privacy of casualties directly will impact their willingness and ability to comply with emergency decontamination procedures. ^{16,25,29} Siegelson³⁹ suggests emergency department resources and hospital care should be reserved for critically ill casualties and recommends providing casualties at the scene with personal decontamination kits that would allow them to complete emergency self-decontamination procedures. Such kits would include some form of disposable cover-up, such as ponchos or coveralls, that casualties could don to preserve privacy, as well as foot coverings and towels. The provision of personal self-care decontamination kits that include a labeling system for identification and tracking of belongings, as well as separate bags to hold clothing, valuables, and personal items (such as wallets, phones, and eyeglasses) is supported in the guiding documents.^{10,16,19,28,29}

Post-decontamination Shelter-Decontaminating casualties outdoors in extreme weather will create considerable discomfort and may discourage cooperation and participation in decontamination procedures. The need for protection from extreme weather should be a primary consideration in the decontamination process. Precautions against cold should be taken when temperatures are below 18°C (64°F) and shelter should be provided immediately following disrobing and emergency decontamination.^{10,27,28} Disrobing and washing down will leave casualties exposed to the weather; shelter should be provided immediately following decontamination and should be part of any community's standard response protocol. Consideration should be given to ensuring that some provision for protection from the elements is available by securing mobile resources, such as buses or tents that are readily available, to be used as decontamination and sheltering facilities. Buses provided by local transit or school authorities can be deployed to the event location quickly and can provide an appropriate method of shelter while awaiting further treatment or release.

Discussion

Recommended Mass-casualty Self-care Decontamination Protocol One of the key findings in this report was the presence of a significant response gap that exists between the time a casualty is exposed to, or contaminated by, a chemical agent and the arrival of first responders appropriately equipped to execute a HazMat/CBRN MCI decontamination response. In order to bridge that gap, the development of a standardized response algorithm that initiates a self-rescue and self-care decontamination protocol with casualties is recommended, and it would provide immediate self-care decontamination while a more thorough technical decontamination response is being mobilized. To be most effective, the response algorithm should be common across all response agencies, including police, fire, and EMS responders, to enable any first-arriving responder to initiate critical rescue and self-care decontamination protocols with casualties at a chemical MCI.

The need to fill this identified response gap is demonstrated by the development of the Initial Operational Response (IOR) by the United Kingdom's Joint Emergency Service Interoperability Programme, which recommends a multi-agency response designed to provide "a more rapid and flexible approach to a CBRN incident."⁴¹ The IOR specifically advocates moving casualties away from the contaminate and disrobing and self-decontaminating as part of the initial response to an incident, and also recommends these actions be undertaken within 15 minutes of exposure.⁴¹

The findings of this study suggest that an effective self-care decontamination protocol can be initiated at the scene of a HazMat/CBRN MCI and that casualties of all types will benefit from the process. The critical first response actions that should not be delayed are: (1) marshal casualties away from the contaminant and out of the hot zone to a safe area; (2) remove outer clothing and wipe contaminant off exposed hair and skin surfaces; and (3) shelter casualties. These three distinct stages should not be delayed: Move/Assist, Disrobe/Decontaminate, Evaluate/evacuate

| Priority | Function | Urgent Action |
|---------------|---|---|
| | Initial Arrival on Scene | Maintain a safe distance from contaminate (hot zone) and casualties (minimum 5 meters). Assess the scene quickly and determine the need for decontamination. |
| | | Immediately communicate the scene assessment and the need for further emergency response resources, including HazMat/CBRN and mobile shelter. |
| Move | Secure and Maintain the Cooperation of the Casualties | Immediately communicate directly with casualties using a predetermined script and sustain communication, by whatever means necessary, in order to encourage cooperation and gain control of the situation: <ul style="list-style-type: none"> • Use a public address system; illustrated signage, mime, etc to ensure Instructions are understood; • Use markers or barriers, as available, to demarcate the hazard zone and CCP. |
| Assist | | Engage ambulatory casualties through a buddy system to assist each other and to assist non-ambulatory casualties and any casualties requiring additional assistance. |
| | | Lead casualties away from the hazard area to a designated CCP located 100 meters upwind and uphill and within the containment area. |
| | | Instruct casualties to take nothing by mouth. |
| | | Distribute personal decontamination kits, If available. |
| Disrobe | | Direct casualties to remove as many layers of outer clothing as possible and to wipe down exposed hair and skin. |
| Decontaminate | Initiate Self-care Decontamination | Demonstrate the use of the personal decontamination equipment contained in the personal decontamination kit and provide guidance through each step: <ul style="list-style-type: none"> • demonstrate outer clothing removal techniques to ensure contaminate is not spread further: pull-over garments should be cut away or removed with care to ensure no further contamination of head and face; • place discarded clothing into largest bag in support kit if level of contamination permits - do not handle excessively contaminated clothing; • place essential items such as keys, eyeglasses, and identification into second bag; and • remove remaining clothing, at least down to under garments, and place in the largest bag. |
| | Demonstrate Procedures as Quickly as Possible (while other decontamination systems are established, as necessary) | Demonstrate eye rinse and self-care decontamination processes by wiping top down, head-to-toe, and away from the body; clean hands and rinse eyes with available eyewash, as necessary, being careful NOT to wash contaminant into eyes. Once cleaned, encourage ambulatory casualties to assist non-ambulatory casualties and any casualties requiring additional assistance. Provide casualties with warm personal-modesty coverings and shelter from the cold as soon as they have completed the self-care decontamination process. |
| | Re-robe Casualties and Provide Shelter | Demonstrate donning re-robe cover and instruct and assist as required. Provide a warm shelter for casualties, as possible, throughout the process and move to a heated holding area, such as tents or buses, immediately following emergency decontamination: <ul style="list-style-type: none"> • Buses may be secured from local transit resources to provide shelter to victims immediately following self-care decontamination and prior to required next steps. |
| | As emergency self-care decontamination is underway, responding operational and technical responders equipped with appropriate PPE will: | |
| Evaluate | | Provide life-saving medical Interventions without delay and initiate medical and decontamination triage: <ul style="list-style-type: none"> • Immediate - urgent care required - transfer to medical facility; • Delayed - non-life-threatening injuries, but requiring medical care beyond the scope of the Incident scene; • Minimal - "walking wounded" - released or transported by mass-transport vehicle to medical facility; • No effect - no exposure - may be released from scene as determined by medical officer. |
| | The technical decontamination corridor will be established while the emergency self-care decontamination process is underway. Actions will be to: | |
| | | Move patients from heated holding area through technical decontamination where soap, cloths, towels, and re-robe garments will be provided in the shower area. Re-robe patients with ponchos/Tyvek suits and footwear, at a minimum, and provide additional comfort items, such as a comb or brush and feminine hygiene items. |
| Evacuate | Post-decontamination Triage | Patients are referred to EMS for further treatment and transport. OR Patients are directed to an ESS recovery center where they can receive immediate support from DPS and transport home. |

Table 2. Best Practices for Self-care Decontamination MADE Simple

Abbreviations: CBRN, chemical, biological, radiological, or nuclear; CCP, casualty collection point; DPS, disaster psychosocial support; EMS, Emergency Medical Services; ESS, emergency social services; HazMat, hazardous materials; PPE, personal protective equipment.

(MADE). These essential components of self-care decontamination are summarized with the acronym MADE and are illustrated in Table 1.

Self-care decontamination should be considerably more comfortable and safer for casualties to experience compared to gross decontamination administered through fire hoses. However, in order to ensure that casualties are not exposed to cold, heat, or a lack of privacy for an extended time (which would simply be exchanging the discomfort of gross decontamination for the discomfort of self-care decontamination), the self-care decontamination process should be executed quickly and efficiently. The more familiar first responders are with this self-care decontamination protocol, the more able they will be to expedite the process.

Disaster Psychosocial Support

An aspect of MCI decontamination that is not supported adequately in the guiding documents is the termination of the incident. While there is considerable focus on the decontamination process, there is very little guidance on how casualties (particularly casualties that do not require further medical attention) should be discharged from the scene. There is support in the literature for the value of disaster psychosocial (DPS) support to casualties during the decontamination process.¹⁶ Consequently, DPS support should be included in MCI decontamination generally, and specifically in self-care decontamination protocols. The literature review found support for a number of additional actions that should be taken to ensure the welfare of casualties and to ensure they remain at the scene.⁴² While the actions described in Table 2 may be considered secondary to the urgent life-saving actions illustrated in Table 1, they are supported as best practices for HazMat/CBRN MCI self-care decontamination.

The self-care decontamination response algorithm described in Table 2 provides a framework for all responding agencies. The advantage to widespread acceptance of a recognized self-care decontamination protocol is to enable arriving responders to recognize the progress casualties are making through the process and to immediately assist or intervene, as required. The confidence to lead casualties through the self-care decontamination protocols will only come through familiarity with the protocols and requires a commitment to their use and to providing training to all first response and first receiver agencies.

Conclusion

The findings presented in this report indicate that casualties involved in a HazMat/CBRN MCI in a typical community would not receive sufficient on-scene care because of operational delays that are integral to a standard HazMat/CBRN first response. This delay in response will mean that casualty care will shift away from the incident scene into already over-tasked health care facilities as casualties seek aid on their own.

The self-care decontamination protocols recommended here present a viable option to ensure decontamination is completed in the field at the incident scene, and that casualties are cared for more quickly and less traumatically than they would be otherwise. Introducing self-care decontamination procedures as a standard first response within the response community will improve the level of care significantly and provide essential, self-care decontamination to casualties.

A HazMat/CBRN MCI is a low likelihood, high consequence event, and as such, may not receive the planning focus in a typical community already challenged to cope with the more common events that occur regularly. However, because something has not happened in a community does not mean it will not happen in the future, and failing to plan and prepare for a HazMat/CBRN MCI could well increase the severity of the event when it does occur.

The self-care decontamination protocols described in this report provide a relatively inexpensive mitigation option when compared to the significant costs that would be incurred by a community if one, or several, of its primary health care facilities were forced to shut down because they were contaminated by casualties arriving directly from the incident scene without first being decontaminated.

First response agencies have limited time and resources to prepare for a HazMat/CBRN MCI. Standard operating procedures are usually entrenched within the agencies; however, they are often untested in practical exercises. The result is an over-reliance on procedures, methods, and equipment that may well fail to operate as expected. Held exercises are the only means by which limitations in response capacity will be discovered. Incorporating citizens into those exercises allows response agencies to develop methods that improve the response capacity of the community. Incorporating self-care decontamination protocols into a community response plan to a HazMat/CBRN MCI may increase the response capacity and the level of resilience in the community. This evaluation clearly demonstrates that the response gap that exists in a HazMat/CBRN MCI can be closed significantly by the introduction of self-care decontamination protocols into a first response.

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