Patient Decontamination in a Mass Chemical Exposure Incident: National Planning Guidance for Communities

U.S. DEPARTMENT OF HOMELAND SECURITY

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Executive Summary

Introduction

Each day, substantial quantities of hazardous chemicals are produced, transported, stored, and used for industrial or household purposes. Stockpiles of chemical weapons around the world, while currently being destroyed, still exist. Various terrorist organizations and non-state actors have shown interest in procuring or developing and using chemicals in terrorist attacks. In each instance, these chemicals pose significant risk to public health due to the potential for accidental or intentional release that could harm large numbers of people. Civilian first responders (e.g., fire, hazardous materials (HAZMAT), and emergency medical service) and first receivers (e.g., health care facility-based and other clinical personnel), along with emergency managers, public health practitioners, law enforcement officials, and risk communication experts, must be prepared to respond to such incidents.

The potential for a large-scale chemical release resulting in the need to decontaminate an overwhelming number of people has garnered wide interest among policy makers and emergency planners. Guidance and best practice documents have been published and specialized equipment has been purchased. However, decontamination practices have evolved based on sparse evidence. Limited research has been conducted on decontaminating civilians. Patient decontamination, like other aspects of disaster response, medicine, and public health, could benefit from an assessment of the body of evidence, enhanced incorporation of the evidence into planning and practice, and additional study to generate needed evidence. Furthermore, many current guidance and best practice documents do not address the full spectrum of issues that a community may face when large-scale patient decontamination is necessary in a mass chemical exposure incident.

The need for examination of current patient decontamination practices was identified by experts in the emergency response and medical communities. The White House National Security Council (NSC) staff followed with a request for evidence-based national planning guidance for mass patient decontamination in a large-scale chemical release. Efforts to enhance preparedness for patient decontamination in a mass exposure incident may also benefit the care that is provided to individual contaminated patients in other circumstances.

Audience, scope, and intent

The intended audience includes senior leaders, planners, incident commanders, emergency management personnel, and trainers of local response organizations and health care facilities. Though the guidance was developed with this specific audience in mind, it may be of value to other audiences, including first responders and first receivers, community leaders, scientific researchers, as well as others from the response and emergency management fields. A basic assumption of this document is that mass patient decontamination takes place at the level of the local affected community. Due to the need for chemically-contaminated patients to be decontaminated as soon as possible, the federal government will likely not be able to participate directly in the decontamination response. Therefore, this guidance is directed primarily at local organizations.

The subject matter considered here is limited to external contamination of living people (henceforth defined as “patients”; see Appendix B: Lexicon) with toxic industrial chemicals (TICs), toxic industrial materials (TIMs), or chemical warfare agents (CWAs) in a mass casualty incident resulting from an accidental or intentional release. This guidance attempts to address the full spectrum of the decontamination response operation, from initial assessment and decision making through evaluation of decontamination effectiveness. Further, the entire affected community is considered, with emphasis on coordination between on-scene and health care facility-based response activities and communication on multiple levels.

Patient decontamination principles are set forth here from a strategic perspective, rather than a tactical one. The principles are meant to guide, but not specify, operational practices. The guidance is evidence-based to the extent possible and the supporting evidence is documented and briefly discussed.

The approach in this guidance is flexible and scalable according to the resource and capability limitations of the community. The recommendations should be adapted as each unique community sees fit according to their own hazard and risk assessment.

Examples of how the guidance might be used include:

- Planners: incorporate current evidence-based recommendations during development or revision of an organization's response plans.
- Community leaders, public health officials: enhance system-wide coordination and develop plans for communicating with patients and the whole community.
- Trainers: develop, improve, or augment training of response personnel for patient decontamination operations, using current evidence-based recommendations.
- Emergency managers: generate policy and plans to address issues related to system-wide coordination, the whole community response, and crisis and risk communications, as well as other overarching issues.
- Hospital emergency managers: incorporate evidence-based recommendations into the hospital response plan and training program addressing the hospital's unique challenges, and enhance coordination of the hospital response with those of the rest of the community through effective interagency planning and communication.
- Researchers: identify knowledge gaps and conduct research to investigate them.

Guidance statement format and quick reference guide

In Section III, each of the guidance statements is described in full along with associated information in the following format:

Functional Area	The guidance statements are organized by six functional areas, each broadly describing a key element of the response
Guidance Statement	Full text of the guidance statement (GS)
Considerations	Additional factors that should be considered when implementing the guidance statement
LOC	Level of Confidence rating (described in Appendix D) for the evidence on which the guidance statement is based
Discussion	Briefly describes the evidence applicable to the guidance statement, from reviews of the scientific literature, current practices, and subject matter expert opinion and experience

Quick Reference Guide

Functional Area	GS#	Description	Page #
Determining the Need for Patient Decontamination	1.1	The decision to decontaminate should take into account a combination of key indicators, including (but not limited to): • Signs and symptoms of exposure displayed by the patient; • Visible evidence of contamination on the patient's skin or clothing; • Proximity of the patient to the location of the release; • Contamination detected on the patient using appropriate detection technology; • The chemical identity (if known), physical state, characteristics, and behavior; and • Request by the patient for decontamination, even if contamination is unlikely	24
	1.2	Decontamination should be performed if the potential contamination on a patient requiring transport to, or care in, a health care facility poses a reasonable risk of exposure to first responders, first receivers, other patients, or contamination of critical infrastructure.	27
	1.3	If the likelihood of adverse consequences from water-based decontamination methods outweighs the likely health outcome gains, then patient decontamination should be performed using alternative practices.	29
Optimized Technical Practices	2.1	A risk-based approach should be employed by a responding or receiving organization to determine the appropriate response level and associated strategies and tactics, including PPE, medical interventions, and decontamination.	31
	2.2	A tiered approach to patient decontamination allows responders and receivers to base the nature and level of decontamination on the type and extent of contamination, as estimated through a risk-based assessment of the incident, as well as available resources. The tiered decontamination response is flexible and adaptable to various types of incidents; each tier can be executed either at the scene or at a health care facility.	32
	2.3	Self-care and/or gross patient decontamination actions should occur as quickly as possible, while decisions on the need and process for technical patient decontamination are made and equipment is set up, if warranted.	35

Optimized Technical Practices	2.4	Attempt to immediately decrease ongoing exposure by removing all patients out of the area of chemical release and provide an area of refuge.	37
	2.5	Clothing removal for patients who have been visibly contaminated or who are suspected of having been contaminated is an essential aspect of decontamination. For patients who can remove their own clothing, it can be a part of self-care. Efforts should be made to collect and account for clothing and personal items removed during patient decontamination.	39
	2.6	Privacy for patients should be incorporated throughout the decontamination process, within the resource limitations of the responding or receiving organization, to include: • Privacy during clothing removal; • Segregation of males and females during decontamination; and • Materials for redressing following decontamination	42
	2.7	Water is the preferred decontaminant in the case that gross patient and/or technical patient decontamination is deemed appropriate, unless specific information about the contaminant indicates otherwise.	44
	2.8	The following parameters are recommended for water-based decontamination, unless specific information about the contaminant indicates otherwise: • Low pressure (~50 – 60 psi); • High volume; • Tepid (i.e., slightly warm, not hot) temperature; and • Duration no longer than three minutes; ensure thorough soaking	47
	2.9	When water-based decontamination is indicated, mild soap, if available, should be added to water for gross patient and technical patient decontamination, especially if the contaminant is thick, oily, or otherwise difficult to remove by water alone.	49
	2.10	The use of a non-abrasive sponge, washcloth, or similar wash item may enhance water-based decontamination by increasing the physical removal of a contaminant through lightly rubbing contaminated areas.	51

Optimized Technical Practices	2.11	Alternative practices or decontaminants should be incorporated into the decontamination process when water-based decontamination is contraindicated (e.g., due to weather/environmental concerns, chemical reactivity) or delayed (e.g., resource or capability limitations or logistics). Planning should include identifying possible alternative locations (e.g., showers at a gym or swimming pool) for water-based decontamination when necessary. • Alternative decontamination practices in lieu of water-based decontamination include: o Delaying water-based decontamination; and o Non-water-based decontamination techniques • Alternative decontaminants include: o Approved neutralizing agents (e.g., partitioning and chelating agents); o Chemical specific decontaminants (e.g., polyethylene glycol (PEG) for phenolic compounds); o Absorbent materials (e.g., spill pads, oil-dry, kitty litter, Fuller's Earth); and o Adsorbent materials (e.g., activated carbon)	53
Evaluating the Effectiveness of Decontamination	3.1	Decisions on whether contamination has been reduced to a level that is safe or additional decontamination is necessary can be guided by the following indicators (and others as appropriate): • Elimination of visible contamination from the skin and/or clothing; • Observable improvement in signs and symptoms which prompted the decision to perform decontamination; • Patient perceptions of the effectiveness of decontamination; • Results from appropriate detection technologies; • Guidelines in Functional Area 2: Optimized Technical Practices were followed; and • If an effective decontamination method, which is known to be appropriate given the nature of the incident and chemical involved, is properly executed, then a sufficient reduction in contamination can be implied.	56
	3.2	Timeliness and efficiency are critical elements of effective patient decontamination: an individual patient needs to be decontaminated with minimal delay and patients in a mass exposure incident need to be decontaminated expeditiously in order to do the greatest good for the greatest number. However, a rapid pace must be balanced with quality and consistency of patient care to achieve the goals of providing first aid to patients and protecting responders, receivers, and health care infrastructure from secondary contamination.	58

Patient Prioritization for Decontamination	4.1	Immediate, lifesaving medical care and/or antidotal therapy should ideally be a priority, over patient decontamination.	59
	4.2	Prioritize patients for decontamination by estimating relative risk and grouping patients into urgent and non-urgent decontamination groups. Risk assessment should take into consideration the following criteria (and others as appropriate) in preferential order: • Need for immediate lifesaving care or antidotal therapy (see GS 4.1); • Visible evidence of contamination on patient's skin or clothing; • Patients displaying signs and symptoms of exposure; • Proximity of patient to the location of release; and • Contamination detected on patient using appropriate detection technology	61
System-Wide Coordination of Patient Decontamination	5.1	If decontamination is indicated, it should be performed as soon as possible, preferably at the scene if not contraindicated by safety considerations.	64
	5.2	Anticipate self-evacuation from the scene prior to decontamination and develop a coordinated whole community response plan to manage the entire spectrum of patients, which include: • At scene: ambulatory and non-ambulatory patients who remain at the scene; individuals other than responders who arrive at the scene after the release and become exposed (e.g., news reporters, bystanders); • Self-evacuated: patients who travel without the assistance of responders to a health care facility (e.g., hospital, physician's office, or urgent care center); and • Left scene: patients who leave the scene and do not seek care (e.g., return home or travel elsewhere), or seek care later due to delayed onset of signs and symptoms	66

	5.3	Responding and receiving organizations should plan for both ambulatory and non-ambulatory patients simultaneously.
		• Ambulatory patients should be able to follow verbal, written, or posted directions with no physical assistance from first responders or first receivers.
		  o May be helped by "buddy" or family member
		• Non-ambulatory patients will need personnel to assist them through the process.
		  o Specialized equipment will be needed (e.g., backboards, raised working surface/roller tables).
			68

System-Wide Coordination of Patient Decontamination	5.4	At-risk populations require additional assistance. Responding and receiving organizations should implement planning and training to assist at-risk populations through the decontamination process. • At-risk individuals have needs in one or more of the following functional areas: communication, medical care, maintaining independence, supervision, and transportation. • At-risk populations may include infants, children, the elderly, and pregnant women, as well as people who have functional or mobility impairments, live in institutionalized or congregate settings, have limited English proficiency or are non-English speaking, or have cognitive impairments.	69
	5.5	A formal rapid communication procedure should be utilized to provide advance notice to area health care facilities of a hazardous chemical incident and to specifically alert facilities to the possibility of self-evacuated patients needing assessment of contamination and arriving unannounced to health care facilities.	73
	5.6	Notification, by graphic, written, or verbal means, and ideally a combination of all three, should be used to record scene decontamination practices for clear communication and coordination with health care facilities.	75
	5.7	PPE selection, training, and use should be based on applicable regulations (OSHA), standards (NIOSH), and/or guidance (NFPA), SME recommendation, and manufacturers' specifications, in conjunction with scene evaluation and risk assessment and Authority Having Jurisdiction standard operating procedures or standard operating guidelines.	77
	5.8	Scene response and health care facility emergency planners should work with federal, state, and local government officials to ensure any guidance, practices, and plans properly address applicable laws, regulations, and guidance concerning environmental issues, such as the management of liquid and solid wastes, environmental monitoring of decontamination area(s), and other environmental impact issues.	79

Crisis and Emergency Risk Communication	6.1	Communication is an essential component of effective disaster management. Crisis and emergency risk communication should be incorporated into all stages of disaster management, so that planning addresses communication before, during, and after an incident. All personnel expected to respond to a mass casualty chemical incident should receive job-appropriate training in crisis and emergency risk communication. Use these best practices for effective communication with the public (WHO, 2005): • Build trust; • Announce early; • Be transparent; • Respect public concerns; and • Plan in advance	81
	6.2	Develop a strategic communications plan for delivering various types of messages during an incident. Prepare as much material in advance as possible: identify message topics and their audiences; write pre-scripted messages; and identify appropriate spokespeople or messengers for each type of message. Communication needs to be coordinated across all organizations so that a single message is spoken with many voices throughout the community.	84
	6.3	Public education can be achieved by using naturally occurring opportunities to communicate patient decontamination goals; potential practices; responsibilities of responders, receivers, and patients; and expected outcomes. A strategic plan for pre-incident communication to enhance community preparedness should be developed to include information about patient decontamination in community outreach by fire service and EMS organizations, public service announcements, and other planned events.	88
	6.4	To facilitate effective two-way communication during and after an incident: • Provide patients with pre-scripted and printed follow-up information before they leave the scene or prior to discharge from the health care facility. • Obtain patient contact information prior to release from the health care facility to allow for follow-up by public health officials. • Establish an easily accessible mechanism for patients to obtain additional information or advice and for authorities to respond directly to patients' questions or comments. • Provide follow-up information for other community members who were either at the scene and not decontaminated or not at the scene.	90

Acronyms List

Acronym	Definition
AAP	American Academy of Pediatrics
ASPR	Office of the Assistant Secretary for Preparedness and Response, US Department of Health and Human Services
ATSDR	Agency for Toxic Substances and Disease Registry, Centers for Disease Control and Prevention, US Department of Health and Human Services
CAL-OES	California, Office of Emergency Services
CBRN	Chemical, Biological, Radiological, and Nuclear
CDC	Centers for Disease Control and Prevention, US Department of Health and Human Services
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHEMM-IST	Chemical Hazards Emergency Medical Management – Intelligent Syndromes Tool, National Library of Medicine, National Institutes of Health, US Department of Health and Human Services
CHEMTREC	Chemical Transportation Emergency Center
CONOPS	Concept of Operations
CWA	Chemical Warfare Agent
DHS	US Department of Homeland Security
DOD	US Department of Defense
DOT	US Department of Transportation
ECBC	Edgewood Chemical Biological Center, Department of the Army, US Department of Defense
ED	Emergency Department
EMS	Emergency Medical Services
EPA	US Environmental Protection Agency
FDA	Food and Drug Administration, US Department of Health and Human Services
FEMA	Federal Emergency Management Agency, US Department of Homeland Security
FOSC	Federal On-Scene Coordinator
GS	Guidance Statement
HAZMAT	Hazardous Materials
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCF	Health Care Facility
HHS	US Department of Health and Human Services
ICS	Incident Command System
IOM	Institute of Medicine
LD_{50}	Lethal Dose for 50% of the population
LT_{50}	Delayed decontamination time that prevents mortality in 50% of the population
LEPC	Local Emergency Planning Committee
LOC	Level of Confidence
LRN-C	Laboratory Response Network – Chemical
MSDS	Material Safety Data Sheet
NFPA	National Fire Protection Association

NIMS	National Incident Management System
NIOSH	National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, US Department of Health and Human Services
NLM	National Library of Medicine, National Institutes of Health, US Department of Health and Human Services
NRF	National Response Framework
OHA	Office of Health Affairs, US Department of Homeland Security
ORCHIDS	Optimization through Research of Chemical Incident Decontamination Systems
OSHA	Occupational Safety and Health Administration, US Department of Labor
PAHPA	Pandemic and All-Hazards Preparedness Act
PEG	Polyethylene Glycol
PHMSA	Pipeline and Hazardous Materials Safety Administration, US Department of Transportation
PPE	Personal Protective Equipment
psi	pounds per square inch
RSDL®	Reactive Skin Decontamination Lotion®
S&T	Science and Technology, US Department of Homeland Security
SALT	Sort-Assess-Lifesaving Interventions-Treatment/Transport
SARA	Superfund Amendments and Reauthorization Act, US Environmental Protection Agency
SDS	Safety Data Sheet
SME	Subject Matter Expert
SOP	Standard Operating Procedure
START	Simple Triage and Rapid Treatment/Transport
TIC	Toxic Industrial Chemical
TIM	Toxic Industrial Material
TLV	Threshold Limit Value
TRANSCAER	Transportation Community Awareness and Emergency Response
TSWG	Technical Support Working Group, US Department of Defense
WISER	Wireless Information System for Emergency Responders
WG	Working Group
WHO	World Health Organization
WMD	Weapon of Mass Destruction

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I. Introduction

Purpose

Whether as a result of an accidental release at a chemical plant, a transportation accident, or an intentional military or terrorist action, the threat of exposure of the public to hazardous chemicals is real. An accidental gas leak at the Union Carbide chemical plant in Bhopol, India, resulted in the release of methyl isocyanate into the environment exposing thousands (Zaidi, 1986). The Iraqi military used chemical warfare agents (CWAs) against Iran and Iraqi Kurds (Darchini-Maragheh et al., 2012; Ghanei et al., 2010). Aum Shinrikyo, a religious cult, produced and released sarin, a nerve agent previously possessed only by nations, on multiple subway cars in Tokyo, Japan (Okumura et al., 1996). In Graniteville, South Carolina, a rail car accident resulted in the release of chlorine gas in a populated area (Duncan et al., 2011). In each of these cases, significant numbers of people were killed or their health adversely affected.

Each day, large quantities of hazardous chemicals are produced, transported, stored, and used for industrial and household purposes. During each of these activities, there is risk that the chemicals could be released into the environment due to an accident or intentional act to cause harm. Stockpiles of chemical weapons around the world, while currently being destroyed, still exist. Moreover, chemical suicide,[1] both abroad and in the United States (US), is a troubling recent trend affecting not only the patients but also creating risk for the first responders and first receivers rendering assistance. Civilian first responders and health care first receivers, along with emergency managers, public health practitioners, law enforcement officials, and risk communication experts must be prepared to respond to incidents involving the release of chemical agents.

The threat of a chemical release carries with it the possibility that workers, bystanders, or others may become contaminated. These contaminated individuals (i.e., patients) require assessment for decontamination needs and then, potentially, decontamination at the scene of the incident and/or at a health care facility. In recent years, the potential for a large-scale chemical release requiring decontamination of an overwhelming number of people has attracted increased interest. In response, methods and procedures for civilian mass patient decontamination have been developed largely through extrapolating techniques used on hazardous waste site personnel and hazardous materials (HAZMAT) responders in personal protective equipment (PPE) (National Institute for Occupational Safety and Health [NIOSH], 1985 - see United States Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, 1985) and military personnel in protective gear (Department of Defense [DOD], 2006 - see United States Department of Defense, 2006). Information sharing among fire and emergency services, HAZMAT response, medical, and military chemical, biological, radiological, and nuclear (CBRN) defense communities improved these practices. Decontamination practices evolved rapidly and industry responded with customized equipment but not necessarily with the benefit of evidence to guide such efforts (Levitin et al., 2003; Stopford et al., 2005). Limited research has been conducted on decontaminating people and much of what has been done is based on the military perspective: decontaminating trained professional service members with the end goal being to return them to the operational environment so that they can continue a mission.

Mass patient decontamination, like other aspects of disaster response, medicine, and public health, could benefit from an assessment of the body of evidence, enhanced incorporation of the evidence into planning and practice, and additional study to generate needed evidence (Auf der Heide, 2006; Institute of Medicine [IOM], 1999; Levitin et al., 2003; Stopford et al., 2005). Various organizations have published guidance and best practice documents but these generally do not categorize recommendations as evidence-based or not, nor do they describe the pertinent evidence. Furthermore, many current

[1] Chemical suicides (also called "detergent suicides" by the media) are specific acts carried out by an individual through the mixing of certain household chemicals to produce toxic chemicals.

guidance and best practice documents do not address the full spectrum of issues, such as coordination and communication, which a community may face when patient decontamination is necessary in a mass chemical exposure incident.

The need to examine patient decontamination practices was identified by experts in the emergency response and medical communities. The White House National Security Council (NSC) staff followed with a request for evidence-based national planning guidance for mass patient decontamination in a large-scale chemical release. Efforts to enhance preparedness for patient decontamination in a mass exposure incident may also help to improve the care that is provided to individual contaminated patients in other circumstances.

How this work is unique

Patient Decontamination in a Mass Chemical Exposure Incident: National Planning Guidance for Communities differs from previous planning, guidance, and best practice documents in two significant ways:

- The guidance is evidence-based to the extent possible and that evidence, or lack thereof, is documented and briefly discussed. As applied in this guidance document, "evidence-based" refers to the conscientious, definitive, and judicious use of current scientific evidence and/or sound technical input from subject matter experts (SMEs) in developing patient decontamination recommendations for the care of patients, both individually and in a mass casualty chemical incident, in order to save lives and mitigate adverse health effects (Sackett et al., 1996).
- This document attempts to address multiple stages of the emergency response, from initial assessment and decision making through evaluation of decontamination effectiveness. Further, a comprehensive approach is taken to the entire affected community with emphasis on coordination between on-scene and health care facility-based response activities and communication on multiple levels.

Audience and intent

The main intended audience includes senior leaders, incident commanders, planners, and trainers for emergency response organizations and health care facilities, as well as emergency managers, and military personnel supporting domestic responses. Though the guidance was developed with this specific audience in mind, it may be of value to other audiences, including first responders, first receivers, and leaders of public health organizations.

The guidance sets forth patient decontamination principles from a strategic standpoint, rather than a tactical one. It is meant to guide, but not specify, operational practices. The approach in this guidance is flexible and scalable according to the resource and capability limitations of the community. The recommendations should be adapted as each unique community sees fit according to their own hazard and risk assessment. The guidance statements comply with the National Response Framework (NRF) and do not promote any additions or changes to the National Incident Management System (NIMS) or the Incident Command System (ICS).

Scope

The subject matter considered here is limited to external contamination of patients in a mass casualty incident resulting from an accidental or intentional chemical release. Contamination of patients with chemicals, including toxic industrial chemicals (TICs), toxic industrial materials (TIMs), and CWAs, is the present focus. Radiological materials and biological agents also pose important risks. Many of the concepts presented here may apply to those agents; in future work, this guidance can be built upon to address radiological and biological agents. While this guidance is aimed at mass casualty chemical

incidents, the recommendations and principles may be applied to individual patients or multi-patient incidents as well.[2]

Methodology

A federal interagency expert working group, the Mass Human Chemical Decontamination Working Group (WG), developed this national planning guidance with the advice of a larger group of federal and non-federal SMEs in emergency response, emergency medicine, toxicology, risk communication, behavioral health, and other relevant fields. The WG was established at the request of the White House National Security Council (NSC) staff and co-chaired by the Department of Health and Human Services (HHS), Office of the Assistant Secretary for Preparedness and Response (ASPR) and the Department of Homeland Security (DHS), Office of Health Affairs (OHA).

In order to define the problem, core questions were identified that were considered essential to performing patient decontamination and most likely to influence on-scene and health care facility approaches. Core questions and their sub-questions naturally fell into three categories, which follow a logical response progression:

1. Risk assessment and decision making
2. Decontamination process and procedure
3. Evaluation of results and patient follow-up

Core questions were further divided so that the three categories were each applied to two distinct situations: individual patient decontamination, in which one to a few potentially contaminated patients present for assessment and local resources are not overwhelmed; and mass patient decontamination, when a mass casualty incident results in numerous potentially contaminated patients and local response capabilities may be overwhelmed. These two circumstances allowed the WG to separately consider: (1) questions pertinent to an incident in which significant resources and attention can be brought to bear on a single patient or small number of patients and therefore, optimal methods can be assumed; and (2) questions unique to a mass casualty situation, when patient needs are likely to exceed available resources and thus prioritization, flexibility, requests for assistance, and other approaches may be necessary.

An extensive search of the published literature for answers to the resulting six core questions was conducted. The following databases were searched, although this is not an exhaustive list: PubMed, Scopus, Web of Science, and Google Scholar. Additional searches were conducted through the National Institutes of Health's (NIH) National Library of Medicine (NLM) databases. Initial search terms were limited to: "human", "chemical", and "decontamination". Additional search terms were topic-dependent. Examples include:

- Triage, assessment, decision to decontaminate;
- Risk communication, emergency communication, crowd behavior, disaster crowd management;
- Hospital preparedness, health care facility response;
- Detection capabilities, portal sensor technology; and
- Effectiveness criteria, determination of clean

Only articles in English were evaluated and no limits were placed on the publication date. Once an initial search was completed, the reference sections of reviewed articles were used as sources of additional material for evaluation. Throughout this process, the WG sought the assistance of SMEs in identifying

[2] Mass patient decontamination (defined in Appendix B) occurs in a large-scale incident; patients may need to be prioritized for decontamination. The number of contaminated patients may exceed the typical response capacity of an organization. Multi-patient decontamination indicates a small-scale incident in which more than one patient requires decontamination but the response is within the resources of the responding organization.

additional references, unpublished data, and ongoing studies.

The literature review results were summarized and presented, along with the core questions and sub-questions, to a group of emergency responders, emergency medicine clinicians, toxicologists, researchers, and other relevant experts at the Symposium on Chemical Decontamination of Humans 2010[3] (see list of participants in Appendix A). Symposium participants helped to identify additional sources of evidence, refine the summaries of the evidence, and initiate lists of knowledge gaps or research needs for each core question.

With strong summaries of the available evidence, as well as the important identified knowledge gaps, an initial draft guidance was created. The guidance follows the path set by the core questions, which define the essential information needed to conduct patient decontamination. For the guidance, each core question has been converted to a functional area (see Table 1 below). Each distinct principle is described as a guidance statement (GS), with associated considerations if applicable. Guidance statements are based on published evidence, if available, and have been additionally shaped by other guidance and best practice documents, expert opinion, and experience.

Table 1. Key Elements of Patient Decontamination

Decontamination	Core Question	Stage of Response	Functional Area
Individual Patient	What criteria can guide the decision on whether the patient needs decontamination or not?	Risk assessment and decision making	Determining the need for patient decontamination
	What are the optimal methods for decontamination of a patient with an unknown level of exposure to an unknown agent?	Decontamination process and procedure	Optimized technical practices
	What metrics can be used to determine if patient decontamination was effective?	Evaluation of results and patient follow-up	Evaluating the effectiveness of decontamination
Mass Patient	What techniques can be used for assessment and triage of patients (both at the scene and at health care facilities) to prioritize for decontamination and medical treatment?	Risk assessment and decision making	Patient prioritization for decontamination
	Where and when should decontamination take place?	Decontamination process and procedure	System-wide coordination of patient decontamination
	Communication: (1) What information should be provided to patients to promote safety and compliance during decontamination and how should it be communicated? (2) How can communication about the incident with the whole community support the response and recovery?	Evaluation of results and patient follow-up	Crisis and emergency risk communication

[3] The Symposium on Chemical Decontamination of Humans was held in Washington, DC, on December 6-7, 2010, co-sponsored by DHS/OHA and HHS/ASPR. The final summary can be found at: http://www.phe.gov/Preparedness/mcm/Documents/summary-chemdecon-20June12.pdf

As evidence of current practice, the WG performed an analysis of current guidance or best practice documents for recommendations that address one of the six core questions. The following documents were included in the analysis:

- United States Department of Health and Human Services, Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry. (2001a). *Managing hazardous materials incidents, Volume I: Emergency Medical Services*. Atlanta, GA: Agency for Toxic Substances and Disease Registry. Retrieved from http://www.atsdr.cdc.gov/MHMI/mhmi_v1_2_3.pdf

- United States Department of Health and Human Services, Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry. (2001b). *Managing hazardous materials incidents, Volume II: Hospital Emergency Departments*. Atlanta, GA: Agency for Toxic Substances and Disease Registry. Retrieved from http://www.atsdr.cdc.gov/MHMI/mhmi_v1_2_3.pdf

- United States Department of Defense, Technical Support Working Group. (2004). *Best practices and guidelines for CBR mass personnel decontamination* (2nd ed.).

- United States Department of Labor, Occupational Safety and Health Administration. (2005, January). *OSHA best practices for hospital-based first receivers of victims from mass casualty incidents involving the release of hazardous substances*. Retrieved from https://www.osha.gov/dts/osta/bestpractices/firstreceivers_hospital.pdf

- California Governor's Office of Emergency Services. (2006). *Multi-casualty mass decontamination guidance document for first responders*. Retrieved from http://www.calema.ca.gov/hazardousmaterials/documents/mcmd-1-2-06.pdf

- United States Department of Labor, Occupational Safety and Health Administration. (2009). *Best practices for protecting EMS responders during treatment and transport of victims of hazardous substance releases*. OSHA 3370-11. Retrieved from https://www.osha.gov/Publications/OSHA3370-protecting-EMS-respondersSM.pdf

- United States Army Research, Development and Engineering Command, Edgewood Chemical Biological Center, and Chemical, Biological, Radiological and Nuclear School. (2013, August). *Guidelines for mass casualty decontamination during a HAZMAT/weapon of mass destruction incident*: *Volumes I & II*. ECBC-SP-036. Retrieved from http://www.nfpa.org/~/media/Files/Research/Resource%20links/First%20responders/Decontamination/ecbc_Guide_MassCasualtyDecontam_0813.pdf

The initial draft guidance statements, their considerations, and the supporting evidence were presented to a group of SMEs at the Mass Human Chemical Decontamination 2012 Symposium[4] (see list of participants in Appendix A). Participants reviewed, discussed, suggested revisions, and voted their approval or rejection of each guidance statement. The evidence to substantiate each guidance statement was also reviewed. Following the symposium, guidance statements were significantly revised, the supporting evidence was summarized, and a level of confidence (LOC) (see Rating the evidence section below and Appendix D), which reflects the amount and quality of evidence supporting a recommendation, was assigned to each guidance statement. In addition, extensive stakeholder review of this guidance document has been conducted, including through professional societies and publication in the Federal Register for public comment, before finalization and distribution to the target audience.

The WG developed a lexicon of terms applicable to decontamination of people in a mass exposure

[4] The Mass Human Chemical Decontamination 2012 Symposium was held in Washington, DC, on January 24-26, 2012, co-sponsored by DHS/OHA and HHS/ASPR.

incident (included as Appendix B). The new lexicon is an attempt to standardize terms and promote use of common language by stakeholders across organizations to describe patient decontamination activities.

Rating the evidence

A Level of Confidence (LOC) score is assigned to each GS. This confidence rating gives the reader a sense of the strength of evidence substantiating a particular GS. The following list provides a synopsis of the LOC five-point scale (additional information can be found in Appendix D).

- LOC I – The highest recommendation is supported by strong scientific evidence, including clinical or field research, in addition to current practice and strong SME consensus.
- LOC II – The second tier recommendation is supported by some scientific evidence which is not definitive or where methodological problems limit the utility of the stated conclusions; current practice and strong SME consensus also substantiate the recommendation.
- LOC III – The third tier recommendation is one for which very limited scientific literature is informative, but for which there is precedent in current practice and for which there is majority SME consensus.
- LOC IV – The fourth tier recommendation is supported by at least majority consensus and current practice but little or no scientific literature.
- LOC V – The fifth tier reflects an absence of literature and precedent; SME consensus forms the sole basis for the recommendation.

Since this is designed to be a living document, LOC scores may change in future versions when new evidence becomes available to inform the guidance statements. The LOC scoring system helps to identify those topics requiring additional research.

Future plans

As the evidence-based principles for conducting patient decontamination set forth here are implemented, response plans and operational practices should themselves become more evidence-based. During development, a variety of gaps in the evidence were identified, many of which are outlined in the GS discussions. These knowledge gaps will be formulated into a research road map describing and prioritizing questions for which evidence-based answers could help to improve the effectiveness of patient decontamination (see Desired end points section below). The research road map will be directed at grant and contract awarding entities and members of the research community. Subsequent revisions to this guidance will reflect updated recommendations based on completion of research studies as well as widely accepted changes to current field practices.

It is crucial to integrate this guidance into training curricula and the WG intends to work closely with federal partners to do so. Ideally, this guidance will be part of an iterative process of updating training programs, operational response plans, and response standards during their normal revision cycles. Additionally, it is important to ensure that the intended audience is aware of the guidance. Promotion will be necessary upon this document's release and subsequent updates. To support this socialization and periodic updating, a web-based version of the guidance document may be designed and published.

Recommendations for meeting the unique needs of infants, children, pregnant women, the elderly, and animals (e.g., household pets and service animals)[5] are described in general in GS 5.4, but targeted recommendations are beyond the scope of this document. These topics require additional work.

[5] The Pets Evacuation and Transportation Standards Act of 2006, Pub. L. 109-308 (Oct. 6, 2006), was intended to ensure that state and local emergency preparedness operational plans address the needs of individuals with household pets and service animals following a major disaster or emergency.

II. Guiding Principles

Defining patient and patient decontamination

For the purpose of this guidance, any individual who may require decontamination is considered a patient.

"Patient" is defined here as:
Any individual who was at or near the location of a hazardous materials release and who was potentially exposed and therefore potentially contaminated and may require some form of care (e.g., decontamination, lifesaving interventions, antidotal therapy, supportive medical care, communication, or reassurance). Additionally,

- Not all patients will require follow-on treatment or evaluation at a health care facility.
- Some patients will leave the incident scene prior to responders arriving (i.e., self-evacuation).
- Some individuals, who were not at or near the scene, are not likely to have been contaminated, or may not require any medical assistance, may still present for evaluation and treatment, including requesting decontamination (see GS 1.1).

Use of the term "patient" to refer to a potentially contaminated individual was decided upon following extensive discussion among WG members, symposia participants, and a special sub-group of SME first responders, first receivers, emergency managers, policy analysts, and military personnel. The term was carefully chosen to reflect the principle that decontamination of a person is a first aid measure that can save lives and reduce other adverse health effects. Candidacy for a preventive medical intervention based on significant risk of exposure to a toxic chemical should qualify a person as a patient. This definition does not imply that all decontamination will be conducted by medical personnel, and does not imply that if decontaminated, the patient must be transported to or evaluated in a health care facility.

In this case, the "patient" designation does not encumber the same financial or contractual responsibility as a formal provider-patient relationship. The WG has found no definition of "patient" which would exclude use of the term for an individual evaluated as to the need for decontamination. Finally, use of the term "patient" avoids negative connotations potentially associated with other terms, such as victim or casualty.

"Patient decontamination" is defined here as:
Any process, method, or action that leads to a reduction, removal, neutralization - by partitioning or binding (as opposed to chemical neutralization, which is not recommended; see GS 2.11) - or inactivation of contamination on or in the patient in order to: prevent or mitigate adverse health effects to the patient; protect emergency first responders, health care facility first receivers, and other patients from secondary contamination; and reduce the potential for secondary contamination of response and health care infrastructure.

This definition is similar to other published definitions of decontamination (e.g., DOD, 2006; National Fire Protection Association [NFPA], 2013a) but uniquely focuses on human health outcomes. The importance of decontaminating a potentially contaminated patient for protecting that patient's health, the health of the responders and receivers treating that patient, the health of other community members, and the integrity of the emergency response and health care systems are explicit in the definition. Since numerous actions, such as distancing oneself from the site of a chemical release, wiping visible contamination from skin and clothing, and removing clothing, can reduce or remove contamination from a patient, they are considered patient decontamination. Our definition is therefore broad and includes steps that a patient can take on his/her own, even before first responders arrive, to protect the health of him/herself and others (see also Tiered risk-based response approach section below and GS 2.2).

Patient decontamination is a medical countermeasure

When conducted within the appropriate time window (which is relatively short for most chemical exposures) and using appropriate strategies (see Functional Area 2: Optimized Technical Practices), patient decontamination can limit the patient's exposure and the toxicities that follow from chemical contamination. It does this directly by preventing or reducing chemical agent absorption by the patient. Therefore, patient decontamination is an essential early step in the response to a chemical incident and can be considered a type of first aid – an initial action that potentially reduces morbidity and mortality. Secondarily, it facilitates the expeditious movement of patients into the health care system where they can be treated by receivers in a reduced level of PPE; the higher levels of PPE worn by responders or receivers treating potentially contaminated patients can inhibit patient care by reducing visual, auditory, and tactile senses.

Secondary contamination leading to adverse health effects in responders and receivers who handle patients in a chemical incident is a well-documented phenomenon (Geller et al., 2001; Horton et al., 2003, 2008; Huff, 1991; Kim, 2001; Merrit & Anderson, 1989; Nozaki et al., 1995; Okudera et al., 1997; Okumura et al., 1998a, 1998b; Okumura et al., 2005; Scanlon, 2010; Zeitz et al., 2000). Proper use of PPE can minimize the risk of secondary contamination and the associated health consequences. However, especially for health care facility-based first receivers, decontamination of the patient prior to entry into patient care areas may be the most appropriate way to reduce the potential for secondary contamination. Similarly, the risk of secondary contamination of facilities and equipment, which can cause significant disruptions to emergency health care for an entire community (Burgess et al., 1997, 1999; Horton et al., 2008; Huff, 1991; Kim, 2001), may be reduced by decontaminating patients before they come into contact with such facilities and equipment.

The health benefits of patient decontamination – mitigating adverse health effects in the patient, permitting faster access to medical care, protecting the health of responders and receivers, and protecting health care infrastructure integrity – warrant its identification as a medical countermeasure. It should be addressed with the urgency appropriate for a medical countermeasure and integrated into planning for other medical countermeasure utilization.

Desired end points for patient decontamination

A long-time weakness in the practice of patient decontamination is the lack of well-defined, outcome-based goals. Complete removal of chemical contamination could be considered one end point, one that requires considerable effort, time, and resources. However, would complete removal of contamination be worth the effort if performing such complete patient decontamination, compared to a less than absolute but adequate decontamination, led to no difference in the short-term or long-term health outcome for the patients, did not prevent any secondary contamination of responders and their equipment or receivers and their facilities, or contribute to the safety and resiliency of the community? Military decontamination doctrine has a well-defined and well-recognized goal: restoration of personnel and materiel to operational status in order to accomplish the mission. This goal drives planning, resource, and time allocation, allows for decontamination that may not result in complete removal of contamination, and provides for a measure of effectiveness (i.e., the ability to resume and complete the mission).

Without a health outcome-based goal for mass patient decontamination, then absolute decontamination itself becomes the end point – clean for clean's sake. This belief in turn drives research, education, and process development and refinement towards the end point of "clean" without questioning whether desired goals – such as reductions in patient morbidity or mortality, or prevention of secondary contamination – are actually being achieved.

The risks of adhering to this model are:

- The same suite of processes, tools, and techniques will be used in every contamination incident, regardless of the specifics of the situation.

- Certain processes (e.g., water-based decontamination) will be applied without questioning whether the process itself is causing harm (e.g., environmental illness, decontamination-related injuries, and psychological stress inherent in the process).
- Future efforts in the patient decontamination field will be driven towards getting more people cleaner, more quickly, and with improved tools and equipment, even as the evidence that it improves health remains uncertain.

This national guidance has departed from previous efforts by focusing on evidence-based determinants of successful patient decontamination which deliver measurable, positive impact on health, infrastructure, and community outcomes. In doing so the WG has identified, not exclusively, the following:

Goals of patient decontamination:

- Achieve an improvement in patients' acute health outcomes by reducing short-term morbidity and mortality.
- Achieve an improvement in patients' long-term health outcomes by preventing delayed morbidity.
- Protect the health and functioning of the health care system by preventing secondary contamination of responders, receivers, and infrastructure.
- Assure the best health outcome for the most patients. This might result in a departure from the current paradigm by allowing for decontamination to a less than complete level but aims to provide everyone with timely decontamination so that:
  - Those patients requiring supportive or definitive medical care receive it at the appropriate time; and
  - The majority of minimally exposed patients may be able to bypass medical evaluation, preserving medical resources for those with the most urgent needs.

Patient decontamination is a whole community issue

***A Whole Community approach attempts to engage the full capacity of the private and nonprofit sectors, including businesses, faith-based and disability organizations, and the general public, in conjunction with the participation of local, tribal, state, territorial, and Federal governmental partners* (Federal Emergency Management Agency [FEMA], 2011, p.3 – see United States Department of Homeland Security, Federal Emergency Management Agency, 2011).**

Patient decontamination, as described in this document, aims towards such an approach. The response to a chemical release, regardless of circumstances, requires a concerted effort from multiple organizations, which may include emergency services dispatchers, first responders, first receivers, emergency management, public health, poison centers, analytical laboratories, and members of the public. Response to and recovery from these incidents can also require action from the private sector (e.g., emergency medical services providers, health care facilities, chemical companies, transportation companies) as well as from multiple levels of government and may necessitate requesting resources from surrounding jurisdictions through mutual aid. Communication and coordination among these groups is essential, yet evidence from past incidents suggests that improvements are needed. For example, basic information about an incident is not always shared in a timely and efficient manner between responders at the scene and receivers at health care facilities (Auf der Heide, 2006; Kirk & Deaton, 2007). One of six functional areas of this guidance is dedicated to system-wide coordination of patient decontamination in order to ensure that the community acts as a whole to provide care, information, and other support to all members in need.

The critical importance of risk communication with the public is also recognized, with it being the subject

of another of the six functional areas. Risk communication before, during, and after an incident supports response and recovery by enhancing preparedness, increasing the likelihood that appropriate protective actions will be taken and inappropriate or potentially harmful actions will not be taken by community members, and by mitigating the stress, anxiety, and dysfunction that can result from a disaster. Recommendations to plan for the needs of at-risk populations[6] are incorporated at every appropriate point in this guidance. Such planning requires identification and understanding of the specific needs and vulnerabilities of all individuals within a community. Similarly, the concept that response plans will work only if they are based on the actual resources and capabilities available in a community at the time they are needed is repeated throughout the guidance. This guidance's emphasis on communication, coordination, and understanding a community's needs and capabilities reflects the view that planning for mass patient decontamination must involve a whole community.

One of the major aims of this guidance is to aid local planning for mass patient decontamination in a manner that supports community resilience and self-sufficiency. Resilient communities have been identified as one of the keys to national health security (HHS, 2009, 2012 – see United States Department of Health and Human Services, 2009, 2012). Through informed and empowered individuals, a resilient community is able to withstand, mitigate the consequences of, and recover from a disaster to at least its previous level of functioning (Chandra et al., 2011; FEMA, 2011; HHS, 2012). It is assumed here that patient decontamination in a mass casualty chemical incident will be executed entirely by a local community, perhaps with assistance from neighboring jurisdictions. Due to the fast-acting nature of hazardous chemicals, the federal government will most likely not be able to participate directly in the patient decontamination response; rather, the knowledge provided here represents a tool to be added to a local planner's toolbox.

Several pieces of this tool directly address actions that contribute to resilience. Risk communication with the public is a mechanism for informing and empowering individuals and was identified as a core component of community resilience in a study by the RAND Corporation (Chandra et al., 2011). Providing for the physical and behavioral health needs, functional needs, and social well-being of all community members, as is recommended at all relevant points of this guidance, is necessary for community resilience. Finally, the decontamination response strategy recommended here is a tiered approach that includes a self-care tier devoted to actions that a patient can take to protect him/herself from the toxic effects of chemical contamination before first responders arrive at the scene (see Tiered risk-based response approach section below and GS 2.2). Integration of the whole community, including the general public, into disaster planning, response, and recovery is supported by a wealth of empirical evidence that the public has the capabilities and the willingness, and actually has made significant contributions to disaster management (Schoch-Spana, 2012).

Tiered risk-based response approach

The general approach to patient decontamination presented here is a tiered response strategy designed to match the nature and extent of decontamination to the characteristics of the incident, including the type and extent of patient contamination, and the capabilities of the responding and/or receiving organizations. Rather than prescribe a specific protocol for all incidents, this approach allows flexibility and a scalable response. The three tiers (i.e., self-care, gross patient decontamination, and technical patient decontamination) represent a progression from relatively limited actions that can be taken without first responder or first receiver assistance and without specialized equipment and supplies, to a more involved, systematic process that will require equipment and supplies.

In some situations, the approach may be executed in a stepwise manner, such that a patient undergoes

[6] Note that the term "at-risk population" is used throughout the document and is representative of all similar terms to include: special needs, vulnerable populations, and access or functional needs. The use of this term is consistent with the Pandemic and All-Hazards Preparedness Act of 2006 (PAHPA), Pub. L. No. 109-417 (Dec. 19, 2006). This definition can be found in Appendix B and on the HHS/ASPR website at: www.phe.gov/Preparedness/planning/abc/atrisk.aspx

all three decontamination tiers. In other situations, stepwise completion of all three tiers may not be required. Self-care and gross patient decontamination tiers aim to reduce contamination as early as possible, while technical patient decontamination aims at reducing contamination to a level as low as necessary to improve health outcomes while preventing secondary contamination. Patients who are minimally contaminated may require only self-care, for example, while other patients may proceed from self-care directly to technical patient decontamination. This approach is described more fully in GS 2.2.

This flexible tiered approach to patient decontamination complements the risk-based response strategy for hazardous materials incidents promoted, for example, by the NFPA:

***Risk-based response process is defined as a systematic process by which responders analyze a problem involving HAZMAT/weapons of mass destruction (WMD), assess the hazards, evaluate the potential consequences, and determine appropriate response actions based on the facts, science, and circumstances of the incident (*NFPA, 2013a, 3.3.55).**

Both strategies recommend evaluation of the situation followed by tailoring of the response to the needs and available resources for that specific situation. This should result in the most effective and efficient response possible under the circumstances.

Practices in mass casualty incidents

As with any other mass casualty incident, an incident involving mass patient decontamination will likely present challenges with resource constraints. There will presumably be more patients than can be adequately provided the same standard of care as under normal circumstances. Responders and receivers will need to prioritize patients for decontamination as well as triage for medical care. One of the fundamental principles of responding to mass casualty incidents applies here as well: ***Do the best you can for the most people with the resources you have.***

III. Guidance Statements

Functional Area 1: Determining the Need for Patient Decontamination

For the case of a single potentially contaminated patient, GS 1.1-1.3 provide information to help a responding organization, whether in the field or at a health care facility, make decisions on the need for and the extent of decontamination. They include key indicators that the patient may be contaminated, as well as risks to the patient, responders, and receivers that should be considered.

Guidance Statement 1.1

The decision to decontaminate should take into account a combination of key indicators, including (but not limited to):

- Signs and symptoms of exposure displayed by the patient;
- Visible evidence of contamination on the patient's skin or clothing;
- Proximity of the patient to the location of the release;
- Contamination detected on the patient using appropriate detection technology;
- The chemical identity (if known), physical state, characteristics, and behavior; and
- Request by the patient for decontamination, even if contamination is unlikely

Considerations:

- Signs and symptoms of chemical exposure may present as a recognized toxidrome (see Appendix C) or as individual symptoms.
- Some signs and symptoms may not reflect actual chemical exposure, but manifest as a result of fear, an acute stress reaction,[7] or somatization due to the patient's presence at the incident itself.
- Environmental detectors are available for many TICs, TIMs, and CWAs but are not readily adaptable to or available for the detection of contamination on patients likely to be encountered in a hazardous materials incident.

Level of Confidence: III

Discussion:

Overall, there is little empirical or experimental evidence in the literature that would indicate there is one best means to assess the decontamination needs of all patients. However, each of the indicators described in the GS is represented in the literature, other guidance, and best practice documents. In addition, SMEs indicated, to varying degrees, the importance of each of these factors in determining the need to conduct decontamination. The assertions in this GS may be difficult to evaluate with a controlled, prospective trial. Assessment of the role of the key indicators in influencing the accuracy of decision making should be obtainable, however, through retrospective studies, other analyses of actual incidents, and exercises.

Signs and symptoms

The factor receiving the most attention in the literature is symptomatology – the use of a patient's apparent signs and symptoms of chemical exposure to determine the need for decontamination. Toxidromes are clusters of symptoms that can help to identify a broad chemical agent category, and

[7] According to the International Classification of Diseases-10, acute stress reaction is defined as: anxiety disorder precipitated by an experience of intense fear or horror while exposed to a traumatic (especially life-threatening) event. The disorder is characterized by dissociative symptoms; vivid recollections of the traumatic event; avoidance of stimuli associated with the traumatic event; and a constant state of hyper-arousal which lasts at least two days and no longer than four weeks. If symptoms of acute stress disorder persist for greater than one month, a diagnosis of post-traumatic stress disorder is more appropriate (World Health Organization [WHO], 2011). For more information see Bryant et al. (2011) and Diagnostics and Statistics Manual 5 (American Psychiatric Association, 2013).

sometimes a more specific chemical agent type, to which a patient may have been exposed. They represent a tool for rapid triage and determination of appropriate emergency treatment of a patient (Kirk et al., 1994; Markel et al., 2008). Symptomatology is a frequently cited criterion for determining whether a patient may be contaminated and need decontamination; equipment is not required, although responders and receivers must be trained in the recognition of toxidromes (Kirk & Deaton, 2007). However, some research suggests that individuals who have a low probability of being contaminated can still exhibit symptoms that do not have an organic origin (Kirk & Deaton, 2007), indicating that additional information should be used in determining the need to decontaminate. Multiple existing guidance documents identify symptomatology as a factor that should be considered in patient assessment for decontamination (CAL-OES, 2006 – see California Governor's Office of Emergency Services, 2006; DOD Technical Support Working Group [TSWG], 2004 – see United States Department of Defense, Technical Support Working Group, 2004; Edgewood Chemical, Biological Center [ECBC], 2013 – see United States Army Research, Development and Engineering Command, Edgewood Chemical, Biological Center, 2013; Occupational Safety and Health Administration [OSHA], 2005 – see United States Department of Labor, Occupational Safety and Health Administration, 2005; OSHA, 2009 – see United States Department of Labor, Occupational Safety and Health Administration, 2009). A majority of SMEs, especially first receivers, who commented on this GS, indicated that signs and symptoms are a major consideration in determining the need for patient decontamination.

Visible contamination

Visible evidence of chemical contamination on the patient or the patient's clothing indicates an ongoing exposure with accumulating contact time. This direct indication of contamination should also be used when deciding if a patient needs decontamination (Kirk & Deaton, 2007; Okumura et al., 2005; Ramesh & Kumar, 2010). Various existing guidance documents list visible contamination as a main factor in determining the need for decontamination (CAL-OES, 2006; DOD TSWG, 2004; ECBC, 2013; OSHA, 2005, 2009).

Proximity

It has been suggested that individuals in close proximity to the release site may need to be decontaminated; at the very least, this factor should be included in the evaluation of the need for decontamination (Vogt & Sorensen, 2002). Patients who were closer in proximity to a release site are suspected of having received a higher dose of contaminant and, therefore, of having a greater need for decontamination than a patient farther from the release site (Kirk & Deaton, 2007). Proximity to the release site is recommended as one of the factors to consider when determining decontamination needs (Ramesh & Kumar, 2010).

Detection

Although environmental detection technologies are available and are used by first responders (e.g., fire fighters, HAZMAT responders) to characterize hazardous environments, there is little discussion in the literature regarding the use of these devices in determining decontamination requirements. Although exposure guidelines have been established for some chemicals, protocols for sampling and analysis of contaminant levels on skin have not been developed (Raber et al., 2004; Vogt & Sorensen, 2002; Volkland, 2000). Furthermore, current detection capabilities may not be sensitive enough or broad spectrum enough to use with patient decontamination (Raber et al., 2004; Volkland, 2000).

Known chemical identity

If the identity of a chemical contaminant is known, as in the case of a properly placarded truck or rail-car accident, then this information should be utilized in deciding whether to decontaminate a patient. Knowledge of the chemical identity would allow responders and receivers to use information about the physical and chemical characteristics from a number of sources (e.g., *Emergency Response Guidebook*, Department of Transportation [DOT], 2012 – see United States Department of Transportation, 2012), which would assist in determining appropriate emergency actions (Kirk & Deaton, 2007). It is unlikely, however, that the identity of the chemical will be confirmed within the initial period of a terrorist attack or an accidental release, and even then, the information may be incorrect (Okumura et al., 1998a, 1998b; Zeitz et al., 2000). Communication challenges between responders and receivers can also prevent the

health care facility staff from learning the chemical identity before patients arrive (Kirk & Deaton, 2007). The physical state of a chemical, even if the identity is not known, can help determine the need for decontamination (e.g., liquid versus gas contaminant) (Houston & Hendrickson, 2005). For exposure to a gas or vapor contaminant, self-care actions, such as evacuation and clothing removal (see GS 2.2), may be sufficient; water-based decontamination may not be necessary (Gaskin et al., 2013). Subject matter experts, especially first responders, indicated that the identity and/or physical state of the contaminant are important considerations when determining the need to conduct decontamination.

Patient request

Subject matter experts generally agreed that a patient who is not exhibiting symptoms, has no visible signs of contamination, and is not likely to be contaminated due to his/her location relative to the release site is unlikely to require decontamination for his/her own health and unlikely to pose a significant risk of secondary contamination. Still, participants in the Mass Human Chemical Decontamination Symposium 2012 recommended, based on their experience with chemical incidents, using patients' perception of their own need for decontamination as a factor in responder or receiver decision making. Patients who perceive their risk for contamination as high, or who request decontamination, should be provided with this opportunity.

Somatization is frequent in acute stress reactions and may manifest as non-physiologically-based symptoms the patient nonetheless expects from the perceived exposure (Fetter, 2005). Additionally an acute stress reaction may occur when a person has been exposed to a traumatic event in which both of the following were present: (1) the person experienced, witnessed, or was confronted with an event that involved actual or threatened death or serious injury, or a threat to the physical integrity of self or others, and (2) the person's response involved intense fear, helplessness, or horror (Bryant et al., 2011). Despite the occurrence of acute stress reactions and/or somatization – each of which could result in unexposed patients nonetheless requesting or undergoing decontamination for symptoms perceived to represent toxic effects - most authors have demonstrated that panic, or anxiety responses and behaviors which are maladaptive, do not occur frequently in disasters, conventional terrorist attacks, or CBRN terrorist attacks (Auf der Heide, 1989; DiGiovanni, 2003; Fetter, 2005; Murakami, 2000; Sheppard et al., 2006; Sullivan & Bongar, 2007).

Guidance Statement 1.2

Decontamination should be performed if the potential contamination on a patient requiring transport to, or care in, a health care facility poses a reasonable risk of exposure to first responders, first receivers, other patients, or contamination of critical infrastructure.

Considerations:

As the sole criterion, prevention of secondary contamination may not justify patient decontamination when the concern is unsubstantiated by any indicator the patient is actually contaminated (see GS 1.1); patients meeting all of the following criteria are unlikely to pose significant risk of secondary contamination:

- Displaying neither signs nor symptoms of chemical exposure;
- No visible contamination on skin or clothing; and
- History that makes exposure unlikely (i.e., not near the location of release)

Level of Confidence: III

Discussion:

The potential for secondary contamination of responders, receivers, and critical infrastructure is well discussed in the literature and best practice guides. The evidence supporting this recommendation amounts to documented cases of responders or receivers being exposed to chemical contaminants from patients they were treating. The recommendation is also based on SME opinion and other published guidance.

First responders and receivers must be cognizant of the potential risk of secondary contamination to both themselves and other people. Secondary contamination of responders and receivers has been well documented following the sarin attacks in Japan (Nozaki et al., 1995; Okudera et al., 1997; Okumura et al., 1998a, 1998b; Okumura et al., 2005; Scanlon, 2010) and from hazardous materials incidents in the US (Geller et al., 2001; Horton et al., 2003; Huff, 1991; Kim, 2001; Merrit & Anderson, 1989; Zeitz et al., 2000). Typically, the greatest risk of secondary contamination is during transportation of contaminated patients by emergency medical services (EMS) providers, who are confined within the enclosed environment of an ambulance or air evacuation asset. However, the potential of exposing receivers at health care facilities remains high, particularly with self-evacuating patients (Cone & Koenig, 2005). Several existing guidance documents (Agency for Toxic Substances and Disease Registry [ATSDR], 2001b – see United States Department of Health and Human Services, Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, 2001b; ECBC, 2013; OSHA, 2005, 2009) emphasize the necessity of patient decontamination due to the risk of secondary contamination.

Published literature also cites the need for patient decontamination in order to prevent contamination of critical infrastructure, including health care facilities (Burgess et al., 1999; Huff, 1991; Kim, 2001). There is a history of emergency departments (ED) closing and evacuating due to secondary contamination, resulting in loss of a community medical care resource and other essential medical services. Subject matter experts indicated that the potential for contaminated patients to effectively shut down an ED or health care facility should be considered when determining the need for patient decontamination.

While these factors must be taken into account when determining the need to decontaminate a patient, the risk of secondary contamination must also be weighed against the needs of an individual patient. Such a risk-based response approach would involve:

- A determination of the need for decontamination by applying the criteria described in GS 1.1;
- Assessing the risk of adverse outcomes to the patient resulting from the decontamination process itself (see GS 1.3);
- Considering alternative decontamination practices described in GS 2.11; and

- Considering relevant chemical and exposure information from the incident scene and unique to the incident, including whether the properties of the contaminant pose a risk of secondary contamination

Subject matter experts generally agreed that a patient who is not exhibiting symptoms, has no visible signs of contamination, and is not likely to be contaminated due to his/her location relative to the release site is unlikely to require decontamination or to pose a significant risk of secondary contamination.

Guidance Statement 1.3

If the likelihood of adverse consequences from water-based decontamination methods outweighs the likely health outcome gains, then patient decontamination should be performed using alternative practices.

Considerations:

- Patient decontamination is not without risk to the patient; appropriate measures should be taken to mitigate these risks and to reduce the negative impact on patients.
- Adverse consequences might be caused by severe weather (e.g., hypothermia due to cold temperatures), chemical reactivity (e.g., water-reactive chemicals or metals, such as lithium or sodium), delay in lifesaving care, or psychological trauma.
- Refer to GS 2.11 for alternative practices.

Level of Confidence: III

Discussion:

The decision to perform decontamination should take into consideration any and all potential consequences. A risk-based response (as outlined in GS 2.1) is necessary to ensure that the health outcome benefit outweighs the potential adverse health effects of decontamination for patients. Responders and receivers must consider environmental conditions, chemical reactivity with water, the potential for mechanical injuries (e.g., slips, trips, falls), the special susceptibilities of at-risk patients, and the psychological impact on patients of conducting decontamination (Freyberg et al., 2008; Levitin et al., 2003). Elements of this GS have support in the available literature and can be considered current practice. The assertions in this GS would be difficult to evaluate in a comparative human trial, but may be evaluated in a retrospective study and subsequent analysis. In addition to information presented in the literature, the potential for adverse consequences is discussed in various existing guidance documents (ATSDR, 2001a – see United States Department of Health and Human Services, Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, 2001a; DOD TSWG, 2004; ECBC, 2013; OSHA, 2005, 2009).

Environmental conditions

Traditionally, patient decontamination has implied water-based showering. However, other decontamination strategies are better suited for certain conditions and may achieve similar outcomes as traditionally implemented decontamination methods. These alternative strategies include the removal of patients from the contaminated area, removal of clothing, and/or use of an implement (i.e., clean rag) for spot decontamination[8] (Feldman, 2010). Such methods may prove especially relevant when environmental conditions present risk of cold weather injuries or other extreme weather (e.g., freezing rain, icy conditions) (Lepler & Lucci, 2004). Decontamination should be scalable and flexible. If the risks of water-based decontamination in an extremely cold environment are too great, then disrobing a patient and providing uncontaminated covering in the short term may be sufficient to substantially reduce the risk of chemical-specific health outcomes without inducing cold weather injuries.

In colder environments, decontamination may require alternative locations in lieu of alternative techniques. Mobile decontamination units or indoor swimming pools, gymnasiums, or other large shower facilities (e.g., arenas, schools, hotels) have been considered in existing guidance documents (ECBC, 2013); response organizations' plans should consider these as potential alternatives to outdoor decontamination.

[8] Spot decontamination - As opposed to decontamination of the entire body, spot decontamination involves the removal of visible contamination from small areas of exposed skin (e.g., limited areas to include hands, face, or portion of the arm or leg). This technique may be water-based or utilize an alternative decontaminant (e.g., RSDL®).

The risk of some adverse consequences of water-based decontamination may be greater in at-risk populations. For example, children compared to adults are more susceptible to environmental adverse effects of decontamination. They lose body heat more rapidly when wet and unclothed, resulting in a higher risk of hypothermia at higher ambient temperature, than adults. In addition, younger children (e.g., infants or non-ambulatory toddlers) can be slippery when wet and will require a system to ensure their safety (e.g., hand spraying while on a stretcher or in a bassinet with holes for drainage).

Chemical reactivity

Alternative decontamination methods should be considered for chemicals that are deemed water-reactive. Water-reactive substances undergo a dangerous chemical reaction when they come into contact with water. This reaction may release a gas that is either flammable or presents a toxic inhalation hazard. In addition, the heat generated when water activates such materials is often enough for the material to spontaneously combust or explode, causing severe burns. The *Emergency Response Guidebook* (DOT, 2012) provides a list of water-reactive chemicals that produce toxic-by-inhalation gas(ses) when spilled in water. In addition to this list, several alkali metals are violently reactive with water (DOT, 2012).

Functional Area 2: Optimized Technical Practices

Guidance statements in Functional Area 2 describe techniques, methods, and practices to optimize the performance of patient decontamination. Functional Area 2 includes methods for reducing, removing, neutralizing, or inactivating contamination on an individual patient, assuming, for the most part, that resources and capabilities are not challenged by a mass exposure scenario.

Guidance Statement 2.1

A risk-based approach should be employed by a responding or receiving organization to determine the appropriate response level and associated strategies and tactics, including PPE, medical interventions, and patient decontamination.

Considerations:

- Appropriately trained supervisory personnel (e.g., see Hazardous Waste Operations and Emergency Response [HAZWOPER] standards, 29 CFR 1910.120(q), or NFPA, 2013a, 2013b) should perform a situational assessment.
- PPE determination should be based upon the unique circumstances of the incident, in consultation with applicable guidance and regulations (OSHA, NIOSH, and NFPA – see GS 5.7).

Level of Confidence: IV

Discussion:

The risk-based approach allows HAZMAT responders and first receivers flexibility in adapting response capabilities to dynamic situations. This approach deviates from standard practice-based response operations by allowing responders and receivers to make critical decisions based on an assessment of the hazards and risks associated with a particular incident. The risk-based response is a systematic approach to responding to an incident that incorporates the knowledge and experience of the responder, the unique circumstances of an incident, and risk analysis in order to make informed response decisions (NFPA, 2013a). Responders and receivers should incorporate these principles into their planning and training for patient decontamination operations, using knowledge of the chemical, if available, site-specific information, environmental monitoring, patient signs and symptoms, and other clues for decision making.

Risk-based response has become a common practice in HAZMAT response following its evolution from street-smart tactics and is incorporated as a core competency in NFPA 472: *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents* (2013a), as well as in textbooks and training guides. Subject matter experts strongly encouraged guidance which reflects the risk-based response approach as a key element of planning for mass patient decontamination. Though a risk-based response is a current standard of practice and SMEs support its use and inclusion, there is a paucity of evidence in the published literature evaluating its effectiveness.

Exposure vs. Contamination

A key determinant for estimating risk is distinguishing chemical exposure alone from chemical exposure with contamination. A chemical exposure may occur without deposition on clothing or body surfaces. For example, a person engulfed in a cloud of gas (e.g., carbon monoxide) will not become contaminated with carbon monoxide depositing on the clothing or body surfaces. On the other hand, an aerosol cloud of a toxic chemical (e.g., hydrofluoric acid) can condense on clothing and skin, contaminating the person. Therefore, a patient can be exposed to a chemical without contamination or be exposed as well as contaminated. Through risk-based assessment, responders and receivers can identify people who were near the release and potentially exposed, but not likely to be contaminated.

Guidance Statement 2.2

A tiered approach to patient decontamination allows responders and receivers to base the nature and level of decontamination on the type and extent of contamination, as estimated through a risk-based assessment of the incident, as well as available resources. The tiered decontamination response is flexible and adaptable to various types of incidents; each tier can be executed either at the scene or at a health care facility.

Mass patient decontamination:
Decontamination activities conducted for a large number of potentially contaminated patients, which may exceed the typical response capacity of an organization, may require additional resources or personnel, and require that patients be prioritized for the decontamination process. The number of patients that constitutes mass decontamination is dependent on the jurisdiction, responding agency, and capacity. Mass decontamination may occur within any of the decontamination tiers.

Recommended patient decontamination tiers

Self-care:
Actions that a patient can perform for him/herself, including distancing him/herself from the site of release, removing clothing, and wiping visible contamination from skin and clothing in order to reduce his/her own contamination level immediately, without waiting for a formal decontamination process to be set up. A perceptive patient or one experiencing acute distress from the chemical contamination may execute self-care even before responders arrive; however, most patients will need instructions.[9]

- Self-care can be conducted with or without readily available equipment or supplies; it mainly depends on patients' knowing what to do either on their own or through instructions from responders.
- Self-care may include actions such as removing clothing at least down to the undergarments, use of handkerchiefs, sanitizing wipes, or other clean cloth to physically remove visible liquid or solid contamination, rinsing contaminated skin and eyes with potable water from convenient sources, and using blankets, towels, or other available items or structures to maintain privacy.
- In some exposure scenarios, such as one involving only a gas or vapor contaminant, self-care may be sufficient (Gaskin et al., 2013).

Gross patient decontamination:
Actions likely to be performed by or with the assistance of first responders or first receivers in order to achieve a gross or hasty reduction in contamination, significantly reducing contamination on skin or clothing, as soon as possible after contamination has occurred.[10]

- Gross patient decontamination is performed with minimal equipment, products, or implements, and can be set up quickly. Examples include the Ladder Pipe Decontamination System to provide a high volume, low pressure water shower from fire apparatus (ECBC, 2013) and spot decontamination using a product such as Reactive Skin Decontamination Lotion (RSDL®) (Schwartz et al., 2012).

[9] Self-care is similar to the concepts of self or emergency decontamination (DOD TSWG, 2004; OSHA , 2005, 2009), emergency decontamination (NFPA, 2013a), and immediate decontamination (DOD, 2006).
[10] Gross patient decontamination is similar to the concept of field-expedient decontamination (DOD TSWG, 2004; OSHA, 2005, 2009) and to DOD's concept of operational decontamination (DOD, 2006) and consistent with NFPA's concept of gross decontamination (NFPA, 2013a).

Technical patient decontamination:
Planned and systematic actions, likely to be performed under the guidance of or with the assistance of first responders or first receivers, to achieve contamination reduction to a level that is as low as possible.[11]

- Technical patient decontamination is achieved through a well-defined, multi-step process that includes evaluation of the results and, if necessary, repetition of the process. It usually involves a high volume, low pressure water shower, with the addition of soap, especially for an oily contaminant, and gentle rubbing with a soft cloth or sponge. The shower may be provided by a number of different types of equipment or facilities.

Considerations:

- The patient decontamination tiers are not necessarily a sequential process. They should be applied in a manner that meets the needs of each specific situation.
- Some health care facilities may require that a patient be technically decontaminated before he/she enters the facility. In this case, local plans should incorporate a technical patient decontamination capability either at the health care facility or on-scene with first responders that will be accepted as sufficient by health care facility personnel.

Level of Confidence: III

Examples of the Tiered Approach

At the scene:
A mass chemical exposure occurring in a jurisdiction with limited resources, where first responders must wait on mutual aid support, may require sequential completion of all three tiers:

- *First responders arrive at the scene and instruct patients to move to a specific area upwind of the area of release, remove at least outer layers of clothing, and wait (Self-care).*
- *Shortly thereafter, patients are guided through a decontamination corridor established at the scene using a Ladder Pipe Decontamination System (Gross).*
- *Subsequently, patients undergo technical decontamination in a mobile tent system also set up at the scene (Technical).*

In a well-equipped jurisdiction, the tiers may be completed nearly simultaneously:

- *First responders arrive on-scene and direct patients to move to a specific area through a mobile tent system for technical patient decontamination.*

Many other sequences of events are possible; these examples illustrate how the tiered approach can be flexibly applied to specific situations as part of a risk-based response.

At a health care facility:
A significant proportion of patients may leave the scene without being decontaminated or evaluated by responders and either proceed directly to a health care facility or not seek care right away.

These patients will have performed some, but perhaps not all possible, self-care actions and then undergo gross patient and/or technical patient decontamination at the health care facility.

[11] Technical patient decontamination is similar to the concepts of thorough decontamination (DOD TSWG, 2004; OSHA, 2005, 2009) and definitive decontamination (ATSDR, 2001a).

Discussion:
In the tiered approach to patient decontamination, the goals and methods depend on the details of the exposure and the resources available. Self-care and gross patient decontamination are primarily first aid measures. These steps are aimed at saving a patient's life and mitigating adverse health effects by reducing the level of contaminant in the patient's immediate environment, thereby reducing the amount absorbed and the dose received (Amlôt et al., 2010; Braue et al., 2011a, 2011b; Feldman, 2010; Hamilton et al., 2004; Preston et al., 2008). Self-care and gross patient decontamination are the most time-sensitive of the three tiers. Given this, for maximum benefit, they should be performed as soon as possible after contamination has occurred (Braue et al., 2011a, 2011b; Hamilton et al., 2004).

Findings from a recent Canadian exercise and workshop suggest that self-care decontamination can have positive psychosocial impacts on patients following a chemical exposure. This group recommends developing standard protocols and kits to support self-care decontamination. The protocols and kits would be different for various age groups (i.e., adults, children, and infants) and would include recommended practices for at-risk populations (Pinette et al., 2014).

The primary objective of technical patient decontamination is to reduce a patient's contamination to a level that is as low as possible in order to minimize the potential for secondary contamination of responders, receivers, other people, equipment, and facilities. Once a patient has undergone technical decontamination, contamination is reduced to a level which allows responders and receivers to handle the patient, evaluate, and administer medical care while operating in a reduced level of PPE. Technical patient decontamination may also save lives and reduce adverse health effects among patients by limiting additional absorption of surface contaminants, depending on how soon it is executed.

The tiered approach is used to tailor the decontamination response to the specific incident. It is not meant to suggest that decontamination must be a sequential process where self-care is conducted first, followed by gross patient, and then technical patient decontamination, though some incidents may proceed in such a manner. Technical patient decontamination requires more resources and time than gross patient decontamination, which requires more resources and time than self-care. The capability to perform each tier of decontamination depends on the availability of those resources. The more resource intensive practices can provide greater privacy and comfort, as well as potentially allowing for further removal of contaminants from patients.

Several existing guidance documents (ATSDR, 2001a, 2001b; DOD, 2006; DOD TSWG, 2004; NFPA, 2013a; OSHA, 2005, 2009) promote a tiered or phased approach to patient decontamination that is consistent with the recommendations of this guidance document. The specific terms used differ and, in some cases, two rather than three tiers are identified. Nevertheless, the concepts and the rationales are basically the same among the existing guidance documents and this guidance document. Most importantly, prior guidance emphasizes the urgency of reducing exposure and removing large amounts of chemical contamination from patients as soon as possible with readily available resources (i.e., self-care and gross patient decontamination). Prior guidance documents also describe a more technical and organized type of decontamination designed to reduce contamination to a level that is as low as possible or as clean as possible in order to limit the spread of contamination and protect responders, receivers, equipment, and facilities (i.e., technical patient decontamination).

The approach is also established in the NFPA's *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents* (NFPA, 2013a), which widely impacts first responder practices. A similar tiered approach is implemented by the DOD (DOD, 2006). Controlled prospective study of the effectiveness of a flexible, three-tiered approach as defined here may be difficult to execute. However, such a study or evidence of successful application of the approach in real incidents or even in exercises would be a welcomed addition to the field.

Guidance Statement 2.3

Self-care and/or gross patient decontamination actions should occur as quickly as possible, while decisions on the need and process for technical patient decontamination are made and equipment is set up, if warranted.

Considerations:

- A determination of the need for technical patient decontamination, or any contraindications necessitating an alternative practice, should be decided according to the guidance in Functional Areas 1 and 2.
- Non-ambulatory or mobility-impaired patients may not be able to perform self-care.

Level of Confidence: II

Discussion:

The importance of early decontamination to reduce contact time and therefore reduce the opportunity for absorption of the contaminant and the subsequent dose received by the patient cannot be overstated. The duration of the time window for effective patient decontamination is not precisely known. Evidence suggests that it varies with the identity of the contaminant, the magnitude and route of exposure, environmental conditions, and other factors. Compared to biological and radiological contaminants, the time window is short: minutes to hours in most cases. Despite the lack of precise, or in many cases even rough, determination of the effective time window for decontamination of chemicals, several studies provide evidence that the efficacy of patient decontamination in saving lives and/or mitigating adverse health effects diminishes over time. This time frame ranges from a few minutes to many hours, depending on the specific contaminant.

Data on the time window for effective decontamination of some TICs are available from a series of studies by Wester and colleagues (1990, 1991, 1992, 1999) using *in vivo* exposure of rhesus monkeys. The efficacy, directly measured as a proportion of surface contamination removed, of washing the skin with soapy water declined as the post-exposure time at which washing was initiated extended over several hours. Methylene bisphenyl isocyanate, glyphosphate, alachlor, and Aroclor 1242 exhibited different decontamination time sensitivities in separate studies. Braue and colleagues (2011a, 2011b) tested the ability of several decontaminants to prevent death in guinea pigs that had been exposed to $5xLD_{50}$ of either VX or soman; studies investigated the effect of immediate and delayed decontamination on lethality. The LT_{50} – the delayed decontamination time which prevented mortality in half of the animals – was 26, 48, and 31 minutes for soapy water, dilute bleach, and RSDL® decontamination of VX-exposed animals, respectively (Braue et al., 2011a). The window for effective decontamination of soman-exposed animals was much shorter: the LT_{50} for decontamination with RSDL® was four minutes (Braue et al., 2011b). In another *in vivo* study of VX exposure, decontamination of domestic pigs with soapy water or dilute bleach was less effective at preventing death and mitigating signs of severe intoxication when performed at 45 minutes than at 30 minutes post-exposure (Bjarnason et al., 2008). Similarly, a delay in initiation of water irrigation of sodium hydroxide exposure sites on mice resulted in greater mortality than immediate water irrigation (Bromberg et al., 1965).

A limited amount of data have been published on the effect of post-exposure decontamination time on health outcomes in chemically contaminated people. Several studies of chemical burn patients, however, do suggest that a shorter delay in decontamination is associated with more favorable health outcomes than a longer delay. Retrospective analysis of chemical burn cases at the Baltimore Regional Burn Center from 1976-1985 demonstrated that initiating a water-only washing of the site of chemical exposure within three minutes significantly reduced the extent of skin injury, mean length of hospital stay, and delayed complications compared to the consequences in patients whose decontamination was initiated later (Leonard et al., 1982; Moran et al., 1987). Based on a similar study of 51 chemical burn patients at the University of Kansas Medical Center, the authors concluded that a group of patients who had received

immediate water or neutralization therapy had a greater rate of survival, lower rate of skin grafting, and shorter duration hospital stay than a group of patients who had received delayed or inappropriate treatment, although statistical analysis of the results was not presented (Sykes et al., 1986).

Clothing removal itself may also have a time-dependence to its efficacy. Clothing fabric covering skin in an *in vitro* diffusion system prevented skin absorption of liquid nerve agent applied to the outermost layer. Protection was greatest when the fabric was removed very soon after exposure. The effectiveness of clothing removal decreased rapidly with increased duration of delay after nerve agent application; protection by a cotton fabric diminished significantly with delays over the course of the first 30 minutes post-exposure (Chilcott, 2014; Matar et al., 2010b).

The tiers of decontamination (i.e., self-care, gross patient decontamination, and technical patient decontamination) all differ in the amount of preparation, time, and resources needed. Early and expeditious forms of decontamination sacrifice thoroughness for the speed with which each can be instituted. Self-care, including removing oneself from the source of exposure, wiping chemical off the skin, and removing contaminated clothing, may occur instantly, be executed by patients using what they have with them, such as a handkerchief or scarf, and be performed before first responders arrive. Gross patient decontamination may be executed by providing patients with rapid access to a high volume of water, such as from a fire hose, in an effort to quickly terminate contact with the chemical contaminant. Lastly, technical patient decontamination usually involves showering, ideally, with soapy water and a wash item (e.g., non-abrasive sponge or washcloth) in an effort to reduce unabsorbed chemicals to as low a level as possible.

The importance of rapidly implementing self-care and gross patient decontamination is described by Kirk & Deaton (2007) who likened decontamination to a first aid procedure. Moran and colleagues (1987) also equate the washing of chemical burns with copious water starting within three minutes of exposure with first aid. Several prior guidance documents describe rapidly initiating decontamination actions, such as disrobing (DOD TSWG, 2004; ECBC, 2013), as the best means of rapidly reducing contamination.

Guidance Statement 2.4

Attempt to immediately decrease ongoing exposure by removing all patients out of the area of chemical release and provide an area of refuge.

Considerations:

- First responders should not enter contaminated areas of release (i.e., hot and contamination reduction zones) without appropriate PPE and training. (For additional information, see GS 5.7.)
- A determination of the subsequent need and level of decontamination may be decided according to criteria in GS 1.1.

Level of Confidence: II

Discussion:

One of the first steps in contamination reduction is to terminate ongoing exposure by removing patients from the hot zone. Scientific evidence substantiating this first step for patients is primarily focused on the effects among first responders and first receivers. A study of the 1982 Hanover County, Virginia, incident involving pentaborane release recommended that first responders "back away" from the scene of a hazardous materials incident until appropriate chemical protective clothing and respiratory protection is donned (Huff, 1991). Occupational health and safety principles also justify guidance to immediately decrease exposure among patients. When evaluating methods of controlling human exposures in a workplace from workplace hazards, the pathway for the hazard to travel from the source to the receiver (i.e., patient, first responder, first receiver) requires examination. In a chemical incident, the source is uncontrolled, at least initially, and methods such as isolation or physical enclosures are not necessarily practical in the short-term. Increasing physical distance between the release source and people and/or placing people in a safe refuge (e.g., shelter-in-place order at home or work, or evacuation upwind and/or upstream from the source) is an effective contingency (Plog et al., 1996). No decontamination practice is of use if performed in an environment in which patients will continue to be exposed.

Determining the size of an affected area, or the evacuation distance, is most often based on a guideline such as the suggested evacuation radii referenced in the *Emergency Response Guidebook* (DOT, 2012). In an attempt to illustrate the influence of the nature of a contaminant (i.e., liquid or vapor) on the size of the hot zone, while establishing the French emergency response plans, Laurent and colleagues (1999) estimated the likely affected hot zone based on the physical properties of a chemical threat. It was noted that a liquid hazard area extended 350 feet in diameter. On the other hand, a vapor hazard area – with winds <1 m/s – could reach, but rarely exceeded, a radius of 1700 feet and extended downwind in a 20° arc. It should be noted that these zones could be dynamic and should be reevaluated throughout the response.

Preston and colleagues (2008) examined 2,930 chemical incidents in which decontamination was infrequent, occurring during only 10% of the incidents. Of the 2,930 incidents, 7.7% resulted in evacuation. When controlled for decontamination, it was determined that those incidents in which there was an evacuation resulted in fewer patients per incident than those incidents for which there was not evacuation. A patient was defined as a person experiencing at least one adverse health effect within 24 hours that likely resulted from the chemical release. However, the difference in number of patients was only significant ($p<0.05$) for incidents involving gasses or vapors (specifically, chlorine, ammonia, and acid gasses).

While removal from ongoing exposure in the hot zone is supported by several existing guidance documents (DOD TSWG, 2004; ECBC, 2013; OSHA, 2009), the idea of evacuation as a decontamination strategy is not described. Specific reference is made to moving patients out of the hot zone, preferably upwind of the release, to a safe refuge while a decision on decontamination and preparations for

decontamination are made (ECBC, 2013).

Patients may evacuate themselves to a location they feel is safe and this may occur prior to the arrival of first responders. Once patients are distanced from the possibility of ongoing exposure, determination of the need for additional decontamination may commence.

Having patients guided toward a location some distance away from the release site may ease the evaluation of large numbers to ascertain the need for decontamination, the issuance of instructions, and the execution of the decontamination processes. However, SMEs also conveyed the concern that the risk of secondary contamination may be increased when patients are grouped together in a small area before decontamination is conducted.

Lastly, as self-evacuation is likely, and since a proportion of those retained at the scene may ultimately be told they do not require decontamination, communication is critical. Instructions to patients who are not decontaminated, but who remain at the scene, must emphasize appropriate follow-up measures. Communication to those who may have already left and who subsequently either (1) develop symptoms, (2) become worried about their own health, or (3) are concerned about exposing family members, is just as important, since they may request decontamination or other assistance from any number of different health care facilities. These and other risk communication issues are addressed more extensively in Functional Area 6.

Guidance Statement 2.5

Clothing removal for patients who have been visibly contaminated or who are suspected of having been contaminated is an essential aspect of decontamination. For patients who can remove their own clothing, it can be a part of self-care. Efforts should be made to collect and account for clothing and personal items removed during patient decontamination.

Considerations:

- If clothing removal is to be conducted outside, be mindful of environmental risks and, if applicable, ensure warming or cooling methods are available (e.g., warming tent, indoor location, shaded area).
- Some patients may require assistance with removing clothing.
- Ensure proper levels of modesty (e.g., separate lines for males and females and cover from bystanders; cultural and religious practices should be taken into consideration during planning).
- Clothing and personal items should be handled in such a manner to address the following priorities (the order of the priorities will be determined by the nature of the incident):
  - Protecting the health and safety of patients, responders, and receivers;
  - Evidence collection for law enforcement;
  - Consistency with logistical capabilities;
  - Allowing patients to retain essential personal items (e.g., prescription eyeglasses, hearing aids, canes);
  - Returning clothing and personal items to patients if possible and safe (e.g., a labeling and tracking system could enhance efficiency); and
  - Analyzing clothing for contaminants to confirm exposure and/or provide an estimate of degree of exposure
- Be aware of the potential for concealed secondary improvised explosive devices or other weapons that may be hidden in clothing or other personal items.
- Patients should be allowed to retain a form of identification that can withstand the decontamination process (e.g., laminated ID card or driver's license, Medic-alert bracelet, "dog tags") and will not retain contamination if adequately decontaminated.
- Provisions should be in place to accommodate law enforcement equipment/weapons.
- If the incident is suspected to be an intentional act, clothing and personal items may become evidence; law enforcement should be incorporated into response planning to develop standard operating procedures for collecting contaminated material and ensuring chain of custody in accordance with jurisdictional guidance.

Level of Confidence: II

Discussion:

Quantitative claims have been made frequently in the literature about the efficacy of clothing removal in reducing contaminants on a patient. It is often stated that removing clothes may reduce contamination on a person by approximately 80-90% (Cox, 1994; Koenig, 2003). However, until recently, references cited in support of such claims have not identified any studies which directly tested how much contamination can be removed from a person after chemical exposure by removing the person's clothing. Chilcott (2014) describes results of experiments using mannequins: clothing removal reduced contamination by approximately 50% after a vertical/overhead exposure and by approximately 70% following a horizontal/head-on exposure. The data and methodology from these studies have not yet been published, making it difficult to assess the generalizability of the findings. The efficacy and safety of clothing removal are likely to vary depending on the specific chemical contaminant, its physical state (i.e., solid, liquid, vapor, or gas), the method and trajectory of dispersal, the method of clothing removal, environmental conditions, and the clothing worn.

There is compelling indirect evidence to suggest that clothing should be removed from a patient who has been exposed to a chemical in order to minimize the amount of contaminant that may potentially be absorbed. Simulated secondary exposure of hospital-based receivers to chemical vapors and dust from clothing on chemically contaminated mannequins provides evidence that receivers can be at risk of receiving dangerous doses of chemical contaminants during patient decontamination (Schultz et al., 1995). Concentrations of vapor or particulate chemical contaminants in the breathing zones of two receivers per "patient" were measured before and during clothing removal from a contaminated mannequin. When the measured levels of the relatively harmless chemicals used in the study were extrapolated to highly toxic chemicals, the estimated potential exposures were high enough that they would have caused severe health effects in receivers not wearing appropriate PPE. These results suggest that clothing on contaminated patients can put patients, responders, and receivers at risk of toxicity from chemical contaminants (Schultz et al., 1995). Feldman (2010) also demonstrated that clothing absorbs and retains chemicals, and that significant off-gassing can occur. In the Feldman study, a variety of civilian clothing articles were exposed to the chemical agent simulant methyl salicylate in vapor form, which has similar physical properties to sulfur mustard. After the exposure was terminated, methyl salicylate vapor was detected near each article of clothing. Off-gassing continued for several minutes longer for heavier clothing (e.g., jackets and sweaters) than the few minutes noted for lighter clothing (e.g., jeans and t-shirts), suggesting that patients and responders may receive additional exposure from clothing that is not removed and isolated after exposure.

Several studies have utilized *in vitro* skin diffusion systems for measuring the transfer of chemicals onto skin and absorption into and through skin after exposure in the absence and presence of various types of fabrics. Clothing materials have been shown to protect *in vitro* skin from contact with and absorption of various chemical contaminants. Csiszár and colleagues (1998) reported that traditional work clothing fabrics absorbed most of the applied pesticide contaminant (i.e., 85-95%) and retained it for at least eight hours, resulting in absorption of only a very small amount of the pesticide (i.e., 0.1-0.2%). Fabrics common in street clothing and military uniforms also offer protection; however, they can act as reservoirs from which, over time, chemical contaminants may penetrate through to the skin surface where they may be systemically absorbed. In addition, the reservoir effect may allow for additional off-gassing (Gaskin et al., 2013; Matar et al., 2010a, 2010b; Wester et al., 1996, 2000). Some of this work suggests that wet fabrics absorb and retain greater amounts of contaminant than dry fabrics, potentially allowing for additional off-gassing and/or transfer to skin compared to dry fabrics (Gaskin et al., 2013; Wester et al., 2000). Gaskin and colleagues reported similar results to Feldman (2010) in that heavier street clothing fabrics retained more contaminant and off-gassed for longer durations than lighter fabrics. The protective effect of clothing decreased rapidly with time (i.e., over minutes to tens of minutes) in experiments in which *in vitro* skin covered with three layers of clothing (i.e., nylon, acrylic, and t-shirt) was exposed to liquid chemical warfare agent or simulant followed by removal of the clothing at various post-exposure times and quantitation of the chemical absorbed through the skin (Matar et al., 2010b).

Reports of secondary contamination of responders or receivers (Horton et al., 2003, 2005, 2008) also indirectly support the recommendation that clothing be removed from contaminated patients. In one of the most cited cases, 10% of the 1,364 responding emergency medical technicians and 13 of the 15 physicians who treated patients in a Tokyo emergency department after the sarin release on subway trains in 1995 experienced acute symptoms of sarin exposure. Since none of the patients was decontaminated, it has been deduced that the first responders and physicians were exposed through off-gassing of sarin from patients' clothing (Nozaki et al., 1995; Okumura et al., 1998b).

Existing guidance documents recommend the removal of clothing for any person suspected of having been exposed to a chemical (ATSDR, 2001a, 2001b; CAL-OES, 2006; DOD TSWG, 2004; ECBC, 2013; OSHA, 2005, 2009). Some of the documents, such as the ECBC (2013) guidance, also provide specific instructions on how clothing should be removed. There is strong experimental work and other indirect evidence that support the concept that clothing removal may eliminate a significant amount of a chemical contaminant from a patient, thereby reducing the potential for additional absorption by the patient, as well as the potential for secondary contamination of responders, receivers, other people, equipment, and facilities. The data, current practice, and SME consensus justify a LOC rating of II. This guidance

document endorses clothing removal as an important decontamination step that can be performed without equipment or supplies and, in many cases, without the assistance of responders.

Use of a system for labeling bagged personal belongings to identify the owner and facilitate their return if possible and safe is recommended in several guidance documents (ATSDR, 2001a, 2001b; CAL-OES, 2006; DOD TSWG, 2004; OSHA, 2005, 2009). This depends on supplies being prepared in advance, which could include labels matched to a unique ID tag that remains with the patient during decontamination. One document suggests that labeling and tracking personal items may improve patients' compliance with decontamination (OSHA, 2009). In an incident in which 53 children and three adults were decontaminated after exposure to n-butyl mercaptan, bags of clothing and personal belongings were not labeled, which caused confusion and delay in management of the incident (Timm & Reeves, 2007). After determination that it was safe, all personal items and clothing were returned to their owners with instructions for appropriate cleaning.

Guidance Statement 2.6

Privacy for patients should be incorporated throughout the decontamination process, within the resource limitations of the responding or receiving organization, to include:

- Privacy during clothing removal;
- Segregation of males and females during decontamination; and
- Materials for redressing following decontamination

Considerations:

- Responding and receiving organizations must balance concerns surrounding patient privacy with the urgency of decontamination needs.
- If a patient is reluctant to completely disrobe, clothing should be removed down to the undergarments initially, and then an assessment made of the need for additional decontamination.
- Families, including caretakers, should be permitted to remain together during the decontamination process.
- Patients and/or their family members may not be comfortable with the patient being decontaminated by staff of the opposite gender. At certain ages, children may be especially uncomfortable disrobing. Responders or receivers of both genders should be available to assist patients.
- Allowances for these concerns may not be appropriate in a life or death situation.

Level of Confidence: IV

Discussion:

Privacy is not directly related to a patient's medical outcome; however, efforts to provide privacy may enhance patient compliance with recommended decontamination practices, which can influence patient outcome. An assessment of simulated patients' perceptions during field exercises involving mass patient decontamination in the United Kingdom (UK) revealed that lack of privacy was a common concern. In feedback from a total of 402 participants in five exercises, requests for greater privacy during various aspects of the decontamination process were submitted. Some participants explained that they felt embarrassed due to the lack of privacy and one person refused to be decontaminated because of modesty (Carter et al., 2012).

Evidence from actual incidents – based on news reports, after action reports, and anecdotes – demonstrates that when patients perceive that they have not been afforded sufficient privacy, they may express dissatisfaction with the decontamination process or the overall way they were treated by responders or receivers. In the suspected biological/chemical incident at B'nai B'rith Headquarters in Washington, DC, in 1997, some police officers who were instructed to undergo decontamination initially refused, and tensions ensued between police and EMS personnel, due to the live broadcasting of pictures of the incident scene from news cameras on top of a nearby building (United States Fire Administration, 1997 – see United States Department of Homeland Security, Federal Emergency Management Agency, Fire Administration, 1997). In some cases, lawsuits have been filed against emergency response organizations alleging that patients' privacy and other rights were violated during decontamination, for which they were requested to disrobe in view of responders of the opposite gender and/or bystanders (Gong et al., 1996). Anecdotes suggest that patients may become upset if separated from family members during decontamination. Furthermore, parents may fear that the privacy, safety, and welfare of their children are not adequately protected if they are cared for by responders of the opposite gender during decontamination. During a drinking water contamination incident in Spencer, Massachusetts, in 2007, local fire departments only conducted decontamination with response personnel of the same gender as the patients. However, an insufficient number of female personnel were deployed to the incident, resulting in delays in decontamination of female patients and female personnel having to work

longer shifts than male personnel (FEMA, 2007 – see United States Department of Homeland Security, Federal Emergency Management Agency, 2007).

Providing for privacy during decontamination typically requires resources; however, supplies or structures that are convenient and available can be used to increase privacy. Curtains or barriers to segregate people, at least by gender if not by individual, can allow for protection of modesty. In a case study of the effectiveness of hospital-based patient decontamination during a simulation, 83% of subjects reported that they felt they were provided a high level of modesty protection while using a fixed decontamination shower setup with multiple curtains (Hood et al., 2011). If some type of simple clothing, such as hospital garments, blankets, or sheets, with which patients can cover up are available, this may not only help to maintain privacy but also provide some comfort, possibly mitigating negative psychological consequences resulting from a patient having been involved in a traumatic mass exposure incident (DiGiovanni, 1999; Fetter, 2005; Holloway et al., 1997). If blankets, sheets, tents, curtains, or other items are not available, then using areas that already provide some cover (e.g., trees, fences with a blanket over them), materials borrowed from accessible areas, or other innovative solutions can be used to provide some level of privacy.

Documentation of the importance of protecting patient privacy during decontamination is inadequate. There is little evidence in the scientific literature demonstrating that protection of privacy influences patient outcome or compliance. However, findings from actual incidents and exercises suggest that the level of privacy provided to patients during decontamination can significantly influence their comfort and psychological well-being and potentially their compliance with the process. Seven of the current guidance documents included in our crosswalk analysis recommend that patients' privacy be maintained as resources allow. Subject matter experts unanimously supported this GS, while emphasizing the importance of not delaying urgently needed decontamination for the purpose of waiting for materials or equipment to provide privacy.

Guidance Statement 2.7

Water is the preferred decontaminant in the case that gross patient and/or technical patient decontamination is deemed appropriate, unless specific information about the contaminant indicates otherwise.

Considerations:

- Depending on the decontamination system, water parameters (e.g., pressure, flow, temperature) may or may not be easily manipulated. (See GS 2.8 for recommended parameters.)
- Water-based decontamination may be contraindicated or delayed due to concerns for weather-related and/or environmental injuries, such as cold weather injuries and heat illness. (See GS 2.11 for alternative practices.)
  - For ambient temperatures between 36° F - 64° F, indoor methods for water-based decontamination should be considered and indoor post-decontamination activities should be implemented.[12]
  - For ambient temperatures at and below 35° F, water-based decontamination should only be conducted indoors (e.g., showers and swimming pools at gyms, schools, or other facilities) and indoor post-decontamination activities should be implemented.
- Water used for decontamination may be subject to local or state environmental regulations regarding storage and disposal. (See GS 5.8.)
- The efficacy of decontamination may be improved by the addition of mild soap to water. (See GS 2.9.)
- Water-based decontamination should be avoided when water-reactive chemicals are involved.

Level of Confidence: I

Discussion:

A variety of decontamination solutions have been demonstrated to either significantly reduce the amount of a contaminant on skin or mitigate adverse health effects and, therefore, be useful as decontaminants. Many of these solutions are water-based but contain an additional ingredient such as soap. Studies that have assessed water alone as a decontaminant are relatively limited. Nevertheless, a significant amount of data demonstrating the efficacy of water alone as a decontaminant have been published. A large proportion of the data has been compiled from chemical burn cases, usually an accidental exposure of a person to a caustic chemical in the workplace or home. Retrospective analyses of such cases have found that patients whose skin was rinsed with copious water within minutes of exposure experienced less severe injuries and needed less extensive medical care than patients who were not decontaminated with water shortly after exposure (Leonard et al., 1982; Moran et al., 1987). Hall & Maibach (2006) conducted an extensive review of the literature on water decontamination of chemical burns, including occupational reports, epidemiological studies, case reports, and animal experiments. They concluded that early water decontamination reduces the severity of chemical burn injuries, although it does not prevent all harmful effects and additional decontamination solutions and/or strategies are needed. Brent (2013) also recently reviewed decontamination of dermal corrosive exposures and concluded that water is the best decontaminating solution for this type of chemical exposure, since its efficacy has been demonstrated in clinical studies and it is widely available and inexpensive.

In two studies utilizing human subjects, a water shower significantly reduced levels of simulated chemical contaminants on the subjects. A water-only shower in the first stage of a hospital decontamination system almost completely removed the relatively water-soluble ethyl lactate (a simulant for sarin) and

[12] The temperature ranges listed in this GS are based on existing ECBC (2013) guidance, the literature review, and SME input during the 2012 symposium.

also greatly reduced the amount of the less water-soluble methyl salicylate (a simulant for sulfur mustard) on subjects (Törngren et al., 1998). Moffett and colleagues (2010) found that an oil-based simulant applied to subjects' forearms was completely removed from all subjects by a water shower of 90 seconds duration and from 90% of subjects with a shower of only 30 seconds duration. This result is contrary to the hypothesis that oily chemical agents require soapy water or another solution for effective decontamination. However, the applicability of experiments on decontamination of simulants to incidents involving TICs or CWAs is not clear.

A series of *in vivo* studies of decontamination efficiency for several different industrial chemical contaminants applied to the skin of rhesus monkeys suggest that washing with water alone can remove a significant proportion of the initial amount of contaminant (Wester et al., 1991, 1992, 1999). Decontamination efficiency was dependent on the specific chemical contaminant and the time after chemical exposure. Glyphosphate, a relatively water soluble herbicide, was the most amenable to removal with water, while alachlor (also an herbicide) and methylene bisphenyl isocyanate, which are much less water-soluble, were more resistant to water decontamination. The efficiency of water decontamination of each of these three chemicals decreased as the delay following chemical exposure increased, although more than one-third of the initially applied amount was still removed with decontamination conducted several hours after exposure. It should be noted that decontamination was conducted in these studies by washing the skin with cotton that had been wetted with water; skin was wiped multiple times with the wet cotton. This procedure differs from the showering used in some other studies.

Finally, the results of several *in vitro* studies, using different experimental setups, lend support to water as an effective decontaminant. Formaldehyde was recovered from human cadaver skin by washing with water with an efficiency that was high at one minute post-exposure but declined with increased decontamination delay (Zhai et al., 2007). Using a model decontamination shower, Reifenrath and colleagues achieved significant decontamination of pig and human cadaver skin that had been contaminated with diethyl malonate, thickened diethyl malonate, soman, or thickened soman by showering the skin with water alone. Decontamination efficiency varied depending on several factors, including water pressure and temperature, shower duration, and the specific contaminant (Reifenrath, 1980; Reifenrath et al., 1984).

Together, the studies described above build a case that water has good efficacy in removing contaminants from skin and mitigating chemical contaminant-induced injuries. The data are based on a variety of chemical contaminants and specific decontamination methods, such as the parameters determining how water is applied to skin. Water has several additional advantages that make it the preferred decontaminant for gross and technical patient decontamination: familiarity to people, wide availability, low cost, stability under a wide range of environmental conditions, ease of storage, and safety. All of the existing guidance documents included in the crosswalk analysis recommend water as a decontamination solution.

When considering using water as a decontaminant, first responders and first receivers need to be cognizant of the risks. Water-based decontamination conducted outdoors may introduce risk from weather-related injuries including cold weather injuries; heat illness may also be a concern if patients remain outside and unshaded on a hot day for prolonged periods. The American Conference of Governmental Industrial Hygienists (ACGIH) publishes annual Threshold Limit Values (TLV), which include guidance on cold injury prevention practices (ACGIH, 2014). Hypothermia is a serious cold injury, the risk of which increases when people are exposed to water and left to remain wet, even in fairly temperate conditions such as 75º F. This is particularly true of certain patients, who may be susceptible to hypothermia even when healthy adults typically would not be due to their body composition (e.g., infants) and impaired thermoregulation (e.g., the elderly). The US Department of the Army has published *Medical Technical Bulletin on Prevention and Management of Cold-Weather Injuries* (Army TB 508, 2005 - see United States Department of the Army, Headquarters, 2005); their studies suggest that convective heat loss is about 25 times greater in water than air. For example, wet clothing and immersion in water increase heat loss substantially, increasing the likelihood of hypothermia. Chemical

incidents occurring in cold temperature conditions require planning to care for patients subjected to water-based decontamination. Plans should include capabilities to provide warm shelters, dry blankets, dry towels, dry clothing, and/or immediate removal from the scene.

Guidance from the US Army Soldier and Biological Chemical Command[13] (2003) suggests that the general population can be decontaminated with water when the ambient temperature is at or above 65º F with a minimal risk of incurring cold weather related injuries, provided that patients are not required to stand outside unprotected from the environment for extended lengths of time. The same guidance recommends water decontamination outdoors when the ambient temperature is 36º F to 64º F if the patient is then directed to a heated enclosure after decontamination. Below 35º F, water decontamination in a heated enclosure or a form of dry decontamination is recommended.

[13] The US Army Soldier and Biological Chemical Command was renamed the Research, Development, and Engineering Command effective October 9, 2003.

Guidance Statement 2.8

The following parameters are recommended for water-based decontamination, unless specific information about the contaminant indicates otherwise:

- Low pressure (~50 – 60 psi);
- High volume;
- Tepid (i.e., slightly warm, not hot) temperature; and
- Duration no longer than three minutes; ensure thorough soaking

Considerations:

Optimal parameters for water-based decontamination have not been uniformly established.

- There is some evidence that increased pressure, duration, and/or temperature can lead to increased absorption or penetration of some chemicals; this is known as the wash-in effect.
- Water pressure for pediatric and geriatric populations may need to be adjusted to minimize additional harm.
- Based upon the class, characteristics, and amount of the chemical contaminant, the duration of the shower may vary.

Level of Confidence: III

Discussion:

Systematic investigation of the influence of the variables which determine how water is delivered to patients on the efficacy of decontamination has been limited. Reifenrath (1980) conducted the most extensive study, varying water pressure, nozzle type, shower duration, decontamination solution temperature, and the addition of a detergent to water. Water pressure had the greatest effect on efficacy in an *in vitro* model of a patient decontamination system in which human cadaver skin was contaminated with one of two radiolabeled chemical simulants. Efficacy was determined by measuring the amount of simulant removed from the skin surface by the decontamination shower. The varied decontamination solution temperatures, nozzle types, and addition of Triton™ X-100 detergent did not affect decontamination efficacy. Longer shower duration improved efficacy but only at the lowest water pressure studied.

Other studies have suggested that increasing shower or wash duration beyond a minimally effective length of time has little or no effect on decontamination efficacy. In a study of a mass patient decontamination system, doubling shower duration from three to six minutes did not result in a change in the effectiveness of the shower in removing a fluorophore from the skin of volunteer patients (Amlôt et al., 2010). An oil-based fluorescent simulant applied to a forearm of volunteer patients was completely removed, or at least undetectable, in 90% of patients after a 30-second shower and in 100% of patients after a 90-second shower (Moffett et al., 2010). A recent comparison of a newly recommended method for mass patient decontamination (i.e., the Optimization through Research of Chemical Incident Decontamination Systems (ORCHIDS) protocol) with a previous standard method suggests that an increase in shower duration from 90 seconds to three minutes does not enhance efficacy as measured by survival and reduction of clinical effects in pigs exposed to a supralethal dose of VX (Misik et al., 2012). The ORCHIDS protocol, which includes the shorter 90-second duration shower, was significantly less effective than the standard protocol, which includes a three minute shower, in preventing a reduction in cholinesterase activity, although the unreliability of cholinesterase activity in predicting clinical effects has been documented previously. There were additional differences between these two decontamination protocols and the results of varying shower duration from this study alone should be interpreted with them in mind. The ORCHIDS protocol comprises a 60-90 second shower with 35º C water containing 0.5% detergent using a soft cloth, although the studies on which the ORCHIDS parameters are based are unpublished (Chilcott, 2014). By contrast, an analysis of patient decontamination efficacy during a simulated mass chemical exposure found that a shower longer than six minutes in duration resulted in

removal of a significantly greater amount of a simulant from patients, which could be visualized and quantitated under a black light, than a shower lasting less than four minutes (Hood et al., 2011). The authors concluded that shower duration should be at least five minutes.

Otherwise, limited information can be gleaned from studies that provide a single data point for a water parameter that is associated with effective decontamination. For example, in the study by Moffett and colleagues (2010), water at 35° C and a pressure between 60 and 70 psi applied to patients for 30-90 seconds resulted in complete removal of an oily contaminant. A hospital-based decontamination system utilizing water at 30° C significantly reduced chemical simulant contamination on patients after a three minute shower and further reduced contamination after an additional five to ten minute shower with soap; water pressure was not reported (Törngren et al., 1998). These studies provide support for particular water temperatures, pressures, and durations in effectively decontaminating patients. However, it must be assumed that such results may be dependent on other factors within each of the specific decontamination systems or methods and comparison between studies should be made with caution. The best approach to estimating the optimal parameters for water-based decontamination is to vary the parameters of interest one at a time while controlling as best as possible for all other variables, using the same system or method for decontamination – more such studies are urgently needed. It should also be noted that the optimal water parameters may depend on the specific chemical contaminant; studies should be conducted using a range of types of chemical agents and simulant contaminants.

Several of the authors cited above mention the importance of identifying the minimal conditions that will lead to effective patient decontamination in order to (1) maximize the patient throughput rate for a mass exposure incident (Amlôt et al., 2010; Misik et al., 2012) and (2) minimize the potential for wash-in of contaminants (Reifenrath, 1980). The risk of wash-in, which is defined by Moody & Maibach (2006) as "an enhancement of percutaneous absorption elicited specifically by skin decontamination," has long been a concern. However, data suggesting that skin decontamination can cause wash-in comes mostly from *in vitro* studies and the mechanisms are not understood. Increased humidity and temperature have been shown to promote percutaneous absorption of acetylsalicylic acid through excised human skin (Fritsch & Stoughton, 1963) and high relative humidity (above 85%) significantly increased absorption of parathion through excised pig skin (Chang & Riviere, 1993). Percutaneous absorption of caffeine through excised human skin could also be enhanced by application of pressure to the skin, which was meant to mimic massage (Treffel et al., 1993). Since humidity, temperature, and pressure are all likely to be elevated on or near a patient's skin by water-based decontamination, some experts have suggested that water-based decontamination can produce a wash-in effect. This hypothesis, however, has not been validated through *in vivo* experiments. More research is needed to identify conditions under which the risk of wash-in may be significant.

Among the previous guidance documents included in the crosswalk analysis, few specific recommendations are provided regarding the parameters for water-based decontamination, reflecting the lack of data in this area. The ECBC (2013) recommends water delivered in high volume and low pressure (~60 psi) for 30 seconds to three minutes. The DOD TSWG (2004) recommends high volume, low pressure, and lukewarm water. An initial rinse of at least one minute with tepid water followed by a more thorough washing with soap and water are recommended by both of the ATSDR guidance documents (2001a, 2001b) and both OSHA guidance documents (2005, 2009). The OSHA guidance documents also cite several other sources that recommend varied durations of water-based decontamination.

The guidance provided here is aimed at achieving a balance between the parameters for water-based decontamination that should provide for effective patient decontamination and those that should minimize the risk of patient harm due to wash-in, based on all of the available evidence. There may be circumstances in which shower time or use of a specific decontaminant is advised by a credible source (e.g., manufacturer Material Safety Data Sheet (MSDS) or Safety Data Sheet (SDS) or Chemical Transportation Emergency Center (CHEMTREC) technician).

Guidance Statement 2.9

When water-based decontamination is indicated, mild soap, if available, should be added to water for gross patient and technical patient decontamination, especially if the contaminant is thick, oily, or otherwise difficult to remove by water alone.

Considerations:

- Do not delay decontamination efforts in order to acquire mild soap.
- Examples of mild soap include items suitable for daily contact with skin.[14]
- Do not use dishwasher detergent, laundry detergent,[15] cleaning products, abrasive cleaners, or anything not suitable for daily contact with skin; consult the MSDS (or SDS) for potential products.

Level of Confidence: II

Discussion:

The efficacy of decontamination may be improved by the addition of mild soap to the water; however, studies comparing the effectiveness of water alone versus soapy water are limited. Soapy water may be particularly efficacious when attempting to decontaminate areas affected by lipid-soluble chemicals (Hall & Maibach, 2006). Soap can increase the partitioning of oily or viscous contaminants away from the skin better than water alone. However, the unavailability of soap should not delay water-only decontamination, nor should water-only decontamination be considered inferior or sub-standard care even if a contaminant is known to be oily or waxy. In a study by Moffett and colleagues (2010), baby oil applied to volunteers' forearms was removed in 90% of cases after a 30-second shower of water alone and completely removed from all participants after a 90-second shower.

The results of two *in vivo* studies by Wester and colleagues suggest that the relative efficacy of water alone and soapy water does depend on the identity of the contaminant. Alachlor, a relatively water insoluble herbicide, was removed from rhesus monkey skin more efficiently with 50% liquid soap than with water alone decontamination (Wester et al., 1992). When decontamination was begun immediately after alachlor exposure, the first wash with soapy water removed 73% of the alachlor, while the first wash with water alone removed 56%. The difference was still seen in the cumulative results of three washes, with soapy water removing 82% and water alone removing 56% of the applied alachlor. By contrast, soapy water and water alone exhibited no significant difference in efficacy of decontaminating rhesus monkeys after the relatively water soluble herbicide glyphosate was applied to their skin (Wester et al., 1991).

Several other *in vivo* animal studies demonstrate that soapy water is an effective decontamination solution but did not conduct a direct comparison of water to soapy water; control groups were exposed to the contaminant and not decontaminated. Soapy water decontamination of pigs exposed to $5xLD_{50}$ of VX on the ear prevented death and severe symptoms (Bjarnason et al., 2008). In a set of experiments on guinea pigs, 1% soapy water decontamination was found to provide good protection against lethality from dermal VX exposure (Braue et al., 2011a) and moderate protection against lethality from dermal soman exposure (Braue et al., 2011b). A recent study comparing two different decontamination protocols, each using water containing a different detergent, showed that both protocols prevented death and mitigated severe signs of nerve agent poisoning in pigs to which $5xLD_{50}$ had been applied on the skin (Misik et al., 2012).

A previously released guidance document (DOD TSWG, 2004) highlights the advantages and disadvantages of soap:

[14] Soap used for washing dishes by hand, soap for washing skin, and shampoo for washing hair qualify as mild soap.
[15] Dishwasher and laundry detergents are relatively concentrated, caustic irritant liquids that are used in machines for washing dishes and laundry.

- Soap can aid in dissolving some of the oilier chemical agents like VX or blister agents.
- Liquid rather than solid soaps should be used because they are quicker to employ, reduce the need for mechanical scrubbing, and could reduce secondary contamination risks.
- Limitations to soap include the need to have it immediately available and the time required for mixing; decontamination should not be delayed while waiting for soap to become available.

OSHA *Guidance for Protecting EMS First Responders* (2009) recognizes the utility of soap and water: "soap and water remains the best practice for most contaminants under most circumstances of mass decontamination." ECBC (2013) guidance suggests that water is often used for initial decontamination, but that soap and water may be needed for a technical decontamination, especially involving the removal of oily liquid agents. Soap can improve decontamination efficacy by increasing degradation of a chemical agent and "aids in dissolving oily substances like blister and nerve agents."

Subject matter experts strongly supported the addition of soap to water for decontamination when possible and specified that soap refers to a mild, non-abrasive, liquid soap, and not a detergent. There should be no delay of water-based decontamination in an effort to procure or prepare soap and water solutions. No ideal percentage for a soap and water solution has been determined scientifically nor is widely accepted in practice. Subject matter experts recognized the limitations of extrapolating the results of studies based on animal models to humans.

Guidance Statement 2.10

The use of a non-abrasive sponge, washcloth, or similar wash item may enhance water-based decontamination by increasing the physical removal of a contaminant through lightly rubbing contaminated areas.

Considerations:

- Technical patient decontamination should not be delayed to acquire specific wash items.
- Sufficient quantities of wash items should be available to avoid reuse and, therefore, contamination transfer.
- The wash item used for rubbing will itself become contaminated. Jurisdictional guidance may dictate the item be disposed of as hazardous waste.
- Wash items should be different than items that may have been used for self-care (e.g., cloths, handkerchiefs, baby wipes).
- Scrubbing too hard can abrade the skin and lead to enhanced chemical penetration.

Level of Confidence: I

Discussion:

The use of a washing item, such as a sponge or washcloth, may enhance decontamination through mechanical removal, especially of thick, heavy contaminants that are relatively adherent to the skin. However, the use of a sponge or washcloth raises several issues, including abrasion of skin due to scrubbing, which can increase absorption, and risk of transferring contamination between patients if there is insufficient availability of clean wash items. Additionally, use of a wash item may transfer contaminant to a relatively uncontaminated body part, such as from the hands to a clean torso. Further, instructions provided to patients on the proper use of a washing item require time, which is a critical factor during decontamination. Lastly, all wash items require appropriate disposal following the incident.

The literature on use of a washcloth or sponge is limited. Amlôt and colleagues (2010) conducted a human study of decontamination effectiveness using a three-way interactive design (i.e., no washcloth, washcloth, and washcloth with instructions on its use) after application of a chemical simulant. The exposure model and unbiased measurements of residual contamination, using infrared imaging, were the study's strengths. Use of a washcloth resulted in a 20% reduction in contamination versus no washcloth. A slight decrease of effectiveness was seen when verbal and pictorial instructions were provided on use of the washcloth. The study's authors subsequently determined that the decrease in effectiveness was due to two factors: (1) subjects spent some of their time in the shower reviewing the instructions instead of washing and (2) adult subjects misinterpreted the pictorial instructions (Winfield, 2011).

Several existing guidance documents also support the use of an implement to assist with contaminant removal. DOD TSWG (2004) emphasizes the importance of replacing sponges or washcloths between every patient. In addition, ECBC (2013) acknowledges the utility of a soft cloth or sponge and that gentle friction may assist with the removal of chemical vapors and aerosols. However, there is the theoretical risk that the use of an implement may spread oily contaminant, such as mustard agent, and, thus, care must be exercised to use gentle friction only in the localized area of contamination (ECBC, 2013). OSHA's *Best Practices for First Receivers* (2005) warns against using a wash item that could damage the skin and facilitate chemical penetration (e.g., stiff brush, abrasive pad).

Subject natter expert input was generally that use of a wash item can improve decontamination effectiveness with the understanding that decontamination should never be delayed in order to procure wash items. Instructing patients in proper decontamination technique with a wash item should emphasize gentle rubbing, avoidance of traumatizing the skin, and localized rubbing (e.g., blotting) when there is risk of spreading viscous or oily contaminant. Sufficient numbers of wash implements are needed in order to avoid cross-contamination between patients by using the same item. It must be

emphasized that in the absence of wash items, decontamination with water or soapy water alone should never be delayed. Additionally, the use of washcloths or sponges for decontamination incurs the issue of waste disposal.

Guidance Statement 2.11

Alternative practices or decontaminants should be incorporated into the decontamination process when water-based decontamination is contraindicated (e.g., due to weather/environmental concerns, chemical reactivity) or delayed (e.g., resource or capability limitations or logistics). Planning should include identifying possible alternative locations (e.g., showers at a gym or swimming pool) for water-based decontamination when necessary.

- Alternative decontamination practices in lieu of water-based decontamination include:
  - Delaying water-based decontamination; and
  - Non-water-based decontamination techniques
- Alternative decontaminants include:
  - Approved neutralizing agents (e.g., partitioning and chelating agents);
  - Chemical specific decontaminants (e.g., polyethylene glycol (PEG) for phenolic compounds);
  - Absorbent materials (e.g., spill pads, oil-dry, kitty litter, Fuller's Earth); and
  - Adsorbent materials (e.g., activated carbon)

Considerations:

- RSDL® is cleared by the Food and Drug Administration as a device only for spot decontamination and only for use with CWAs.
- Bleach solutions are not recommended for chemical decontamination in a civilian mass exposure incident; the contact time required for effectiveness is too long to be practical and is associated with potential irritation to the skin, which may increase chemical penetration.
- Chemical neutralization of acids or alkalis on skin or eyes with acidic or basic decontamination mixtures (e.g., 1% acetic acid for alkali burns; sodium bicarbonate for acid burns) is not recommended.
- Prior planning in conjunction with a hazard vulnerability analysis along with communication among health care facility-based first receivers, first responders, and poison centers can help to identify any alternative decontaminants.

Level of Confidence: IV

Discussion:

When the decision is made to perform decontamination, it should be conducted preferably at the scene, as expeditiously as possible to reduce chemical contact (i.e., residence) time, and should be applied through a tiered approach including self-care, gross patient decontamination, and technical patient decontamination. The cornerstone of effective decontamination is the removal of contaminated clothing, followed by decontamination with water, as well as with soap and a cloth or sponge, if available.

Risks prompting consideration of alternative practices or decontaminants

Water-based decontamination has the ability to create adverse outcomes itself. These include:

- Extending contamination to clean parts of the body: minimally contaminated patients who undergo gross patient or technical patient decontamination may inadvertently wash contaminant onto an uncontaminated limb, into their eyes, or aerosolize and subsequently inhale contaminant during showering.
- Patients decontaminated in cold weather risk the development of hypothermia in addition to their chemical-specific injuries.
- Patients also run the risk of mechanical injury (i.e., slips, trips, and falls).
- Psychological consequences in patients involved in a traumatic mass exposure incident may be compounded in patients for whom a technical patient decontamination process, which may include removing clothing and showering in view of rescuers and other patients, is necessary and in which responders manage casualties without sufficient communication (Carter et al., 2012; Fetter, 2005).

Alternatives to immediate gross patient or technical patient decontamination in cold weather
Decontamination is scalable, and if the risk of wet decontamination in an extremely cold environment is too great, disrobing patients and providing uncontaminated covering in the short term may be sufficient to substantially reduce the risk of chemical-specific adverse health outcomes without inducing hypothermia. Technical patient decontamination may then occur indoors when warm refuge is available. Alternate decontamination practices should be considered when water-based decontamination might be contraindicated due to cold weather. These practices include, but are not limited to:

- Delaying water-based decontamination due to unfavorable weather conditions; and
- Forgoing water-based decontamination in favor of evacuation and clothing removal for patients contaminated with non-reactive gasses

Alternative decontaminants when water is contraindicated
Unique contamination situations may require consideration of an alternative decontamination solution. For example, RSDL® is considered more efficacious than other solutions for CWAs (i.e., nerve and mustard agents) because the solution itself is designed to specifically neutralize nerve agent and partition sulfur mustard away from the skin. In certain niche industries, a particular chemical or mixture may have an especially effective decontaminant, such as PEG to decontaminate phenol (Monteiro-Riviere et al., 2001). It is not clear how such unique situations might inform general patient decontamination guidelines. Water-reactive chemicals, such as lithium or sodium metals or white phosphorus, require consideration of alternative removal processes such as dry mechanical removal/brushing (Brown et al., 1975).

Chemical neutralization of acids/alkalis is contraindicated
Early experimental evidence supports the efficacy of immediate water decontamination of acid and alkali chemical burns; the same experiment demonstrated more severe burns if chemical neutralization (5% sodium bicarbonate for acid burns; 1% acetic acid for alkali burns) was attempted in lieu of water decontamination (Davidson, 1927). Sodium hydroxide burns treated with 0.35M sodium citrate in a rat model showed higher (i.e., more alkaline) subcutaneous pH at one minute over those decontaminated with water alone, suggesting that “neutralization” of the alkaline chemical was (1) slower when an acidic decontamination solution was used, and (2) caused more harm than water washing alone (Yano et al., 1994). Water decontamination also resulted in less severe burns in a 45% sodium hydroxide-exposed rat model than did PEG decontamination (Brown et al., 1975). While neutralization (e.g., chelation, partitioning, physical removal of a dry contaminant) may be more appropriate than water decontamination in select circumstances, the use of a neutralizing solution (i.e., acid burn/alkali solution; alkali burn/acidic solution) can cause more extensive injury.

Chemical state may be affected by environmental conditions
The ambient temperature of the surrounding air and weather conditions may impact the physical state of the released chemical. Freezing points of select chemicals may make the method of decontamination variable, depending on the physical state at the time of release. Conversely, chemicals initially released as liquids may evaporate, causing an increased inhalational hazard for patients and responders.

Bleach is no longer recommended as an alternative decontaminant
For the purposes of mass patient decontamination in a civilian population, dilute bleach solutions are not recommended as an alternative decontamination solution. While bleach solutions have proven efficacious in certain situations and with specific CWAs, notably some nerve agents and sulfur mustard (Bjarnson et al., 2008; Braue et al., 2011a, 2011b; Wormser et al., 2002), their use in the civilian population with an unknown chemical contaminant is not recommended. Research on the use of bleach solutions indicates that the concentration and/or contact time required to neutralize CWAs exceeds the contact time shown to cause skin or eye irritation (Wormser et al., 2002).

Additionally, the following logistical considerations were identified by SMEs, suggesting that a bleach solution is an impractical alternative solution for civilian mass patient decontamination. They include (but are not limited to): (1) stocking and storage of bleach for mixing, and (2) ensuring the correct ratio is mixed (0.5%) and maintained throughout the decontamination process.

Consideration for adverse outcomes of water-based decontamination, including physical and psychological injury to patients, has been previously established in several existing guidance documents (DOD TSWG, 2004; ECBC, 2013; OSHA, 2009).

Functional Area 3: Evaluating the Effectiveness of Decontamination

Guidance Statements 3.1 and 3.2 recommend criteria for determining if a patient has been decontaminated sufficiently. Distinctions between effectiveness of patient decontamination and efficiency of decontamination operations are also presented.

Guidance Statement 3.1

Decisions on whether contamination has been reduced to a level that is safe or additional decontamination is necessary can be guided by the following indicators (and others as appropriate):

- Elimination of visible contamination from the skin and/or clothing;
- Observable improvement in signs and symptoms which prompted the decision to perform decontamination;
- Patient perceptions of the effectiveness of decontamination;
- Results from appropriate detection technologies;
- Guidelines in Functional Area 2: Optimized Technical Practices were followed; and
- If an effective decontamination method, which is known to be appropriate given the nature of the incident and chemical involved, is properly executed, then a sufficient reduction in contamination can be implied.

Considerations:

- The effectiveness of decontamination may not be objectively measurable with current capabilities. However, the above can be used as subjective indicators of achievement of the goals of providing first aid to patients and protecting responders and receivers from secondary contamination.
- Detection technologies must be appropriate to the chemical, properly calibrated, and the user properly trained.

Level of Confidence: III

Discussion:

Within the available literature, there are no widely accepted guidelines for determining the effectiveness of patient decontamination. In order to develop and validate tools for evaluating the effectiveness of a process, objectives must be established. Such objectives for patient decontamination have not been defined nor adopted by the emergency response community. Completely eliminating contamination is not realistic and may not be necessary. Reducing contamination to below a threshold for causing adverse health effects is difficult to implement because the acceptable human exposure limit is not known for many chemicals. Further, equipment with validated standards for its use in detecting contaminants on a person is not available for making the precise measurements necessary to assess whether such objectives have been met. The challenges of determining “how clean is safe” have been discussed in the literature (IOM, 1999; Raber et al., 2001, 2004; Vogt & Sorensen, 2002). In the absence of established standards, patient decontamination goals have been proposed here (see Desired end points for patient decontamination section). The proposed end points are based on health outcomes: improving patients’ short- and long-term health outcomes, protecting the health of responders and receivers, and protecting the integrity of health care infrastructure. The criteria recommended here for evaluating patient decontamination effectiveness are based on those health outcome-focused goals.

Due to the lack of established goals and standards up to this time, there is little scientific data or other published evidence to substantiate this or other approaches to evaluating patient decontamination effectiveness. However, the guidance presented here is based on SME opinion and current practice, and complements guidance statements on determining whether a patient needs decontamination (GS 1.1)

and prioritizing among multiple patients who may need decontamination (GS 4.1 and 4.2).

Looking for elimination of visible contamination on skin and/or clothing is a common sense step toward determining the effectiveness of decontamination. Signs and symptoms of chemical exposure that are manifest before decontamination may diminish during the course of decontamination. In some cases, however, such as with the absorption of a significant dose of toxic chemical prior to decontamination, effects may progress and become systemic. Signs and symptoms of systemic effects may not improve until antidotes and/or other medical treatments are administered. Given these possibilities, it is recommended that improvement in signs and symptoms be considered in combination with other indicators, rather than by itself.

Some patients may be quite aware of where they are contaminated and where the levels are greatest. If so, they might also have a sense of whether the decontamination process reduced that contamination or missed important areas. Many patients can potentially offer feedback on whether or not, in their judgment, the decontamination process was thorough and if they feel any improvement in their condition.

The guidelines presented in Functional Area 2: Optimized Technical Practices represent the best current thinking, based on available scientific evidence, expert opinion, and common practices in the field. Although the guidance statements do not describe operational step-by-step practices, following the guidelines can help to ensure that desired end points are achieved. Finally, if specific decontamination practices have been demonstrated to be efficacious for known contaminants or certain incident types, then their implementation should contribute to, and can be used as an indicator of the achievement of, patient decontamination goals.

With patient decontamination goals defined, it should be possible to more rigorously analyze the criteria recommended here as indicators of effective decontamination.

Guidance Statement 3.2

Timeliness and efficiency are critical elements of effective patient decontamination: an individual patient needs to be decontaminated with minimal delay and patients in a mass exposure incident need to be decontaminated expeditiously in order to do the greatest good for the greatest number. However, a rapid pace must be balanced with quality and consistency of patient care to achieve the goals of providing first aid to patients and protecting responders, receivers, and health care infrastructure from secondary contamination.

Considerations:

- Patient throughput or process-based endpoints alone, without consideration of impact on the health of patients, responders, and receivers, is not a useful measure of effectiveness of patient decontamination.
- Evaluation of the effectiveness of decontamination must take into account the desired end points, which are health outcome-based.

Level of Confidence: V

Discussion:

Timeliness and efficiency of a patient decontamination operation are relatively easy to measure. The delay between patient exposure and completion of decontamination should be estimable in most cases, and patient throughput in a mass exposure incident should be calculable. While minimizing the time between exposure and decontamination is critical, the thoroughness of decontamination that does improve patient health outcome(s) should not be compromised for the sake of increasing patient throughput that in-and-of-itself may not. Protocols need to be carefully executed and the operation should be monitored for quality control. A rapid pace without proper execution will not lead to attainment of health outcome-based patient decontamination goals. Therefore, a combination of factors need to be included in an evaluation of effectiveness: (1) the indicators listed in GS 3.1, which are the best means currently available to determine, directly or indirectly, if and to what extent patient contamination has been reduced; and (2) timeliness and efficiency.

Rapid decontamination and high patient throughput are often discussed in the literature and best practice guides as measures of effective patient decontamination (Brennan et al., 1999; Burgess, 1999; DOD TSWG, 2004; ECBC, 2013; Houston & Hendrickson, 2005). Patient throughput is also frequently reported in after-action reports for exercises. However, the SMEs who participated in this project expressed an urgent need to redirect assessments of effectiveness toward indicators that are more closely aligned with health outcome-based goals, but with timeliness and patient throughput still considered as measures of efficiency. This GS, then, has an LOC of V, since it is based on SME consensus but is not, to our knowledge, current practice and no published supporting evidence is available. With increased acceptance and analysis of the effect of this guidance on patient, responder, and receiver health outcomes, the LOC may improve in the future.

Functional Area 4: Patient Prioritization for Decontamination

For the case of a mass exposure incident, GS 4.1 and 4.2 advise on prioritizing patients for decontamination and coordinating decontamination with medical care.

Guidance Statement 4.1

Immediate, lifesaving medical care and/or antidotal therapy should ideally be a priority, over patient decontamination.

Considerations:

- Responders must be appropriately trained and have the proper PPE in order to implement medical care prior to patient decontamination.
- Lifesaving medical care will be defined by the Authority Having Jurisdiction.[16]
- This GS should be followed as closely as possible within the resource and capability limitations of the organization.

Level of Confidence: III

Discussion:

The balance between the need for lifesaving medical care and decontamination is tenuous and requires responders and receivers to perform a risk and capabilities assessment to determine whether it is appropriate and feasible to provide medical interventions in the contamination reduction zone while patients await decontamination. The literature suggests that there is an ongoing debate about when medical care should be given following a chemical exposure. On the one hand, in the US, medical care following a chemical exposure is typically conducted after patient decontamination (Hick et al., 2003b; Horton et al., 2003; Koenig et al., 2008). Personnel trained to provide lifesaving medical care are not always trained to wear and conduct operations in PPE, whereas personnel trained to wear PPE do not always have the skills necessary to render medical care to patients (see GS 5.7). On the other hand, setting up gross patient or technical patient decontamination operations takes time, during which it might be necessary to administer immediate, lifesaving care prior to – or in conjunction with – one or more tiers of patient decontamination. However, non-lifesaving measures, such as diagnostic and ancillary testing and ongoing vital sign assessments, are not appropriate until decontamination is complete and the victim is in a clean environment (Hall, 1995; Jagminas, 2008a; Laurent et al., 1999; Ramesh & Kumar, 2010). As one example in which a delay in lifesaving care led to an excess of morbidity and mortality, in the October 2002, Moscow theatre siege, delay in administration of an opioid antidote has been suggested to be responsible for a majority of the hostage deaths (Wax et al., 2003). Although decontamination was not performed during the Moscow incident, the delay in antidote administration resulted in preventable deaths from respiratory arrest.

In other countries (e.g., France, Japan, Israel, UK), some have recommended allowing properly trained medical providers wearing appropriate PPE to provide lifesaving medical care in the contamination reduction zone (Laurent et al., 1999; Markel et al., 2008; Okumura et al., 2003; Pillin, 2008). Additionally, some US guidance documents contain provisions for the administration of lifesaving medical care in the contamination reduction zone or concurrently with decontamination, in circumstances where the patient's condition poses a greater risk of death or morbidity than the ongoing exposure itself (ATSDR, 2001a, 2001b; DOD TSWG, 2004). OSHA's *Best Practices for First Receivers* also describes stabilizing those with life-threatening conditions or injuries, such as shock and respiratory failure, prior to initiation of decontamination (OSHA, 2005). Byers and colleagues (2008) suggested that rapid triage and

[16] "Authority Having Jurisdiction" is defined by HHS in the Public Readiness and Emergency Preparedness (PREP) Act, Declaration for Pandemic Flu (2009) as: The public agency or its delegate that has legal responsibility and authority for responding to an incident, based on political or geographical (e.g., city, county, Tribal, State, or Federal boundary lines) or functional (e.g., law enforcement, public health) range or sphere of authority.

lifesaving care, such as antidotes and trauma care, could be administered to patients by fire service personnel wearing Level A PPE and by medical providers on scene wearing Level C. An obvious limitation to the model proposed by Byers is that the use of Level C PPE on any scene in which the nature of the chemical hazard has not been fully characterized may not allow for adequate protection of medical personnel. Laurent and colleagues (1999) also proposed that medical personnel enter the hot zone in PPE to administer lifesaving care (i.e., the French "Red" Plan). Lifesaving interventions administered before or during decontamination should be limited to those likely to increase the chances of survival through the decontamination process and until the patient reaches a definitive medical care setting. For example, it may be possible to administer a nerve agent antidote to prevent respiratory failure and terminate seizures for a non-ambulatory patient as he/she moves through decontamination, thereby allowing him/her to survive to reach a health care facility where a ventilator and intensive care unit level care are available for definitive management. On the other hand, it may not be practical to perform extensive resuscitation, including cardiopulmonary resuscitation (CPR), throughout the decontamination process, since the likelihood of surviving out-of-hospital cardiac arrest is very low, regardless of the cause (Berdowski et al., 2010).

In certain situations, administration of lifesaving interventions can occur during any of the tiered decontamination processes, however:

- There must be adequate PPE for any responders providing immediate lifesaving interventions for a potentially contaminated patient, and the intervention must be doable while wearing PPE.
- Lifesaving interventions are resource and capacity dependent, and should only be performed if they are likely to prolong survival to the next level of care.
    - For example, a patient who has performed self-care after nerve agent exposure and subsequently developed seizures and respiratory arrest might receive antidotes via autoinjector prior to undergoing non-ambulatory technical patient decontamination.
    - A patient with life-threatening hemorrhage might have bleeding control (e.g., direct pressure, dressing) applied prior to decontamination.
    - An unconscious patient whose airway is compromised by position, vomitus, or secretions might have his/her airway repositioned, cleared, or an airway adjunct inserted prior to decontamination.
- The lethality of many CWAs, even at low levels of exposure, suggests that minimal amounts of contamination may result in mortality irrespective of any lifesaving interventions.

Guidance Statement 4.2

Prioritize patients for decontamination by estimating relative risk and grouping patients into urgent and non-urgent decontamination groups. Risk assessment should take into consideration the following criteria (and others as appropriate) in preferential order:

- Need for immediate lifesaving care or antidotal therapy (see GS 4.1);
- Visible evidence of contamination on patient's skin or clothing;
- Patients displaying signs and symptoms of exposure;
- Proximity of patient to the location of release; and
- Contamination detected on patient using appropriate detection technology

Considerations:

- Priority should be given to those patients who require decontamination in order to receive immediate care for life-threatening conditions or injury, including antidotal therapy.
- Children should be prioritized before adults within the same decontamination priority group.
- Age, pregnancy, and chronic medical conditions should be considered when estimating relative risk and prioritizing patients for decontamination.
- Concerned citizens who are at low risk of contamination may request to undergo decontamination.
- In a mass exposure chemical incident, patients needing decontamination most urgently may not be the first to present; ambulatory patients may reach first responders or first receivers more quickly than non-ambulatory patients.
- Self-reporting patients arriving at a health care facility should also be prioritized according to these criteria.

Level of Confidence: III

Discussion:

There is little published evidence, either experimental or empirical, suggesting the best means to triage or prioritize patients according to their need for decontamination. A variety of triage systems are proposed in the literature, many based on traditional mass casualty incident medical triage protocols (e.g., START, SALT, Triage sieve) (Cieslak et al., 2000; Cone & Koenig, 2005; Kenar & Karayilanoglu, 2004; Neal et al., 2010; Okumura et al., 2007; Ramesh & Kumar, 2010; Subbarao et al., 2005). With the exception of assessments of two triage systems, no attempts have been made to evaluate these prioritization schemes empirically or to validate them as effective in leading to a decrease in overall levels of morbidity or mortality (Bond et al., 2008; Cone et al., 2008).

The triage system evaluated by Cone and colleagues (2008) was developed as a CBRN triage system, which includes recommendations for both patient decontamination and medical care (Cone & Koenig, 2005). The evaluation of the system was conducted in conjunction with a disaster drill and was limited to only the chemical and trauma algorithm. Despite recent training, the study found a high rate of under-triage (i.e., placing casualties in a triage category that was lower than where they should have been placed) as well as a failure to recognize toxidromes. The results indicate that the system needs further refinement and testing.

Subbarao and colleagues (2005) developed a set of symptom-based triage algorithms for CBRN incidents based on situational characteristics (e.g., type of attack or release) and patient presentation. While patient decontamination is identified in some of the algorithms, others focus on providing medical care or other protective measures. Bond and colleagues (2008) conducted a usability assessment of this system with first receivers (e.g., attending physicians, emergency medicine residents, and nurses) using 26 paragraph-length written scenarios. Aggregate scores for all scenarios and all testing groups yielded a correct triage rate of 45%, indicating that additional revision and simplification of the algorithms is needed.

The use of triage protocols or other methods to prioritize patients is well represented in best practice guides – six of the documents examined mention prioritizing patients for decontamination (ATSDR, 2001a; CAL-OES, 2006; DOD TSWG, 2004; ECBC, 2009; OSHA, 2005, 2009). The assertions in this GS would be difficult to evaluate in a controlled human trial but could be analyzed through retrospective study of actual incidents. It has also been noted that there is no commonly accepted method for evaluating the effectiveness of a triage system. Before an applicable triage system can be examined, a standard evaluation method needs to be established (Ramesh & Kumar, 2010).

The list of criteria proposed here is an extension of the criteria recommended in GS 1.1 for determining if a patient requires decontamination in the first place. These criteria are used to prioritize patients who require decontamination within a resource and/or time-constrained response, where some patients may require decontamination sooner than others. Upon evaluation, patients should be categorized into urgent or non-urgent categories; this evaluation is in addition to, and should take into account, traditional medical triage.

Need for lifesaving medical care or antidotal therapy
Patient decontamination should not be delayed when lifesaving medical care or antidotal therapy are needed and available. Alternatively, if resources are available (e.g., trained personnel, appropriate PPE, medical supplies, and equipment), lifesaving medical care and/or antidotal therapy can be administered before or concurrent with decontamination. Providing medical care and antidotal therapy in the contamination reduction zone requires properly trained personnel in appropriate PPE (Laurent et al., 1999; Markel et al., 2008; Okumura et al., 2003).

Visible contamination
Visible indications of chemical contamination on the patient or the patient's clothing are a common sense factor that can be used to determine the need and urgency of decontamination (Ramesh & Kumar, 2010). Visible evidence of contamination indicates an ongoing exposure with increased contact time (Kirk & Deaton, 2007).

Symptoms
Toxidromes, or clusters of symptoms, can be utilized to help distinguish between affected and unaffected individuals (Kirk et al., 1994; Markel et al., 2008) and between priority levels (i.e., urgent and non-urgent). However, there is some research to suggest that individuals who have a low probability of being contaminated can still exhibit symptoms that do not have an organic origin (Kirk & Deaton, 2007), indicating that additional information is required to determine their appropriate priority level for decontamination.

Proximity
Patients who were in closer proximity to a release may be likely to have received a higher level of contamination and therefore have a greater need for decontamination than patients who were farther from the release (Kirk & Deaton, 2007). Proximity to the release is cited in various articles as one of the main factors to consider when determining decontamination needs (Ramesh & Kumar, 2010).

Detection
Historically, there is a lack of discussion in the literature regarding the use of detection and diagnostic technologies that can be used to determine decontamination requirements. Although environmental detectors are available and used by first responders to characterize hazardous environments, there is little mention of the use of these devices to prioritize patients for decontamination. Protocols for sampling and analysis of contaminant levels on skin have not been developed (Raber et al., 2004; Vogt & Sorensen, 2002; Volkland, 2000). Ancillary testing, such as laboratory confirmation of contaminants in biological samples, has no role in the immediate decision to decontaminate or in the prioritization of patients for decontamination. While subsequent confirmation of exposure through laboratory testing may inform some aspects of attribution, medical management, or prognosis, no laboratory result could reasonably be expected to be available, on scene, for decontamination prioritization decisions.

Age extremes, pregnancy, and chronic medical conditions should also be factored in to the prioritization framework, with the assumption that patients in these categories may have a higher risk of injury due to the chemical contamination. For example, children have thinner skin, larger body surface-to-mass ratio, more rapid respiratory rates, and are closer to the ground where heavier-than-air substances can accumulate, making them more susceptible to contamination than adults (American Academy of Pediatrics [AAP], 2006; Mueller, 2006). The elderly may have increased vulnerability due to changes in the skin, diminished enzymes for detoxification, and other metabolic changes (NLM – Chemical Hazards Emergency Medical Management [CHEMM], n.d. – see United States Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response, National Institutes of Health, National Library of Medicine, Chemical Hazards Emergency Medical Management website, n.d.). Pregnant women may also experience physiological and respiratory changes that increase their susceptibility to chemical (primarily inhalational) exposure (James, 2005; NLM – CHEMM, n.d.; Teran-MacIver & Larson, 2008). Historical examples indicate that in a mass patient incident, those needing a higher level of care are not the ones to reach responders and receivers first (Okumura et al., 1996; Scanlon, 2010). In these cases, decontamination should still be conducted until patients of a higher risk category arrive for decontamination and treatment.

Functional Area 5: System-Wide Coordination of Patient Decontamination

The purpose of Functional Area 5 is to promote planning that is coordinated throughout the entire community and addresses the needs of all community members. Guidance particularly emphasizes the importance of communication and coordination between responders at the incident scene and at health care facilities.

Guidance Statement 5.1

If decontamination is indicated, it should be performed as soon as possible, preferably at the scene if not contraindicated by safety considerations.

Considerations:

- The location for on-scene patient decontamination should be at the perimeter of the contamination reduction zone upwind, uphill, and far enough away from the chemical release location to prevent recontamination and serve as the egress point to the cold zone.

Level of Confidence: II

Discussion:

The best location for decontamination is at the scene or another suitable location that can be accessed with minimal delay if there are contraindications to on-scene decontamination such as extreme weather, safety concerns, or a risk of additional release. The preference for decontamination at the scene is based on several observations:

- Decontamination at a facility introduces a delay, during which there can be ongoing absorption of contaminants.
- Decontamination at a facility risks contamination of transport assets.
- Decontamination at a facility increases the risk of secondary contamination of medical infrastructure and personnel.
- First responders are for the most part more proficient in decontamination than first receivers, based on their training and frequency of equipment use (Keim et al., 2003):
  - They are more skilled in the use of PPE.
  - They are more familiar with decontamination equipment.
  - They exercise and re-train frequently.

Kirk & Deaton (2007) contended that decontamination is a first aid procedure and that any delay in its execution increases the contact time patients have with a chemical. Decontaminating patients at the scene may help to minimize potential delays. See GS 2.3 for further discussion of the importance of initiating decontamination as soon as possible.

Considerable concern exists with regard to secondary contamination. Okumura and colleagues (2005) noted that 10% of fire service personnel and 23% of the staff at St. Luke's Hospital had exposure to sarin vapor following the 1995 Tokyo subway attack; however, it should be emphasized that no decontamination – either on-scene or at the hospital – was performed. Burgess (1999) examined 11 ED secondary contamination events and found that the resulting ED evacuations lasted from one to 10 hours during which between zero and 50 ED patients had to be moved. In addition, up to 15 medical personnel were treated for exposure.

Several existing guidance documents describe decontamination on-scene as the preferred approach (DOD TSWG, 2004; ECBC, 2013) when not precluded by contraindications such as weather or safety concerns. Subject matter experts also asserted that decontamination at the scene, if possible, is preferable to

transporting patients to other locations for decontamination. First, rapid removal of contaminant and prevention of secondary contamination are obvious advantages. Second, estimation of resources and personnel needed is easier when based on the patients marshaled at the scene, than when decontamination is performed at multiple alternative sites or health care facilities. Third, transport of patients to appropriate medical facilities is easier from one location than among several different sites. Fourth, uniformity of assessment of the need for decontamination, quality of that decontamination, and determination of the need for medical evaluation is easier from the scene. It is possible that medical resources may be more readily available for those patients most in need if decontamination is performed at the scene; effective decontamination and decision making at the scene could eliminate the need to transport a portion of patients to a health care facility, thereby preserving transport and hospital access for those who more urgently require it. Some patients may not require decontamination and thus, be released, while some patients may undergo decontamination and be released following a period of asymptomatic observation.

Subject matter experts recognize several limitations to the guidance provided in this statement: many patients may self-evacuate and decontamination at health care facilities may be still required (Okumura et al., 1998a, 1998b; Chemical Safety and Hazard Investigation Board [CSB], 2008 – see United States Chemical Safety and Hazard Investigation Board, 2008; Vogt & Sorensen, 2002). At the same time, some patients will still insist on medical evaluation even if the possibility of exposure has been ruled out; they too may be required to first undergo decontamination at the facility at which they seek such evaluation. Finally, some facilities may perform additional decontamination despite assurances that patients have already been decontaminated at the scene.

The health outcome benefits of reducing contact time sooner rather than later – if weather or safety concerns do not require consideration of an alternative approach – are apparent. Decontamination at the scene, or as soon as possible thereafter, is optimal, even if not completely achievable.

Guidance Statement 5.2

Anticipate self-evacuation from the scene prior to decontamination and develop a coordinated whole community response plan to manage the entire spectrum of patients, which include:

- At scene: ambulatory and non-ambulatory patients who remain at the scene; individuals other than responders who arrive at the scene after the release and become exposed (e.g., news reporters, bystanders);
- Self-evacuated: patients who travel without the assistance of responders to a health care facility (e.g., hospital, physician's office, or urgent care center); and
- Left scene: patients who leave the scene and do not seek care (e.g., return home or travel elsewhere), or seek care later due to delayed onset of signs and symptoms

Considerations:

- The response community should be prepared for a variety of patients who may seek delayed care, including:
  - Those who remain without symptoms but who present out of concern based on media reports; and
  - Those who may be especially susceptible to low levels of secondary contamination introduced by an asymptomatic patient who left the scene
- Patients should remain at the scene or health care facility for observation and/or treatment as long as suggested by responders and/or receivers based on medical guidance/protocols.

Level of Confidence: III

Discussion:

During an incident, patients will use various routes to reach medical care. Scanlon (2010) described the means by which patients self-evacuated and self-transported to reach medical care after the 1943 Bari, Italy, mustard gas release and after the 1995 subway sarin attack in Tokyo, Japan. In Bari, patients self-evacuated the seaside and reported to the hospital to seek treatment for burns and respiratory injuries. In Tokyo, many patients walked or used a taxi to get to the closest hospital. Tokuda and colleagues (2006) described the transport of patients after the Tokyo subway attack: 35% of the injured walked to the hospital, 24% were transported by taxi, and only 7% were transported by ambulances. Wenck and colleagues (2007) reviewed the 2005 liquid tanker car derailment that caused the release of chlorine gas in Graniteville, South Carolina, and interviewed the patient population that sought medical treatment. Transportation data was collected for the 57% of patients who were treated within the first 24 hours: 63% self-transported in a privately owned vehicle to a medical center; only 35% were transported by EMS; and 2% were transported by the police (Wenck et al., 2007). An analysis of 70 after action reports from full-scale CWA incident exercises similarly demonstrated that a majority of contaminated participants tried to leave the scene without being decontaminated (Phelps, 2006). These results indicate that many patients will not wait for EMS and will leave the scene, possibly delaying decontamination. These patients may be contaminated and could potentially spread the contamination to others. Many may travel across a city to their preferred health care facility for treatment. Because of the tendency to self-evacuate and self-transport to reach medical care, Scislowski (1997) and Auf der Heide (1989, 2006) describe that in nearly all mass casualty incidents, ambulatory patients arrive first while the most seriously injured arrive last for medical treatment.

Medical personnel should be prepared and able to control access to the decontamination site and prevent contaminated patients from entering the health care facility itself. In both the Bari and Tokyo incidents, the medical staff did not initially decontaminate the patients. In the Tokyo attack, 39% of nursing assistants, 27% of nurses, 26% of volunteers, 22% of physicians, and 18% of clerks became ill with nerve agent exposure symptoms (Okumura et al., 1998b; Scanlon, 2010). By being prepared, first

responders and first receivers will be able to protect themselves and provide the best care to patients. Health care facility managers and health and city officials must also be prepared to manage resources (e.g., facilities, equipment, and emergency medical transport vehicles and aircraft) so that they can be kept in service or, if they become contaminated, quickly restored to service.

Since some patients may leave the scene and return home prior to seeking and/or receiving medical care, information should be available to advise them on proper self-decontamination procedures. This includes recommendations that clothing be removed, sealed in a bag, and then sealed in another bag (i.e., double bagged). Showering with the use of soap and washcloth should be advised. These individuals should be further instructed to seek medical care if exhibiting any of the signs and symptoms as described by local authorities responding to the chemical incident.

Guidance Statement 5.3

Responding and receiving organizations should plan for both ambulatory and non-ambulatory patients simultaneously.

- Ambulatory patients should be able to follow verbal, written, or posted directions with no physical assistance from first responders or first receivers.
  - May be helped by "buddy" or family member
- Non-ambulatory patients will need personnel to assist them through the process.
  - Specialized equipment will be needed (e.g., backboards, raised working surface/roller tables).

Considerations:

- Planning for ambulatory and non-ambulatory patients should occur for all tiers of decontamination (non-ambulatory patients may not be able to conduct self-care).
- A significant number of ambulatory patients are expected to leave the scene prior to decontamination and may self-present at a health care facility.

Level of Confidence: IV

Discussion:

The need to prepare for both ambulatory and non-ambulatory patients is highlighted in existing guidance documents and is typically based on reports following actual incidents. The most notable example of this planning need is the 1995 sarin attack in Tokyo, Japan. In reviewing a report from St. Luke's Hospital in Tokyo, Tokuda and colleagues determined that 35% of the injured walked to the hospital. In addition, 24% were transported by taxi, and only 7% were transported by ambulances, which may have included both ambulatory and non-ambulatory patients (Tokuda et al., 2006). The expected ratio of ambulatory to non-ambulatory patients is difficult to predict and will depend on the characteristics of the specific incident. However, non-ambulatory patients should be expected in any given incident, whether due to the direct effects of chemical exposure, other injuries from the incident, pre-existing conditions, or age.

Non-ambulatory patients will consume more resources than ambulatory patients, most notably in terms of the efforts of response personnel. Surge capacity for ambulatory patients can reduce pressure on the system and allow concentration of resources toward non-ambulatory patients (Hick et al., 2004).

Tiered decontamination (i.e., self-care, gross patient decontamination, and technical patient decontamination) must, therefore, account for resource-intensive requirements to care for non-ambulatory patients. Self-care may not be appropriate for non-ambulatory patients. Ambulatory patients, on the other hand, should be able to follow commands and be self-sufficient in conducting decontamination, including self-care. Ambulatory patients may also be able to assist other ambulatory and non-ambulatory patients, if necessary. A buddy system, such as an ambulatory patient assisting a child or an elderly patient through the decontamination process, can facilitate the utilization of the ambulatory route by those who require minimal assistance. In a health care facility, for example, a buddy system could be implemented through the use of solicited volunteers (e.g., former employees and retirees) and unsolicited volunteers (e.g., bystanders and ambulatory patients who are well enough) (Hick et al., 2004).

Guidance Statement 5.4

At-risk populations require additional assistance. Responding and receiving organizations should implement planning and training to assist at-risk populations through the decontamination process.

- At-risk individuals have needs in one or more of the following functional areas: communication, medical care, maintaining independence, supervision, and transportation.
- At-risk populations may include infants, children, the elderly, and pregnant women, as well as people who have functional or mobility impairments, live in institutionalized or congregate settings, have limited English proficiency or are non-English speaking, or have cognitive impairments.

Considerations:

- Planning, training, and communication with members of at-risk populations should be practiced prior to an incident.
- Ensure response plans include integration of additional personnel to assist patients through decontamination and/or pairing non-ambulatory patients with ambulatory patients to assist. Each responding organization should have response plans that include specific protocols for at-risk patients.
- Make every effort to keep a child with a parent or trusted adult, but if a child is alone, a responder/receiver should make eye contact and try to explain what is going to happen and, if possible, assist the child through decontamination.
- Unless contraindicated due to medical needs, families should undergo decontamination together. Keeping children with parents or caregivers may reduce psychological stress for all family members and reduce the need for additional assistance from responders or receivers.
- A method to hold or carry an infant through decontamination must be in place (e.g., laundry basket or bassinet with holes for drainage).
- Certain individuals may have increased susceptibility to cold or heat injuries (e.g., infants, young children, the elderly, and patients with history of cold or heat injury) and should be closely observed by first responders and first receivers.
- Have a plan for service animals; integrate into the process personnel trained in animal triage (as resources allow) and decontamination; efforts should be made to keep animal with patient.
- Patients with decreased mobility (e.g., in wheelchairs) may need to be transferred to a backboard or gurney and treated as a non-ambulatory patient.
- Patients should retain, to the greatest extent possible, all materials required for “normal” functionality (e.g., prosthetics, hearing aids, eyeglasses).
- Provide written and pictographic instructions for the decontamination process; translate to the most commonly used languages within the population (see Functional Area 6: Crisis and Emergency Risk Communication).
- Integrate interpreters into a response plan or have pre-recorded messages in the most frequently used languages within the population, as resources allow.
- Integrate behavioral health professionals early in the response, as resources allow.
- Every effort should be made to keep at-risk patients with a trusted person/caretaker.
- During the planning process, identify at-risk groups within the community; include members of these groups as advisors to the decontamination planning team and as participants in decontamination exercises.

Level of Confidence: IV

Discussion:
Existing guidance documents (ATSDR, 2001a; DOD TSWG, 2004) cite the need for additional planning for decontaminating at-risk populations. However, scientific studies are lacking for specifics of how to assist such patients through the decontamination process.

Taylor and colleagues (2009) describe the results of a decontamination exercise utilizing people with disabilities as both advisors to the planning process and as exercise participants. This particular exercise involved: (1) deaf participants who used American Sign Language to communicate; (2) Spanish-speaking participants with limited English proficiency; and (3) participants with physical disabilities (e.g., requiring a wheelchair or other device for functional mobility). In an effort to meet the needs of these groups, the planning team added the following personnel to the decontamination team: interpreters for Spanish-speaking and deaf patients, and physical therapists to assist in transferring mobility-impaired patients. Different equipment was also utilized, including accessible shower tents (e.g., low wall stalls) and shower chairs, which were used in lieu of transferring wheelchair participants to backboards or gurneys.

Three main themes emerged from the interview and focus group data: (1) communication; (2) disability awareness; and (3) differing expectations. For communication, deaf participants indicated that more direction was needed to instruct participants how to move through decontamination. Other suggestions included: making eye contact, use of body language or gestures, and posting signs to tell and show what participants should do. It is interesting to note that the comparison group (fluent English-speaking participants without a disability) was also confused about where to go and how to conduct decontamination. With regards to disability awareness, it was noted that decontamination team members should ask participants if they have a disability and whether they need assistance, particularly when transferring from a wheelchair to the shower chair. Participants with disabilities described fears that their auxiliary devices (e.g., wheelchairs, canes, walkers) would be taken from them, with one participant stating "When they take away your way of moving, they strip you of everything!" (Taylor et al., 2009). Actions that allow at-risk populations to maintain self-control should be taken into consideration (e.g., maintaining eyeglasses, explanation of the process before starting).

Taylor and colleagues (2009) asserted that by "addressing the needs of people with disabilities, the needs of other individuals are often met, providing a universal benefit". Incorporating people from at-risk populations in the planning process for decontamination operations, as well as including them as participants in exercises, permits planners opportunities to identify new issues and improve the process. This requires additional preparation to identify in advance the population characteristics – their demographics, ethnic make-up, language barriers, and resources/resiliency – that may impact the decontamination response. Subject matter experts indicated that their experience shows that owners will bring their animals (including household pets and service animals) with them. Therefore, it is beneficial for a community to build this component into their plans and to identify capabilities prior to an incident.

Additional information on specifics for communication with patients and the general public can be found in Functional Area 6: Crisis and Emergency Risk Communication. State and local public health emergency, medical countermeasure distribution, disaster evacuation, and other disaster response and recovery plans may provide additional recommendations for accommodating at-risk populations unique to specific locations.

How best to care for at-risk populations, especially the pediatric population, is one of the important gaps identified during development of this guidance. Little evidence is focused specifically on this population. Several articles and a video identify unique challenges and provide expert opinion about managing pediatric patients in a mass exposure incident (Agency for Healthcare Research and Quality [AHRQ], 2005 – see United States Department of Health and Human Services, Agency for Healthcare Research and Quality, & the Children's Hospital Boston, 2005; Heon & Foltin, 2009; Mueller, 2006; New York City Department of Health and Mental Hygiene, 2008; Timm & Reeves, 2007).

The pediatric population actually refers to diverse populations with unique needs. Planners should view

children as several subgroups with distinct needs, considering different ages (i.e., infants, toddlers, preschoolers, school-aged children, and adolescents) and other specific challenges (e.g., physical disabilities, cognitive impairments, reduced communication skills, limited or no English proficiency).

Children are more susceptible than adults to chemical poisoning, to the adverse effects of decontamination, and to the emotional distress from a mass casualty incident (AAP, 2006; Mueller, 2006). They breathe more rapidly, have larger body surface area-to-mass ratio, and have more permeable skin than adults, allowing greater chemical exposure through inhalation or skin contact. Chemicals heavier than air hover low to the ground, increasing the concentrations within their breathing zones. Children have less body fluid reserve and can rapidly become dehydrated from chemicals that cause vomiting and diarrhea. They are more susceptible to adverse effects of decontamination, particularly with regards to environmental factors; they lose body heat more rapidly when wet and unclothed than adults, resulting in a higher risk of hypothermia at higher ambient temperature. In addition, younger children (e.g., infants or non-ambulatory toddlers) can be slippery when wet and will require a system to ensure their safety (e.g., hand spraying while on a stretcher or in a bassinet with holes for drainage).

Expert opinion suggests incorporating processes for protecting children from developing hypothermia such as avoiding prolonged periods of exposed, wet skin, maintaining water temperature for decontamination at 98° F to 110° F, wrapping children in blankets, towels, or foil heating blankets, and using heat lamps. In addition, those performing decontamination should take care to ensure each child's airway remains open and protected during the process.

A child's limited cognitive and emotional development may increase his/her susceptibility to anxiety and fear when exposed to extraordinarily stressful circumstances. Such circumstances include the incident itself or when a first responder or receiver approaches while wearing chemical protective PPE. Response plans should attempt to incorporate family-centered care, limiting separation of children from parents or caregivers, and rapidly prioritizing reunion if separation occurs. For unaccompanied minors, psychosocial support should be provided in a child-friendly environment with age appropriate activities. This may include support from child life specialists or social workers in a play therapy area for medically cleared patients. The DOD TSWG guidance (2004) also recommends to keep children with an adult family member and provide escorts for unaccompanied children.

A recent workshop and exercise identified various improvements to protocols that could support the psychosocial needs of children, though not all are limited to children (Pinette et al., 2014):

- Selecting a buddy to provide psychological and physical support throughout the process;
- Simple steps to complete self-care decontamination using numbers and colors;
- Use of pictographs to support those undergoing the decontamination process who may not hear or understand the first responder leading the process;
- Items to reduce personal stressors such as a sanitary napkin; one-size fits all mesh underpants; age-appropriate clothing and footwear; soothers and diapers; and a "Decon Doll" or "Action Figure" to reduce the fear generated by the arrival of first responders;
- Showering protocols in pictograph format so that patients can quickly grasp what needs to be done at each step of the process, including protocols for infants and children; and
- Showering procedures to enable families, friends, and buddies to provide support to each other

The elderly, pregnant women, and people with chronic medical conditions also may be at greater risk of adverse health effects due to the chemical contamination. The elderly may have increased vulnerability due to changes in the skin, diminished enzymes for detoxification, and other metabolic changes (NLM – CHEMM, n.d.). Pregnant women may also experience physiological and respiratory changes that increase their susceptibility to chemical (i.e., primarily inhalational) exposure (James, 2005; NLM – CHEMM, n.d.; Teran-Maciver & Larson, 2008). However, evidence-based methods are severely lacking for decontaminating pregnant women, the elderly, children, and other at-risk populations in ways that

optimally care for their distinct physiological and psychological needs. More research is needed to inform evidence-based guidance for the decontamination of at-risk populations in a mass exposure chemical incident.

Guidance Statement 5.5

A formal rapid communication procedure should be utilized to provide advance notice to area health care facilities of a hazardous chemical incident and to specifically alert facilities to the possibility of self-evacuated patients needing assessment of contamination and arriving unannounced to health care facilities.

Considerations:

- First responders and first receivers should have ongoing communications throughout the incident.
- Communication systems should be redundant, interoperable, multi-directional, and include notifications to all emergency response partners.
- A pre-scripted template indicating critical information requirements should be produced during planning between first responders and first receivers.
    - Initial communications should include the following: initial scene assessment; identity of the involved chemical(s) and their toxicity, if known; commonly observed signs and symptoms; and patient decontamination efforts underway at the scene.
    - Updates from the scene to health care facilities, through the incident command system, should include the confirmed identity of the involved chemical(s); estimated patient numbers requiring transport; their triage categories; estimated times of arrival; and the status of patient decontamination.
    - Updates from receiving health care facilities to the scene should include: expected hospital capacity; re-routing of traffic around hospitals or ambulance diversions; effectiveness of decontamination and medical treatment from the scene; the status of facility-based patient decontamination efforts, if any; information on chemical identification and toxicity (e.g., through hospital laboratory testing); and delayed symptoms observed.
    - Regional poison centers can serve as an authoritative information resource for both responders and receivers regarding the human health effects of toxic chemical exposure. A central point of information will prevent conflicting recommendations.
- All communication pathways should be pre-established and frequently rehearsed for the most effective use of resources, in accordance with the National Incident Management System (NIMS). Clearly establish expectations and critical information needs among all response stakeholders regarding information sharing.
  The volume of information to be expected on communication systems in mass casualty events is often underestimated. It is important that response plans include provisions to rapidly augment communications capacity and personnel.

Level of Confidence: III

Discussion:

While there is a large amount of anecdotal literature concerning this topic (Auf der Heide, 1989, 2006; Okumura et al., 1998a, 1998b), Hood and colleagues (2011) described an exercise where a team provided both decontamination and medical care during a simulated mass casualty incident. One of the study's findings was that first receivers took 40 minutes to set up the decontamination facility and equipment as well as to don appropriate PPE before handling the first patient. Therefore, any warning given to first receivers prior to receiving the first patients will aid in reducing the delay between patient arrival and decontamination capabilities being fully functional, allowing for more immediate care.

In addition, Tokuda and colleagues (2006) asserted that the ability of the ED to provide timely and effective treatment is enhanced by the information coming from HAZMAT teams at the scene. This emphasizes the need for rapid, early, and accurate communication from the field to health care facilities.

Such early communication will allow receiving facilities to prepare for the self-evacuating patients who, many times, show up before first responder-transported patients. Additionally, this communication allows health care facilities to coordinate transport of non-critical patients to neighboring hospitals; increase staffing levels; identify and collect medication, references, and other materials needed to treat incoming patients; and possibly coordinate patient load based on availability of resources at a given institution. In mass casualty incidents of all types, coordination of patient distribution is often lacking. Kirk & Deaton (2007) describe the early period immediately following initiation of the incident as the "silent gap", during which little information has been shared from the scene about the nature of the incident and first receivers experience uncertainty. To a certain extent, this is because some patients self-evacuate (Auf der Heide, 1989, 2006; Zoraster et al., 2007).

Many communities require first responders to notify first receivers of any transport to their facility. Communication between on-scene first responders and first receivers is a critical ongoing requirement (Auf der Heide, 1989). Despite the acknowledgement of this essential function, many SMEs believe such coordination does not occur much of the time because of ineffective communication networks among first responders, first receivers, poison centers, and other emergency response entities. For example, cellular and telephone systems are unreliable in disasters because, if they are not damaged, they quickly become overloaded and non-functional (Auf der Heide & Scanlon, 2007). Cell phones may play a vital role in communicating to both responders and potential patients through newly implemented emergency text message systems such as FEMA's Integrated Public Alert Warning System and the Commercial Mobile Alert System. A potential approach to the issue of communication needs in a chemical incident is to begin to adapt these communication procedures and networks for more routine emergencies to increase responders' familiarity with them and to identify problems with the communication system itself (e.g., lack of interoperability, lack of redundancy). Another issue to consider is the accuracy of information being conveyed between on-scene responders and receiving health care facilities. However, literature suggests that most secondary contamination occurs because the health care facility is not ready to receive potentially contaminated patients (Okumura et al., 1998a, 1998b). Thus, it is better for any available information regarding chemical identity, route/duration/severity of contamination, toxidrome or symptom complex, and extent of decontamination efforts to be communicated without delay. For planning purposes, other suggestions include establishing a fill-in-the-blank form that would help first responders notify health care facilities of pertinent information (e.g., chemical substance, if known; state of chemical; sign and symptoms patients are presenting; patients' responses to antidotes, if given; number of patients; and what type of decontamination, if any, is being performed at the scene).

The Laboratory Response Network – Chemical (LRN-C) may also provide communication to first receivers on the likely chemical identity. The LRN-C is a nationwide network of local and state public health accredited clinical laboratories organized by the Centers for Disease Control and Prevention (CDC). These laboratories analyze blood and urine specimens from hospitals for the biological indices of a particular chemical exposure. From the clinical laboratory results, LRN-C facilities can communicate the likely chemical identity - or at least the class of chemical agents - involved with patient exposure. However, the process may take several hours depending upon the number of clinical samples received and the analytical methods used.

Guidance Statement 5.6

Notification, by graphic, written, or verbal means, and ideally a combination of all three, should be used to record scene decontamination practices for clear communication and coordination with health care facilities.

Considerations:

- If a physical notification system is used, it should be durable to withstand the decontamination process.
- Notification systems should be redundant, interoperable, and multi-directional and include notifications to all emergency response partners.
- If a physical notification system is used, the amount of time the notification tool is valid after the incident is over should be determined.
- All directions should be easy to read and understand.

Level of Confidence: III

Discussion:

Triage is discussed in the literature and in several existing guidance documents recommending the utilization of such tools to help organize patients. Given this, clear guidelines need to be set for language used with the triage tools. These guidelines can standardize communication between responders and receivers, making decontamination more efficient and avoiding duplication of efforts. When large numbers of patients arrive at the ED in a short amount of time, it may be difficult for ED staff to differentiate between those who are contaminated and those who have been decontaminated in the field (Clarke et al., 2008). The marketplace has developed numerous triage tags that convey information such as vital signs, medical countermeasures or antidotes administered, if and what type of decontamination has occurred, and location of injuries. Okumura and colleagues (2007) described development of a new system specifically for the initial triage and decontamination of patients in a chemical release. This system will use colored clothes pegs, where red indicates the need for emergency care, yellow for semi-emergency care, green for non-emergency care, black for expectant, white for dry decontamination, and blue for wet decontamination. The group proposed that two clothes pegs should be used per patient. Once the patient has completed wet decontamination, responders should switch back to conventional paper triage tags.

Many EMS and HAZMAT organizations utilize the START (Simple Triage & Rapid Treatment/Transport)[17] model for categorizing patients' injuries at the scene. However, this model is of limited use to prioritize patients for decontamination. First responders and receivers can utilize tools such as the HHS Chemical Hazards Emergency Medical Management Intelligent Syndromes Tool (CHEMM-IST) or the National Library of Medicine's Wireless Information System for Emergency Responders (WISER) to recognize toxidromes and identify the general class of chemical agent to which patients may have been exposed. This additional information will aid in using START, particularly in prioritizing patients for resuscitation, antidotal therapy, decontamination, and then transport or release from the scene.

However, Zoraster and colleagues (2007) found that the START triage system has challenges. In particular, there is the potential for misdistribution of patients to health care facilities. This poses communication challenges in relaying decontamination practices occurring at the scene to the various health care facilities. For example, if some patients were adequately decontaminated with self-care or gross patient decontamination processes while others were technically decontaminated, communicating

[17] Defined as a trauma-based system utilized for the triage of adult and pediatric medical patients resulting in a reproducible triage process so that different EMS providers come to the same triage category conclusion when assessing patients based on severity (Gonzalez, 2011).

what decontamination has (or has not) occurred may be difficult if not almost impossible in a mass casualty incident. The communication challenges are further compounded by patients evacuating the scene quickly and showing up at health care facilities on their own, or possibly assisted by bystanders who may not know that the patients were possibly contaminated (Okumura et al., 2007).

Two-way communication should occur between the health care facilities and first responders on-scene. Ideally, first responders should relay to supporting health care facilities information on the decontamination tier(s) used on the patients (i.e., self-care, gross patient, and technical patient). In addition, first responders should communicate to first receivers the suspected or field-confirmed identity (using field chemical detection methods) of the agent released in order for appropriate definitive care to occur. Furthermore, if decontamination is not or cannot (due to environmental conditions) be performed, this must also be communicated to health care facilities and may result in routing contaminated patients to facilities with appropriate decontamination capabilities. In turn, health care facility-based first receivers should send feedback to first responders in the field on decontamination effectiveness and effectiveness of initial emergency medical treatment. This will allow responders to alter practices in real–time, identify the need for specific interventions/antidotes (if the health care facility is first to identify the chemical), and alert responders of adverse effects (e.g., patients are arriving hypothermic). Regional poison centers can serve as an authoritative information resource for both responders and receivers regarding the human health effects of toxic chemical exposure. A central point of information will prevent conflicting recommendations.

Determining the endpoint of field decontamination and emergency medical treatment – when those activities have ceased – also requires communication to participating health care facilities. This information proves valuable for evaluating patients arriving to a facility at a later time (but who may have left the scene earlier in the response). These patients, then, would require decontamination at the facility, which requires a state of readiness in anticipation that patients will show up after the incident response transitions to recovery.

Guidance Statement 5.7

PPE selection, training, and use should be based on applicable regulations (OSHA[18]), standards (NIOSH[19]), and/or guidance (NFPA[20]), SME recommendation, and manufacturers' specifications, in conjunction with scene evaluation and risk assessment and Authority Having Jurisdiction standard operating procedures or standard operating guidelines.

Considerations:

- PPE selection should incorporate the contingency that responders may conduct lifesaving medical interventions, supportive care, and/or antidote administration for contaminated patients prior to or during the conduct of patient decontamination.
- All respirators used by civilian responders and receivers should be NIOSH-approved.

Level of Confidence: III

Discussion:

Studies on PPE efficacy against a variety of chemical agents and among first responder and receiver communities are well-founded (Myers, 2000; Ziskin et al., 2003). PPE is the last in the line of defense to protect personnel; it typically follows after engineering controls, workplace practices, and administrative controls (OSHA, 2006 – see United States Department of Labor, Occupational Safety and Health Administration, 2006). In a chemical incident, however, these higher in the hierarchy forms of protection may not be immediately available or practical, particularly within the first few hours of a dynamic incident. Therefore, PPE remains the most viable and readily accessible form of protection against chemical agent exposures. In addition, PPE will limit cross contamination from patient to responder.

The OSHA, NIOSH, and NFPA advise a risk-based approach when determining the type and use of PPE. Horton and colleagues (2008) found that the level of PPE and respiratory protection needed by HAZMAT personnel varies greatly and depends on their anticipated work activities. The factors to consider in the selection of PPE include the anticipated substance, toxicity of the substance, potential routes of exposure, degree of contact, and the specific task assigned to HAZMAT personnel. Personnel must be provided with appropriate respiratory and dermal protection specific to the contaminant. Currently, no PPE can protect the wearer from exposure to all possible hazards (NFPA, 2013a). Therefore, responders and receivers must determine the appropriate combination of PPE based on the specific substance and a risk assessment.

A limitation of PPE is the physical, psychological, and communication hindrances to the provider, which may limit the amount and type of care that can be delivered to patients due to reduced dexterity while wearing the equipment. Berkenstadt and colleagues (2003) describe past studies that show emergency medical technicians wearing higher levels of PPE have decreased dexterity. Koenig (2003) also described the physiological burden of PPE to the human wearer and concluded with the importance of creating appropriate PPE guidance that sufficiently protects responders' and receivers' health while allowing them to perform their primary duties. Furthermore, Clarke and colleagues (2008) explained that limitations include the limited lifespan of the respiration filters and the time it takes to replace these filters; rotation of staff members to avoid fatigue and heat exhaustion; and the cumbersome nature of PPE that can cause decreased dexterity and interfere with communication between ED staff and patients. In addition,

[18] OSHA's mission is to assure safe and healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education, and assistance. OSHA HAZWOPER (29 CFR 1910.120) and PPE (29 CFR 1910 Subpart I) regulations can be found at http://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=1&p_keyvalue=1910

[19] NIOSH is a federal public health agency that develops technical performance standards and evaluates respirator technologies and PPE. For additional information regarding NIOSH-approved respirators and PPE, see http://www.cdc.gov/niosh/npptl/

[20] The mission of the NFPA is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training, and education. For additional information regarding NFPA standards for PPE, see NFPA 1991 and 1992 at http://www.nfpa.org/catalog/

other limitations first responders and first receivers will encounter while wearing PPE are limited vision and hearing.

Therefore, PPE requires extensive pre-incident training and regular practice to attain skills, sustain skills, and achieve familiarity with the physical restrictions. During mass patient decontamination, planning and logistical management related to wearing PPE (e.g., decontamination personnel rotations, replacement of air purifying filters, or swapping out of self-contained breathing air tanks) may affect patient throughput; communities should address these issues in response plans.

Guidance Statement 5.8

Scene response and health care facility emergency planners should work with federal, state, and local government officials to ensure any guidance, practices, and plans properly address applicable laws, regulations, and guidance concerning environmental issues, such as the management of liquid and solid wastes, environmental monitoring of decontamination area(s), and other environmental impact issues.

Considerations:

- Environmental concerns need to be subordinate to life-safety concerns.
- Coordination through the Local Emergency Planning Committee (LEPC) or state and local agencies may be necessary.
- Current US Environmental Protection Agency (EPA) guidance suggests decontamination performed for lifesaving operations takes precedent over containing or on-site treatment of water run-off.
- Communication and coordination with wastewater treatment facilities about the contaminant identity, if known, and approximate quantities discharged can help plan these facilities' operations including the protection of their plant personnel.

Level of Confidence: IV

Discussion:

Scientific literature and regulatory guidance point toward the requirements of containing hazardous waste, which includes decontamination run-off. Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986 requires hospitals to participate in community disaster planning for HAZMAT incidents (Cox, 2013). The EPA is charged with carrying out the responsibilities of SARA, Title III, which states that LEPCs must develop community hazardous substance emergency contingency plans to be followed by facility owners, police, hospitals, local emergency responders, and emergency medical personnel.

The EPA (2000 – see United States Environmental Protection Agency, 2000), however, has issued the following statement for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-related activities and enforcement authorities:

During a hazardous materials incident (including a chemical/biological agent terrorist event), first responders should undertake any necessary emergency actions to save lives and protect the public and themselves. Once any imminent threats to human health and live [sic] are addressed, first responders should immediately take all reasonable efforts to contain the contamination and avoid or mitigate environmental consequences. EPA will not pursue enforcement actions against state and local responders for the environmental consequences of necessary and appropriate emergency response actions.

The EPA policy quoted above is based on CERCLA Section 107 (d) (2). However, this protection does not apply in cases where the local government is grossly negligent or intentionally engages in misconduct. Negligence and intentional misconduct are fact-specific determinations (EPA, 2011 – see United States Environmental Protection Agency, 2011). Furthermore, this proclamation does not confer immunity from state environmental regulations. Responder and health care organizations should ensure that they comply with all applicable local, state, and federal regulations. Emergency responders should notify the Federal On-Scene Coordinator (FOSC) through the National Response Center. By involving the FOSC when there is the potential for or actual environmental contamination, responders will reduce potential liability concerns as FOSCs can determine which environmental regulations are applicable (or relevant and appropriate) to the response actions being taken. The FOSC can also provide additional technical

assistance and support or assume the environmental response action, if needed.

The LEPC identifies a local health care facility that has agreed to accept and treat patients of emergency incidents. However, evidence is lacking to show that self-transporting patients are aware of this designation or that they will go to the designated facility even if they are aware (Auf der Heide, 2006). Dealing with contaminated patients requires ED staff to consider key aspects of readiness, including mitigation, preparedness, response, and recovery (Adini et al., 2006). There are numerous historical examples of low percentages of patients arriving at health care facilities via ambulance. They include: 33% of known casualties in the bombing of the Murrah Federal Building, Oklahoma City, Oklahoma in 1995; less than 11% of the patients in the sarin attack, Tokyo, Japan in 1995; and 6.8% of patients injured from the terrorist attack on the World Trade Center, New York City in 2001 (Guttenburg et al., 2002; Hogan et al., 1999; Okumura et al., 1998a, 1998b; Pangi, 2002). Therefore, non-LEPC designated health care facilities should also plan and prepare to treat chemically contaminated patients.

Provisions at the decontamination site should be made to collect wastewater and prevent it from running into sewer drains. This can be accomplished by the use of a portable, outdoor decontamination unit or a dedicated decontamination facility with appropriate ventilation and water containment. This assumes there is either a separate wastewater containment system or sewer system for the health care facility that has the capacity to treat the low concentrations of chemical contaminants. Wastewater can be kept in sealed containers for later disposal. Portable pools can be used for collection, but provisions must be made to prevent access to these prior to removal (Burgess et al., 1999). Despite these efforts, in a large-scale incident, containment of wastewater may be impossible. This issue should be addressed through comprehensive planning that includes local environmental and water authorities, which should result in plans for the management of contaminated materials and equipment that are less subjective and fortified by scientific input. Similarly, solids must be collected and properly stored prior to characterization and disposal. Although lifesaving measures are a priority over requirements for proper decontamination waste containment, responding and receiving organizations should plan to contain and manage decontamination waste as best as possible during an incident.

Functional Area 6: Crisis and Emergency Risk Communication

In Functional Area 6, basic principles of crisis and emergency risk communication are described and strategic recommendations on planning for effective risk communication during a mass exposure chemical incident are provided. Topics include designing messages for various audiences, choosing appropriate spokespeople, coordinating messages from multiple organizations, providing specific instructions for patients on how to decontaminate, and pre-incident public education, among others.

Guidance Statement 6.1

Communication is an essential component of effective disaster management. Crisis and emergency risk communication[21] should be incorporated into all stages of disaster management, so that planning addresses communication before, during, and after an incident. All personnel expected to respond to a mass casualty chemical incident should receive job-appropriate training in crisis and emergency risk communication. Use these best practices for effective communication with the public (World Health Organization [WHO], 2005):

- Build trust;
- Announce early;
- Be transparent;
- Respect public concerns; and
- Plan in advance

Considerations:

- Crisis and emergency risk communication training can be incorporated into existing curricula so as not to increase the training burden on emergency response personnel. However, additional training focused on crisis and emergency risk communication may be appropriate in some cases, such as for personnel expected to serve as a public information officer (PIO) during an incident.
- Effective crisis and emergency risk communication is a learned skill. Personnel at all levels (i.e., from first responders and first receivers up through high-level managers) who will be involved in the response to a mass casualty chemical incident should be trained in effective crisis and emergency risk communication principles.
- CDC's *Crisis and Emergency Risk Communication Quick Guide*[22] provides a brief overview of the principles of effective crisis and emergency risk communication as well as practical guidance and tools for developing a communication plan and specific messages.

Level of Confidence: II

Discussion:

A great deal of empirical evidence is available, including results of case studies of actual incidents, upon which an emphasis on the importance of effective communication to successful disaster management is based. Community members' responses to a disaster can influence morbidity and mortality; in turn, communication with the public can influence their responses. Effective communication enhances the likelihood that at-risk community members will take appropriate protective actions and reassures those at lower risk (Rogers et al., 2007). Many of the cases analyzed in the literature demonstrate the detrimental effects of poor communication on patients and/or community members' behavior or health. An implication of such findings is that improved communication could have led to better outcomes,

[21] Crisis and emergency risk communication is defined by the CDC as "the effort by experts to provide information to allow an individual, stakeholder, or an entire community to make the best possible decisions about their well-being within nearly impossible time constraints and help people ultimately to accept the imperfect nature of choices during the crisis" (CDC, 2012 – see United States Department of Health and Human Services, Centers for Disease Control and Prevention, 2012).

[22] The guide can be downloaded at the CDC website: http://emergency.cdc.gov/cerc/resources/index.asp

though it is perhaps more difficult to demonstrate directly through case studies that good communication positively influences health outcomes. Since empirical evidence relevant to this GS has been reviewed in the literature by numerous experts in the fields of communication, risk management, behavioral health, and others, and is too extensive to cover comprehensively in this discussion, a few example cases are highlighted along with select articles.

- In the 1995 Tokyo sarin attack, passengers on the affected subway trains generally acted calmly and without panic (Murakami, 2000). However, some passengers reported becoming fearful when their calls to emergency services were not answered in a timely manner (Murakami, 2000; Sheppard et al., 2006). A number of factors may have contributed to the nervousness and unease, including: false announcements on trains, news media reports of confusion, chaos and, patients becoming ill, and later, limited information and a lack of openness from officials (Pangi, 2002).
- The CDC received angry feedback from postal workers after they learned they would receive a different antibiotic (i.e., doxycycline) than Congressional members, Congressional staff, and television network employees (i.e., ciprofloxacin) after the mailing of anthrax in letters in the US in 2001. A message explaining the distribution of doxycycline to at-risk postal workers was distributed by the CDC. These communications failed to adequately explain the reason for the different antibiotic distribution. As a result, postal workers expressed perceptions that they were being treated as second class citizens and perhaps being discriminated against (Sheppard et al., 2006; Vanderford, 2003).
- Improved crisis and emergency risk communication potentially could have reduced the intense fear and stress-induced physical effects such as vomiting, diarrhea, blisters, burns and reddening of the skin, as well as longer term negative consequences including discrimination experienced by residents of Goiania, Brazil, at the time of the radiation accident in 1987 (Becker, 2004).
- Perhaps one of the most compelling examples of less than optimal communication leading to detrimental behavior is Israeli citizens dying due to improper use of gas masks during the 1991 Persian Gulf War (Barach et al., 1998). At least 13 people reportedly died from asphyxiation after failing to follow instructions for and demonstrations of proper use of protective masks and infant carriers in response to a missile attack alarm (Hiss & Arensburg, 1992).
- In a study of the types of information desired by the public during a hypothetical attack using plague, subjects predicted that they would be fearful as they learned about the attack and resulting casualties. However, many reported that their fear would be reduced by communication suggesting that emergency responders were responding to the incident. Most subjects said they would seek out information about the attack and use that information to decide what actions to take for themselves and their families. Mass media, local authorities, emergency responders, and medical personnel would serve as key sources of information, with some differences in priority among demographic groups. In general, urban participants indicated they would first seek general information from the national media, then specific information about their community from local media, whereas rural participants would initially look to local health officials, first responders, and civil authorities, followed by mass media (Wray & Jupka, 2004).

These cases illustrate the roles of crisis and emergency risk communication in both instructing people to take appropriate protective actions to benefit their health and safety, and reassuring people and easing their fears when the risk is low. After the 2001 anthrax attacks in the US, effective communication was needed to support the treatment of those determined to be at-risk with antibiotics for post-exposure prophylaxis. In Israel during the Persian Gulf War, precise instructions for the use of respiratory protective devices, a complex activity not without risk itself, was necessary to promote proper use and prevent injury. The cases of the Tokyo sarin attack, the anthrax letters, the radiation accident in Goiania, and the hypothetical plague attack illustrate the need to provide complete, accurate, and timely information, explanations for official actions, and reassurance when appropriate. Gaps in communication, including lack of timely and accurate information, led to intense fear, stress-induced physical effects, and large numbers of people seeking potentially unnecessary medical care.

Motivated by the emergence of severe acute respiratory syndrome (SARS) in 2001, WHO convened a meeting in 2004 to consider the role public communications play in a disease outbreak. Risk communication and public health experts from multiple countries and international organizations reviewed the risk communication literature and their own experiences with outbreak response. Based on the gathered evidence, these experts identified best practices for communicating with the public during a disease outbreak in order to rapidly contain the outbreak while minimizing the disruption to economies and society (WHO, 2005). Although this effort was focused on infectious disease outbreaks, there are no apparent reasons why the following best practices or principles would not apply to chemical incidents or other public health emergencies.

Best practices recommended by the WHO's Expert Consultation on Outbreak Communication (WHO, 2005) are:

- **Build trust.** Trust in the people managing and communicating about an emergency enhances the likelihood that community members will comply with recommended protective actions. It also reduces the likelihood of suspicion that information is being concealed or downplayed and the potential for community members to act on such suspicion. Pre-incident planning presents opportunities to build trust. When emergency managers and community leaders work together, they can establish trusted relationships that will support effective disaster response. With community leaders involved in emergency planning and perhaps, in emergency response, individual community members may be more likely to follow the recommendations made by authorities in an emergency (FEMA, 2011). An organization that actively communicates and responds to concerns through social media outside of emergencies can build a following that will be in place at the time of an emergency. Boston Police Department's use of social media as part of its everyday community policing activities, such as "Tweet from the Beat," may have facilitated effective engagement with the public during the aftermath of the 2013 Boston Marathon bombing (Davis et al., 2014).

- **Announce early.** Communicating with the public about an emergency as soon as possible allows for protective actions to be taken during the effective time window. It also supports confidence and trust that authorities are being honest and forthcoming with the information that they hold. The first message about an incident is often the most important and influences all subsequent communications.

- **Be transparent.** Communication that is candid, easily understood, complete, and accurate provides transparency, which in turn helps to build and maintain trust. Social media can enhance transparency by allowing for timely messages to be disseminated and for photos and videos to help substantiate those messages. During the response to Hurricane Sandy, FEMA posted on its website summaries of the federal government's activities, for example in the form of a timeline and data on various response elements such as deployed personnel, financial assistance approved, and others (DHS Science and Technology Directorate [S&T], 2013 – see United States Department of Homeland Security, Science and Technology Directorate, 2013).

- **Respect public concerns.** The concerns of community members should be considered legitimate and addressed in messages. The community will comprise many different audiences, based on how they are affected by or their roles in managing the incident.

- **Plan in advance.** As much advanced planning as possible should be done in order to avoid rushed efforts that can cause mistakes.

Guidance Statement 6.2

Develop a strategic communications plan for delivering various types of messages during an incident. Prepare as much material in advance as possible: identify message topics and their audiences; write pre-scripted messages; and identify appropriate spokespeople or messengers for each type of message. Communication needs to be coordinated across all organizations so that a single message is spoken with many voices throughout the community.[23]

Considerations:

- Ensure messages are developed for and disseminated to all stakeholders, including:
  - Those who were exposed and need to be decontaminated;
  - Those who may have been exposed but left the scene without being decontaminated or evaluated;
  - Those who were at the scene and have a low likelihood of having been exposed;
  - Those with family members or loved ones who were at the scene;
  - Community members who were not at the scene;
  - Emergency response organizations;
  - Health care providers; and
  - Public health community
- Utilize an authoritative source such as an elected official (e.g., mayor), a public health official, a medical association, or a well-known local physician to deliver messages to the public for strong credibility.
- Social networking sites, which enable people to create digital content and interact with others such that each user can both receive and disseminate information, are powerful communication tools that should be a key element in a strategic communications plan.
- All elements of instruction during an incident should be redundant and interoperable, verbal and non-verbal, and be available in all common languages spoken in the community.
- Communication challenges may include hearing impairment, language barriers, illiteracy, vision impairment, and impairment caused by the chemical exposure itself.
- Communicating information about why decontamination is necessary and how the process will be conducted may increase compliance.
- Give simple, clear instructions using a calm but authoritative voice broadcast through a public address or voice amplification device. It is essential to direct people – expect them not to act quickly and not to panic.
- Patients should be informed of potential health risks to themselves and family members if they neglect recommended decontamination procedures.
- Evidence suggests that panic is not a common response by people involved in a mass casualty disaster. However, psychosocial intervention in the first hours to several months following a disaster that provides the following elements can mitigate social and behavioral distress and dysfunction that may develop over time and can promote recovery (Hobfoll et al., 2007):
  - A sense of safety;
  - Calming;
  - A sense of self- and community efficacy;
  - Connectedness; and
  - Hope
- Integrate behavioral health professionals early in the response to address potential acute stress reaction in patients, as resources allow.

Level of Confidence: II

[23] Practical guidance, example messages, and templates for communicating during the first hours of an incident are available at: http://emergency.cdc.gov/firsthours/index.asp

Discussion:
As with several other guidance statements, the effects of the recommendations made here on patient outcomes may be difficult to test in experimental studies. However, the content above is substantiated by rigorous survey or interview-based research and some by empirical evidence from actual events.

After the 2001 terrorist attacks in the US, CDC funded a series of studies to aid planning for effective communication in CBRN terrorist incidents. Several research teams utilized focus groups and individual interviews to assess the types of information that members of the public wish to receive during such an incident. This was based on the premise that in order to be optimally effective, messages must take into account the recipients' needs and concerns. Experts in the fields of risk communication, behavioral health, and public health have recommended that crisis and emergency risk communications include what members of the public want to know in addition to what government officials want them to know (Rogers et al., 2007; WHO, 2005).

This Pre-Event Message Development Project worked with a total sample size of 1,013 individuals in several different regions of the US. The project gathered data through purposive sampling to provide adequate representation of ethnic groups, urban and rural dwellers, proficiency in the English language, age, socioeconomic status, education level, and gender (Becker, 2004; Glik et al., 2004; Henderson et al., 2004; Wray & Jupka, 2004; Wray et al., 2008). Participants in these studies expressed their desires for information about the nature of the threat, how to protect themselves and their families, and the official response to the situation. Specifically regarding protective actions, they wanted to know how to avoid exposure, recognize symptoms, and treat effects. Furthermore, they wanted as much protective information as possible.

Information needs did not differ among regions of the US or among other sub-groups. Study participants reported that one of the immediate actions they will take is to actively seek information from mass media, local authorities, emergency responders, and medical personnel, which supports the best practice of announcing early. Study results also suggest that people will seek and compare information from multiple sources, substantiating the recommendation that communication be coordinated across organizations so that a single message is delivered, and supporting the utilization of all available messaging channels, including social media, traditional media, and others (DHS S&T, 2013). Inconsistencies will not only cause confusion for the public but can undermine their trust and confidence in the government and other authorities (Wray et al., 2008). Reports on the responses of New York City residents and workers to communications from government officials in the first weeks and months after the September 11 attacks on the World Trade Center illustrate the potential for poor communication practices to create uncertainty and mistrust of authorities among members of the public. Mixed messages were created by the combination of early assurances that the local environment was safe with subsequent guidance that citizens should be cautious with dust and ash, and reports that the environment was causing people to become ill (Lyman, 2003). Once inconsistencies became apparent, several organizations requested access to data on environmental monitoring for health hazards in the area but were denied. This led some people to conclude that authorities were concealing information about dangers to human health (Lyman, 2003).

Members of the public want to know that the information they receive about an emergency is credible. Many participants in the Pre-Event Message Development Project studies stated that they wanted to know the source of the information, so that they can judge credibility for themselves. Some offered examples of respected sources, which included both local and national level authorities: local health, fire and police departments, the CDC, the American Red Cross, the military/National Guard, the President, and other organizations having relevant expertise (Wray et al., 2008). In another study of community responses to a simulated intentional infectious disease outbreak, all participants expressed desire to receive information from additional sources besides federal officials. This reflected their interest in comparing information from varied sources, as well as hearing directly from local public health authorities in particular (DiGiovanni et al., 2003).

A small but growing body of work addresses the best ways to instruct and inform people who need to be decontaminated. From an assessment of the perceptions of 402 participants in field exercises involving mass patient decontamination in the UK, communication problems between responders and patients were common. A majority of the perceived communication challenges fit into one of three themes: instructions were not clear enough, lack of explanation about what the decontamination process involved and why it was necessary, and difficulties understanding responders through PPE (Carter et al., 2012). A subsequent field experiment was designed to assess the effectiveness of various communication strategies used by responders during mass patient decontamination. A strategy that covered health-focused explanations about the decontamination process and included sufficient practical information resulted in the quickest and most efficient progression of participants through decontamination and the fewest instances of non-compliance and confusion. This was in comparison to both a standard practice communication strategy which included sufficient practical information but no health-focused explanations, and a brief communication strategy that contained no health-focused explanations and insufficient practical information (Carter et al., 2014).

The influence of non-verbal instructions on the effectiveness of patient decontamination has been assessed in one experimental study. A pictorial aid was provided to subjects in one group in addition to verbal instructions on what actions a subject should perform for decontamination. The proportion of contaminant (a chemical simulant) removed from these subjects was compared to the proportion removed from subjects who received only verbal instructions. Decontamination effectiveness was not significantly different between the group who had received verbal plus non-verbal instructions and the group who had received only verbal instructions (Amlôt et al., 2010). This result seems counterintuitive and contradictory to the guidance provided here. However, the investigators have provided additional explanatory information in a subsequent article that suggests that the pictorial instructions were misinterpreted, at least by the adult study subjects (Winfield, 2011). In addition, many circumstances and challenges that could arise during a mass patient decontamination incident would seem to warrant the inclusion of non-verbal instructions in a response plan. These include verbal instructions not being available in all languages spoken by patients and difficulty hearing and/or understanding verbal instructions spoken by responders wearing respiratory protection devices (Carter et al., 2012).

The recommendation to expect people not to act quickly and not to panic is based on numerous case studies (Auf der Heide, 1989; DiGiovanni, 2003; Murakami, 2000; Sheppard et al., 2006; Sullivan & Bongar, 2007). First, it is important to be clear about the definition of panic and recognize that fear, anxiety, and a sense of urgency are often appropriate and necessary responses to an emergency, as they can facilitate protective actions, such as evacuation and decontamination, in a timely manner. In the context of an emergency affecting a community, panic is characterized by irrational behaviors, hope of receiving apparently scarce resources, a focus on achieving personal safety rather than assisting others, and contagiousness, in addition to the heightened anxiety and fear of dying associated with panic in other situations (Keating, 1982; Sheppard et al., 2006). DiGiovanni and colleagues (2003) analyzed several natural disasters and concluded that people generally acted with composure and did not exhibit irrational behaviors. The author added a caveat, however, that people might behave differently in terrorist attacks with CBRN agents than in natural disasters. However, four terrorist attacks (the Tokyo sarin attack, the September 11, 2001, New York City World Trade Center attack, the US anthrax letter mailings, and the July 7, 2005, London bombings) were analyzed by Sheppard and colleagues (2006) and it was concluded in all cases that the affected community members generally acted calmly and rationally, rather than with panic. Individuals on the train cars involved in the Tokyo sarin attack and the London bombings reported unity and cohesion among those affected (Sheppard et al., 2006). Others have described the composure exhibited by community members in the Tokyo sarin attack (Murakami, 2000) that was disrupted by slow responses by emergency service personnel and images of chaos and severely ill patients in the news media (Pangi, 2002).

Distinct from the question of how people behave during and in the immediate aftermath of an incident is the issue of relatively longer-term psychological effects of a disaster on the people impacted. Evidence

from actual incidents, including many of the cases mentioned above, suggests that the psychological impact of terrorist attacks, CBRN incidents, or other disasters can be significant, both in terms of the numbers of people affected and the severity of effects (Bleich et al., 1991; Murakami, 2000; Sullivan & Bongar, 2007). The types of symptoms experienced can be described by mass psychogenic illness, acute stress reaction, post-traumatic stress disorder, and other syndromes or disorders (Bleich et al., 1991; Sullivan & Bongar, 2007;). In order to identify tools for mitigating such psychological effects, a large body of empirical evidence was compiled by a panel of experts on the study and treatment of individuals exposed to disaster and mass violence and used to define by consensus a set of evidence-informed psychosocial intervention principles (Hobfoll et al., 2007). The authors recommend that these elements be incorporated into intervention efforts during the short- and mid-term period (i.e., immediate hours to several months) following a disaster or terrorist attack. The principles are: (1) promote sense of safety, (2) promote calming, (3) promote sense of self-efficacy and collective efficacy, (4) promote connectedness, and (5) promote hope. Each of these measures can be addressed at least partially through crisis and emergency risk communication. For example, messages for the public can aim to promote a sense of safety in the face of the bad news broadcast on mass media during a disaster by highlighting the protective actions being taken by responders and local officials. Education about behavioral health responses to disaster, techniques for managing anxiety, signs of severe illness, and sources of professional evaluation and treatment, all of which help to promote calming, can be provided through community outreach.

Self-efficacy and community efficacy, which are directly related to the self-care tier of patient decontamination described in this guidance, can be promoted pre-incident through public education campaigns and during an incident through messages delivered by emergency responders, receivers, public health officials, and other trusted community leaders. Resilient communities encourage perceptions of both self-efficacy and collaborative support of one another during times of need. Hobfoll and colleagues (2007) note that the positive role of social support and connectedness in mitigating stress and trauma is probably the best empirically supported of their five recommended principles, yet there is little evidence suggesting how to apply it for effective intervention in a disaster. This principle is integrated into several parts of the guidance presented here. Keeping families and loved ones together during decontamination and especially keeping children connected (or reconnecting them) with parents or caretakers (GS 2.6 and 5.4) will support the connectedness recommended by Hobfoll and colleagues (2007). Facilitating the reconnection of family members who were in different locations at the time of the incident (Auf der Heide, 1989) as well as reaching out to community members who may be socially isolated or lack strong social support may also allow connectedness to help shape an effective community response to a disaster. Hobfoll and colleagues (2007) emphasized that a sense of hope can be enhanced by many external factors and is not solely an internal attribute held by an individual. They suggest that a community can foster hope by “helping people focus on more accurate risk assessment, positive goals, building strengths that they have as individuals and communities, and helping them tell their story” (Hobfoll et al., 2007).

Over the past few years, social media has begun to be integrated into public agencies’ operations. Its use in recent disasters has also been documented and analyzed, with some evidence of its effectiveness in management of the incident as well as needs for improvement (Davis et al., 2014; DHS S&T, 2012, 2013). Social media serves as a source of information from the public that can be used to build situational awareness, gauge public sentiment, and identify needs, gaps in information, and misinformation. It is a means of quickly disseminating information in an easily digestible format. A growing proportion of the public obtains real-time information and guidance through social media during emergencies; trusted and verified accounts often gain significant numbers of followers. However, additional research is needed to identify optimal strategies for applying social media tools to manage a mass exposure incident and in particular, an incident in which mass patient decontamination is conducted.

Guidance Statement 6.3

Public education can be achieved by using naturally occurring opportunities to communicate patient decontamination goals; potential practices; responsibilities of responders, receivers, and patients; and expected outcomes. A strategic plan for pre-incident communication to enhance community preparedness should be developed to include information about patient decontamination in community outreach by fire service and EMS organizations, public service announcements, and other planned events.

Considerations:

- Prioritize communities that are at-risk (e.g., due to the presence of an industrial site or a transportation route) for messaging tailored to the community's specific hazards.
- Integrate pre-incident communication about patient decontamination into ongoing efforts by the chemical industry and other organizations (e.g., LEPC, Transportation Community Awareness and Emergency Response [TRANSCAER]).
- Public interest in learning about and preparing for rare hazardous materials incidents may be low. Some communities may decide that it would be more efficient to prepare public messages for dissemination at the time of an incident rather than to engage in a pre-incident public education campaign.

Level of Confidence: V

Discussion:

From the perspective of an individual living in the US, hazardous materials incidents are rare; the likelihood that an individual will be involved in or affected by such an incident is relatively low. According to the Pipeline and Hazardous Materials Safety Administration (PHMSA) of the US Department of Transportation (DOT), during the ten years of 2003-2012, there were 159,411 hazardous materials incidents in the US by all modes of transportation, resulting in 129 deaths and 2,690 injuries (PHMSA, 2013 – see United States Department of Transportation, Pipeline and Hazardous Materials Safety Administration, 2013). Therefore, it is not surprising that members of the public are generally not well informed about hazardous materials. The CDC's Pre-Event Message Development Project found that study participants had limited understanding of CBRN agents or the differences between categories of agents (e.g., infectious vs. non-infectious) (Wray et al., 2008). Pre-incident education could improve the public's understanding of hazardous materials, what to expect from responders, receivers, and officials during a response, and what they can do to protect themselves and their families. In turn, the increased knowledge and enhanced understanding among the public can improve the potential for an effective response in an actual incident by promoting appropriate protective actions.

A study of the impact of public education programs on the public's preparedness to respond to a chemical terrorist incident in the UK and in Israel suggests that the rates of uptake and assimilation of the information were relatively low (Hildebrand & Bleetman, 2007). Thirty-three percent of respondents in the UK and 22% in Israel reported reading the educational booklet provided to all citizens. Large percentages of respondents in both countries (i.e., 41% in the UK and 33% in Israel) stated that they would not wait for emergency services to arrive at their location; rather, they would travel to or call a hospital for help. These actions would be contrary to what was recommended in the educational booklet and could undermine the local emergency response. However, as noted in other parts of this guidance document, if response organizations are prepared for some affected community members to self-evacuate and self-present at a health care facility, then the community's overall response will not necessarily be undermined. Furthermore, perhaps improved education and awareness among even a small percentage of a population can be considered a partial success.

The influence of a pre-event public education campaign on the effectiveness of a response to a chemical

or hazardous materials incident (e.g., using health outcomes or protective actions by the public or some other measure of effectiveness) has not been studied. This would require measuring disaster response effectiveness before and after a public education campaign in the same community or comparing disaster response effectiveness in two similar communities, one of which had conducted a public education campaign and one of which had not. Public health practitioners use public education campaigns regularly to promote healthy behaviors, with demonstrated success in areas of high-prevalence, high-risk behaviors such as smoking cessation and the prevention of HIV transmission. However, the extension of such public health successes to preparedness for low probability events such as a hazardous chemical release is questionable.

Community resilience depends on informed, empowered, and prepared community members. This requires education, two-way communication, and collaborative planning. HHS and FEMA both recommend that significant pre-incident work be conducted on an ongoing basis to engage the whole community in emergency planning. Communities should leverage existing programs and events while also initiating additional activities focused on emergency preparedness (FEMA, 2011; HHS, 2012).

This GS acknowledges that the available evidence suggests the time and attention of the public are limited, especially for topics that they perceive as low risk to themselves. Additionally, the time and other resources of emergency response and public health organizations are limited. Some SMEs are skeptical that the cost/benefit ratio for pre-incident public education about chemical incidents is favorable. The study described above (Hildebrand & Bleetman, 2007) also casts some doubt on the potential for educational material to significantly increase preparedness. These factors are reflected in the low LOC assigned to this GS. Further, the GS emphasizes efficiency; education about hazardous materials, patient decontamination, and protective actions associated with both self and community efficacy should be incorporated into community outreach efforts and planned events in ways that make best use of opportunities to engage with the public.

Guidance Statement 6.4

To facilitate effective two-way communication during and after an incident:

- Provide patients with pre-scripted and printed follow-up information before they leave the scene or prior to discharge from the health care facility.
- Obtain patient contact information prior to release from the health care facility to allow for follow-up by public health officials.
- Establish an easily accessible mechanism for patients to obtain additional information or advice and for authorities to respond directly to patients' questions or comments.
- Provide follow-up information for other community members who were either at the scene and not decontaminated or not at the scene.

Considerations:

- Develop follow-up information in consultation with appropriate medical, technical, behavioral health, and crisis and emergency risk communication experts.
- Include instruction sheets in the most common languages used in the community; confirm that translations use proper syntax.
- This information should be accessible electronically and through multiple mechanisms or locations.
- Engage the public health community, poison centers, and other community resources to help coordinate delivery of patient follow-up information and develop a patient registry for further communication.
- The ATSDR *Medical Management Guidelines for Acute Chemical Exposures* include a printable Patient Information Sheet and Follow-Up Instructions for dozens of specific chemicals as well as guidance for responders and receivers treating patients exposed to an unknown chemical. [24]
- All medical information disseminated to patients and community members must have a consistent message that is easy to understand and that can be coordinated across the entire response.

Level of Confidence: III

Discussion:

Providing written, in addition to verbal, follow-up or discharge instructions to patients is common medical practice and has been shown to increase patient compliance with medical recommendations compared to verbal instructions alone. Preparation of patient follow-up information in advance of an incident allows for thorough review and input by medical experts and enhances preparedness. The printable Patient Information Sheets and Follow-Up Instructions available on ATSDR's website have been developed by experts in medicine and toxicology and are regularly reviewed and updated.

The CDC's Pre-Event Message Development Project, which conducted over 1000 individual and group interviews, found that study participants would actively seek information about how to protect their health and that of their families in a CBRN terrorism incident (Wray et al., 2008). In the study of a hypothetical plague attack, participants reported that after initially seeking information from local and national authorities, over time, they would use the internet and newspapers to find more in-depth information (Wray & Jupka, 2004). Therefore, the internet and newspapers could be used to disseminate follow-up and provide additional information to patients and other community members as the incident, response, and recovery proceed. The same mechanisms could provide means for collecting and responding to patients' and community members' questions and comments.

[24] Available at: http://www.atsdr.cdc.gov/mmg/Index.asp

Obtaining patient contact information allows for additional medical or other information related to the incident to be communicated to patients later, if necessary. Most importantly, such communication should address patients' physical, behavioral, and mental health needs. Additionally, data on the impacts of the incident and the effectiveness of countermeasures can be collected through post-event communication. Assessment of patients exposed to sarin vapors in the 1994 Matsumoto and the 1995 Tokyo attacks in Japan has led to documentation of acute and long-term health effects as well as data on the efficacy of medical interventions (Yanagisawa et al., 2006). This type of analysis provides information on the effects of hazardous materials on human health that is difficult to obtain, helps to fill in significant knowledge gaps, and can be used to improve emergency preparedness and response.

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Appendix A: Working Group Charter and Membership; Symposia Participants

Mass Human Chemical Decontamination Working Group
Subcommittee on Standards-CBRNE
Committee on Homeland and National Security
National Science and Technology Council

Background

Chemical attacks perpetrated by terrorists and accidental releases of toxic industrial chemicals are recognized as current threats to public health in the United States. Both types of events can potentially expose significant numbers of people to dangerous chemicals that would overwhelm local response capabilities. Patient decontamination, when performed using appropriate techniques and during the appropriate time frame, limits patient exposure and the toxicity that follows as well as protects responders in the field and in the hospital setting from secondary contamination. Therefore, patient decontamination is an integral component of the medical response to a chemical incident. Patient decontamination also impacts the flow of casualties at many levels of a mass casualty chemical incident, meaning that decisions about decontamination will impact the entire emergency response. Thus various aspects of patient decontamination are of interest to multiple responder agencies, such as fire/HAZMAT, emergency medical services, hospitals, public health, and emergency preparedness.

Patient decontamination plans and procedures have evolved over time with only limited guidance based on scientific evidence; many basic questions about decontamination have not yet been addressed by research. Evidence-based planning and best practices are thus limited. For example, attempting to fully decontaminate every person in the vicinity of a chemical release will slow the transport of seriously ill patients from the scene to hospitals. In this case, inappropriate decontamination protocols might hamper, rather than contribute to, medical mitigation of morbidity and mortality. In addition, past chemical incidents demonstrate that scene perimeters will not be established quickly enough after the release to prevent a large number of people from leaving the scene. These potentially exposed people will show up at hospitals or other facilities without being decontaminated. Health care facility chemical incident response plans should address such scenarios. The recent closure of two St. Louis hospital emergency departments due to suspected secondary contamination of the facility from exposed patients illustrates the need for scrutinizing the patient decontamination process.

Homeland Security Presidential Directive-22, Domestic Chemical Defense, calls for the federal government to support the development of state and local plans and protocols for the decontamination of persons. In order to best accomplish this task, the Federal government, through the Mass Human Chemical Decontamination Working Group (WG), will attempt to ensure that those State and local plans and protocols reflect current best practices. The WG will also identify decontamination issues in need of research and draft a strategic plan for addressing such research gaps.

Purpose

The WG will assess the current state of capabilities and the current knowledge base regarding patient decontamination practices and technologies. Recommendations will then be made as to how the federal government could facilitate improvements in these areas.

Scope

The WG will address a variety of issues including operational analysis and research, technology research and development, emergency preparedness planning, education, training, exercises, and assessments.

Objectives

- Prepare a strategy that addresses the following (estimated timeline: 1 year from 1st meeting):
  - Review national standards of care for mass casualty human decontamination, compare and contrast differing standards and assemble a gap analysis;
  - Provide an assessment of current human decontamination education, training, exercises, and assessments for fire, EMS, and health care systems;
  - Perform a literature review of patient decontamination research, identify current research activities, and describe research questions that need to be addressed;
  - Establish Concept of Operations (CONOPS) for mass decontamination after chemical exposure;
  - Assess decontamination solutions;
  - Evaluate current decontamination solutions (e.g., soap & water, dilute bleach, RSDL®) for effectiveness/feasibility/cost/barriers and safety (e.g., intact skin, eyes, open wounds, prolonged contact, environmental run-off);
  - Define role of each solution in CONOPS;
  - Develop optimizing strategies for decontamination that may be employed recognizing constraints in equipment, training, time, and capability at local response levels and provide proposals for evaluation and validation. Proposed strategies will consider current capabilities and time constraints for mass casualty decontamination.
  - Define metrics for mass patient decontamination after a chemical exposure; and
  - Provide WG recommendations to Target Capabilities Working Group
- Implement plans to address highest priority areas (estimated timeline: year 2 and beyond).

Reporting structure

The Mass Human Chemical Decontamination Working Group reports to the Subcommittee on Standards-CBRNE, under the Committee on Homeland and National Security of the National Science and Technology Council within the Executive Office of the President. The WG also works closely with the White House National Security Council (NSC) staff through the Domestic Chemical Preparedness and Response Sub-Interagency Policy Committee.

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Additional subject matter experts are invited as necessary. The WG may interact with and receive ad hoc advice from various non-federal persons and entities, provided such interactions occur in a manner that maintains the WG's status as compliant with the Federal Advisory Committee Act.

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Appendix B: Lexicon

Terms defined here to apply to civilian incidents

The WG developed a lexicon of terms applicable to decontamination of people in a mass exposure incident. These definitions are either modifications of other definitions or new, and include the concept that any individual who may be contaminated and should be evaluated for decontamination is a patient. The new lexicon is an attempt to standardize terms and promote use of common language by stakeholders across organizations to describe patient decontamination activities.

General Definitions
Contaminant: Any hazardous chemical (solid, liquid, or gas) that is capable of causing harm to life or health and found in the area around the person, internally, or on the person's body or clothes.
Evidence-based Guidance: As applied in this guidance document, evidence-based refers to the conscientious, definitive, and judicious use of current scientific evidence and/or sound technical input from subject matter experts in developing patient decontamination recommendations for the care of patients, both individually and in a mass casualty chemical incident, in order to save lives and mitigate adverse health effects (Sackett et al., 1996).
First Responder: An appropriately trained member of a response organization dispatched to the incident scene for purposes of incident management • Examples: fire and rescue services, emergency medical services, HAZMAT technician, law enforcement officer
First Receiver: An appropriately trained member of a hospital or other health care facility who may encounter and work with contaminated or potentially contaminated patients from a hazardous materials incident • Examples: member of hospital decontamination team, emergency department personnel, security officer
Patient: The WG identified the term patient to represent any individual who may require decontamination. In this guidance document, a "patient" is defined as: Any individual who was at or near the location of a hazardous materials release and who was potentially exposed and therefore potentially contaminated and may require some form of care (e.g., decontamination, lifesaving interventions, antidotal therapy, supportive medical care, communication, reassurance). • Not all patients will require follow-on treatment or evaluation at a health care facility. • Some patients will leave the incident prior to responders arriving (i.e., self-evacuation). • Some individuals, who were not at or near the scene, are not likely to have been decontaminated, or may not require any medical assistance, may still present for evaluation and treatment up to and including requesting decontamination (see GS 1.1). This definition does not imply that all decontamination will be conducted by hospital or medical personnel, and does not imply that by conducting decontamination the patient must be transported to or evaluated in a health care facility.
Patient Decontamination: Any process, method, or action that leads to a reduction, removal, neutralization – by partitioning or binding (as opposed to chemical neutralization, which is not recommended; see GS 2.11) - or inactivation of contamination on or in the patient in order to: prevent or mitigate adverse health effects to the patient; protect emergency first responders, health care facility first receivers, and other patients from secondary contamination; and reduce the potential for secondary contamination of response and health care infrastructure.

Patient Decontamination Prioritization: Any method used by responders or receivers in an effort to ensure that patients who have a higher relative risk of contamination or are in a higher medical triage category are decontaminated ahead of lower risk patients or those with a lower medical triage category. This may be part of the broader triage effort used to determine medical needs.
Spot Decontamination: As opposed to decontamination of the entire body, spot decontamination involves the removal of visible contamination from small areas of exposed skin (e.g., limited areas to include hands, face, or portion of the arm or leg). This technique may be water-based or utilize an alternative decontaminant (e.g., RSDL®).

Patient Categories
Ambulatory: Patients who can walk without assistance or with minimal assistance, follow responder or receiver directions, and conduct certain decontamination tasks without assistance from responders or receivers (e.g., remove clothing). These patients may include: minor to moderately wounded (e.g., ocular injuries, lacerations, breaks, or strains); members of at-risk populations (e.g., pediatrics, sight and/or hearing impaired, elderly); and patients with minor symptoms of the chemical exposure. Some patients in this category may require buddy-help or responder/receiver assistance to complete the decontamination procedure.
Non-ambulatory: Mobility-impaired (e.g., stretcher- or wheelchair-bound) patients. This category of patient may require response personnel to complete decontamination actions with limited, if any, assistance from the patient. • Decontamination of these patients is very resource and time intensive and typically requires specialized equipment (e.g., rollers, chemical resistant backboards). • Additional personnel may be required to decontaminate a single non-ambulatory patient.

Descriptors of Scale
Individual Patient Decontamination: Decontamination activities conducted for a single contaminated patient. These activities should almost always fall within the resource and capacity limitations of the properly prepared responding or receiving organization.
Mass Patient Decontamination: Decontamination activities conducted for a large number of potentially contaminated patients, which may exceed the typical response capacity of an organization, may require additional resources or personnel, and requires that patients be prioritized for the decontamination process. Mass decontamination generally requires much higher levels of resource coordination than multi-patient or individual decontamination situations. The number of patients that constitutes mass decontamination is dependent on the jurisdiction, responding agency, and capacity.
Multi-Patient Decontamination (Resource Sufficient): Decontamination activities conducted for multiple contaminated patients in a situation in which resources are not limiting. Requests for additional resources or assistance should not be required for this level of decontamination. The number of patients that constitutes multi-patient decontamination is dependent on the jurisdiction, responding agency, and system capacity.

Tiers of Patient Decontamination
Self-Care: Actions that a patient can perform for him/herself, including distancing him/herself from the site of release, removing clothing, and wiping visible contamination from skin and clothing in order to reduce his/her own contamination level immediately, without waiting for a formal decontamination process to be set up. A perceptive patient or one experiencing acute distress from the chemical contamination may execute self-care even before responders arrive; however, most patients will need instructions.
Gross Patient Decontamination: Actions likely to be performed by or with the assistance of first responders or first receivers in order to achieve a gross or hasty reduction in contamination, significantly reducing contamination on skin or clothing, as soon as possible after contamination has occurred.
Technical Patient Decontamination: Planned and systematic actions, likely to be performed under the guidance of, or with the assistance of, first responders or first receivers, to achieve contamination reduction to a level that is as low as possible.

Previously Defined Terms

Acute Stress Reaction: An anxiety disorder precipitated by an experience of intense fear or horror while exposed to a traumatic (especially life-threatening) event. The disorder is characterized by dissociative symptoms; vivid recollections of the traumatic event; avoidance of stimuli associated with the traumatic event; and a constant state of hyper-arousal which lasts at least two days and no longer than four weeks. If symptoms of acute stress disorder persist for greater than one month, a diagnosis of post-traumatic stress disorder is more appropriate. (For more information, see Bryant et al., (2011), and Diagnostics and Statistics Manual V.)

At-Risk Populations:[25] Those who have needs in one or more of the following functional areas: communication, medical care, maintaining independence, supervision, and transportation. At-risk groups may include children, senior citizens, and pregnant women, as well as people who have disabilities, live in institutionalized settings, are from diverse cultures, have limited English proficiency or are non-English speaking, are transportation-disadvantaged, have chronic medical disorders, or have pharmacological dependency.

Authority Having Jurisdiction:[26] The public agency or its delegate that has legal responsibility and authority for responding to an incident, based on political or geographical (e.g., city, county, Tribal, State, or Federal boundary lines) or functional (e.g., law enforcement, public health) range or sphere of authority.

Crisis and Emergency Risk Communication: The effort by experts to provide information to allow an individual, stakeholder, or an entire community to make the best possible decisions about their well-being within nearly impossible time constraints and help people ultimately to accept the imperfect nature of choices during the crisis (CDC, 2012).

Evidence-based Guidance: As applied in this guidance document, evidence-based refers to the conscientious, definitive, and judicious use of current scientific evidence and/or sound technical input from subject matter experts in developing patient decontamination recommendations for the care of patients, both individually and in a mass casualty chemical incident, in order to save lives and mitigate adverse health effects (Sackett et al., 1996).

[25] Note that this term is used throughout the document and is representative of all similar terms to include: special needs, vulnerable populations, and access or functional needs. The use of this term is consistent with the Pandemic and All-Hazards Preparedness Act of 2006 (PAHPA), Pub. L. No. 109-417 (Dec. 19, 2006). This definition can be found on the HHS/ASPR website at: http://www.phe.gov/Preparedness/planning/abc/Pages/atrisk.aspx

[26] As defined by the HHS in the PREP Act, Declaration for Pandemic Flu (2009).

Appendix C: Toxic Chemical Syndrome Lexicon[27]

Introduction

Military and civilian emergency response communities use a "toxic syndrome" (toxidrome) approach to quickly assess victims and determine the best immediate treatment when information on chemical exposures is limited. Toxidromes provide a common language to describe and recognize the clinical manifestations of toxic chemical exposures which can be defined by a unique group of clinical observations, such as vital sign abnormalities, mental status, pupil size, mucous membrane irritation, and lung and skin examinations. Once the toxidrome is recognized, emergency responders and hospital first receivers can consider a list of chemicals, exposure to which may manifest that toxidrome, as possibly causing the incident at hand. The US Department of Health and Human Services (HHS) National Library of Medicine (NLM) provides comprehensive, user-friendly, web-based resources for first responders and hospital first receivers. Chemical Hazards Emergency Medical Management (CHEMM) and Wireless Information System for Emergency Responders (WISER) provide lists of potential chemicals that align with specific toxidromes.

The Department of Homeland Security (DHS) Office of Health Affairs (OHA), with the National Library of Medicine, sponsored a technical workshop on May 8-9, 2012, to discuss and develop a consistent lexicon to describe toxic chemical syndromes or toxidromes.[28] The goal aimed at consensus on a list of syndromes, their definitions, and designated syndrome names to establish a common language for chemical defense planners, policy makers, first responders, first receivers, and hazardous materials (HAZMAT) stakeholders. The syndrome list aims to provide this common lexicon to assist key stakeholder communities in quickly and accurately identifying the broad chemical agent category (if not the specific chemical agent type involved) by which a patient was exposed in order to rapidly determine appropriate emergency treatment. Comprehensiveness, accuracy, and clear understanding of the lexicon served as the primary criteria in developing this lexicon.

Background

Tens of thousands of chemicals are harmful to humans and knowing the specific toxic effects of even a large portion of the possible chemical agents would be an impossible task. Toxic chemicals can often be grouped into classes, whereby all the chemicals in a given class cause similar types of adverse health effects. These constellations of toxic effects or syndromes comprise a set of clinical "fingerprints" for groups of toxins. Moreover, all the toxic chemicals associated with a given toxic syndrome are treated similarly. Hence, during the early phases of a toxic chemical emergency, when the exact chemical is often unknown, identification of the toxic syndromes that are present can be a useful decision making tool that can overcome many of the problems associated with the lack of information on chemical identity.

Toxic syndromes are easily identified with only a few observations, such as:

- Vital signs;
- Mental status;
- Pupil size;
- Mucous membrane irritation;
- Lung exam for wheezes or rales; and
- Skin for burns, moisture, and color

Toxic syndrome recognition is important because it provides a tool for rapid detection of the suspected cause and can focus the differential diagnosis to consideration of only a few chemicals with similar toxic effects. By focusing on certain chemicals, specific diagnostic testing and empiric therapies can be

[27] The information contained in this appendix is copied from the workshop summary from the Toxic Syndrome Workshop co-sponsored by DHS/OHA and NIH/NLM, held May 8-9, 2012.

[28] Workshop attendees agreed that the terms toxic syndrome and toxidrome can be used interchangeably as toxidrome is a contraction of "toxic syndrome."

rendered based on objective clinical evidence. Specifically, during a mass exposure, recognition can provide a triage tool for identifying toxic effects and also provide a common "language" so that all personnel, from emergency responders on the scene to the hospital emergency department, can clearly communicate a clinical message (Table C-1). With the extraordinary number of chemicals in use, this tool does not apply to every chemical but to most of the commonly encountered chemicals reported in HAZMAT incidents. The use of toxic syndromes as a diagnostic tool is fundamental to an effective and timely medical response.

Table C-1: Toxidrome Names and Descriptions

Toxidrome	Description
Topical Irritant/Corrosive	Immediate effects range from minor irritation to severe skin, eye, and mucosal membrane effects, which may progress to rapid systemic toxicity.
Inhalation Irritant/Corrosive	Immediate effects to the respiratory/pulmonary tract presenting as respiratory distress, coughing, wheezing, and/or nasal and oral secretions, which may progress to rapid systemic toxicity.
Oral Ingestion Irritant/Corrosive	Immediate effects to the oropharynx and gastrointestinal (GI) tract presenting as burns, nausea, vomiting, diarrhea, and drooling, which may progress to rapid systemic toxicity.
Knockdown/ Asphyxiants	Altered state of consciousness, progressing from fatigue and lightheadedness to coma, with possible seizures and cardiac signs, secondary to disrupted cellular oxygen delivery and/or utilization.
Anticoagulants	Alteration of the blood coagulation that results in abnormal bleeding, indicated by excessive bruising, bleeding from mucous membranes, and longer bleeding from other soft tissue trauma.
Cholinergic	Overstimulation of cholinergic receptors leading to first activation and then fatigue of target organs, leading to pinpoint pupils (miosis), seizing, wheezing, muscle twitching, as well as urination, bronchorrhea, and copious secretions (e.g., tearing, runny nose, salivation).
Cellular-Asphyxia (Cyanide-like)	Inability to use oxygen, leading to acute-onset gasping, convulsions, loss of consciousness, breathing cessation, and cardiac arrest.
Convulsant	CNS disinhibition or excitation (e.g., glycine or GABA antagonism, glutamate agonism) leading to generalized convulsions.
Opioid	Opioid agonism leading to pinpoint pupils, and central nervous system (CNS) and respiratory depression.
Stress-Response/ Sympathomimetic	Stress- or toxicant-induced catecholamine excess or CNS excitation leading to confusion, panic, and increased pulse, respiration, and blood pressure.
Anticholinergic	Under-stimulation of cholinergic receptors leading to dilated pupils (mydriasis), decreased sweating, elevated temperature, and mental status changes, including characteristic hallucinations.
Acute Exposure to Solvents, Anesthetics, or Sedatives	Decreased level of consciousness (progressing to coma in some cases), depressed respirations, and in some cases ataxia (difficulty balancing and walking) from acute exposure to solvents, inhalational anesthetics, or sedative-hypnotic compounds.

Appendix D: Level of Confidence (LOC) Ratings

Purpose

A formal process for evaluating and scoring the quality and quantity of evidence to substantiate each Guidance Statement (GS) was established by the Mass Human Chemical Decontamination Working Group (WG).

Background

A Level of Confidence (LOC) score for each GS reflects the WG's expert judgment of the strength of evidence underpinning the recommendation. The LOC is not a value judgment. The LOC is also not a measure of appropriateness of a given practice: the circumstances of a particular chemical incident and aftermath determine the proper course of action for successful patient decontamination. A recommendation of LOC IV or V (relatively low on this scale) may save lives every day even if strong scientific evidence to substantiate it is not available. Rather, the LOC represents the strength, breadth, quality, and quantity of evidence (including scientific literature, current guidance and best practice documents, and subject matter expert (SME) input) supporting a particular recommended practice.

Rating scale

Three main sources of knowledge were used together to establish a rating scale that helps to distinguish guidance statements based on the strength of the supporting evidence: published literature, current practice, and SME opinion and experience.

Definitions

Literature quality – A published article was assigned one of the following quality levels:

A = strong clinical (human or trial data) or field research supports study's conclusions;

B = strong basic science (*in vitro* or *in vivo* models) research supports study's conclusions; or an uncontrolled study, field report of an actual response, or findings from an exercise; and

C = consensus panel recommendations when not based on original research; or review of other studies, editorial, or opinion paper

Current practice – A specific principle or operational element is considered current practice if it is supported in two or more of the previously published guidance or best practice documents included in the crosswalk analysis (for more information, see Methodology section).

SME consensus - Defined as a group decision making process that seeks the consent, not necessarily the agreement, of participants and the resolution of objections. For the 2012 Symposium, consensus was achieved through one of the following results:

- Strong consensus – Two-thirds or more of the participating reviewers all vote, in writing, in support of the particular GS
- Simple consensus – 50% or more of the participating reviewers all vote, in writing, in support of the particular GS

LOC ratings definitions

LOC I - The highest recommendation is supported by strong scientific evidence, including clinical or field research, in addition to current practice and strong SME consensus.

- Substantiated by strong scientific literature (including at least one Level A article)
- Current practice
- Strong SME consensus

LOC II - The second tier recommendation is supported by some scientific evidence which is not definitive or where methodological problems limit the utility of the stated conclusions, but which is current practice, and for which there is strong SME consensus.

- Substantiated by adequate scientific literature (>three Level B articles)
- Current practice
- Strong SME consensus

LOC III – The third tier recommendation is one for which very limited scientific literature is informative, but for which there is precedent in current practice and for which there is simple SME consensus.

- Substantiated by limited scientific literature (at least one Level B article)
- Current practice
- At least simple SME consensus

LOC IV- The fourth tier recommendation is supported by at least simple SME consensus and current practice but little or no scientific literature.

- Substantiated by very limited scientific literature (no Level A or Level B evidence)
- Current practice
- At least simple SME consensus

LOC V - The fifth tier reflects an absence of literature and precedent; SME consensus forms the sole basis for the recommendation.

- No Level A, B, or C articles
- Not a current practice
- At least simple SME consensus

The WG contends that to varying degrees, additional primary research (basic, epidemiological, clinical trial, or observational) is needed for all of the present guidance statements. Additional study could validate a particular recommendation, and its LOC might therefore rise. Additional research may also lead to the conclusion that a particular practice is not scientifically supported, in which case its LOC would fall and the recommendation would be reconsidered. The LOC score reflects the current state of evidence on which a GS is based. Any GS in this document may be amended as science leads to better understanding of the best practices for mass patient chemical decontamination.

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