Under contract to the U.S. Department of Homeland Security (DHS), American College of Medical Toxicology (ACMT) Subject Matter Experts (SMEs) reviewed this report and accompanying comments which were submitted by the 2012 Workshop participants provided in follow-up to the meeting. Following an iterative discussion of the nature, scope, and specific content of the participant stakeholder comments, the original 2012 DRAFT workshop document was edited to incorporate these subsequent comments and discussions. These edits were reviewed and approved by DHS Office of Health Affairs' Chemical Defense Program, and have been incorporated into this updated workshop report. The 23 pages of this report represent updated Sections 1 and 2 of the 2012 Draft document. These edits involved:

1) Consolidating the initial 12 toxidromes from the Workshop's breakout activities into a final total of 9; with the 3 routes of exposure (inhalation, ingestion, dermal) described within the single "Irritant/Corrosive" toxidrome;
2) Combining the "Cyanide-like" and "Knockdown Agents" into a single toxidrome: "Knockdown" and;
3) Expanded narrative to the toxidrome descriptions.

A detailed memo about specific changes is available from the CHEMM project team.

Report on the Toxic Chemical Syndrome

Definitions and Nomenclature Workshop

May 8-9 2012

Homeland Security

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Report of the Toxic Chemical Syndrome Definitions and Nomenclature Workshop May 8-9, 2012

Submitted to: National Library of Medicine and Department of Homeland Security

Submitted by: Toxicology Excellence for Risk Assessment

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List of Acronyms

AHLS – Advanced Hazmat Life Support program

ALS – Advanced life support

BLS – Basic life support

CHEMM – Chemical Hazards Emergency Medical Management

CHEMM-IST – Chemical Hazards Emergency Medical Management Intelligent Syndromes Tool

CNS – Central nervous system

CSAC – Chemical Security Analysis Center

CTRA – Chemical Terrorism Risk Assessment

CWAs – Chemical warfare agents

DHS – Department of Homeland Security

EMTs – Emergency medical technicians

F&ES – Fire and Emergency Services

GI – Gastrointestinal

Hazmat – Hazardous materials

HHS – U.S. Department of Human and Health Services

HPV – High Production Volume

HSDB – Hazardous Substances Data Bank

NICC – National Interagency Coordination Centers

NIOSH – National Institute for Occupational Safety and Health

NLM – National Library of Medicine

NOC – National Operations Center

OHA – Office of Health Affairs

PNS – Peripheral nervous system

SAS – Solvents, Anesthetics, or Sedatives

SLTT – State, Local, Tribal and Territorial

SME – Subject matter expert

SOCs – Support and Operations Centers

TERA – Toxicology Excellence for Risk Assessment

TICS – Toxic industrial chemicals

TIMS – Toxic industrial materials

WISER – Wireless Information System for Emergency Responders

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1. Introduction

The Department of Homeland Security (DHS) Office of Health Affairs (OHA), with the National Library of Medicine (NLM), sponsored a technical workshop on May 8-9, 2012 to discuss and develop a consistent lexicon to describe toxic chemical syndromes, or toxidromes[1]. The workshop goal was to reach 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) 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.

Over forty people participated in the workshop, including first responders, first receivers, medical directors, trainers, and subject matter experts (SMEs) in emergency medicine, emergency response, and medical toxicology. Participants were from civilian and military agencies, universities, hospitals, and emergency response entities.

A workshop organizing committee conducted extensive literature reviews of current toxic syndromes and developed proposed criteria and syndromes to serve as a starting point for the workshop discussions and consensus building. Workshop participants reviewed these materials and provided written comments prior to the workshop. The Workshop Organizing Committee shared comments with participants and used the valuable input to structure the workshop discussions and process.

The workshop was highly interactive to fully utilize the experience and knowledge of the participating subject matter experts. The first day focused on discussing and agreeing upon key components and issues related to toxic syndrome definitions and nomenclature. The participants then divided into three breakout groups to discuss and reach agreement on specific syndrome definitions and nomenclature. The breakout groups reported back to the larger group on the second afternoon with proposed syndromes and definitions. This report provides an accurate record for the workshop participants and will serve as a reference for the next phases of Toxidrome Lexicon development.

1.1 Workshop Organizing Committee

A committee comprised of DHS/Office of Health Affairs (OHA), NLM and Toxicology Excellence for Risk Assessment (TERA) scientists organized the workshop. Members included:

- Dr. Mark Kirk, Division of Medical Toxicology, Department of Emergency Medicine, University of Virginia
- Capt. Joselito Ignacio, Department of Homeland Security

[1] Workshop attendees agreed that the terms toxic syndrome and toxidrome can be used interchangeably as toxidrome is a contraction of "toxic syndrome." See Discussion for further explanation.

- Jen Pakiam, National Institutes of Health, National Library of Medicine
- Hillary Sadoff, Best Value Technology Inc., contract support to the Department of Homeland Security
- Michael Carringer, Best Value Technology Inc., contract support to the Department of Homeland Security
- Dr. David Siegel, National Institutes of Health, National Institute of Child Health & Human Development
- Dr. Pertti (Bert) Hakkinen, National Institutes of Health, National Library of Medicine
- Florence Chang, National Institutes of Health, National Library of Medicine
- Stacey Arnesen**,** National Institutes of Health, National Library of Medicine
- Dr. Andrew Maier, Toxicology Excellence for Risk Assessment
- Jacqueline Patterson, Toxicology Excellence for Risk Assessment
- Dr. Sue Ross, Toxicology Excellence for Risk Assessment (Fellow)
- Oliver Kroner, Toxicology Excellence for Risk Assessment

1.2 Background

Tens of thousands of chemicals are harmful to humans and knowing the specific toxic effects of even a 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 toxicants. 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.

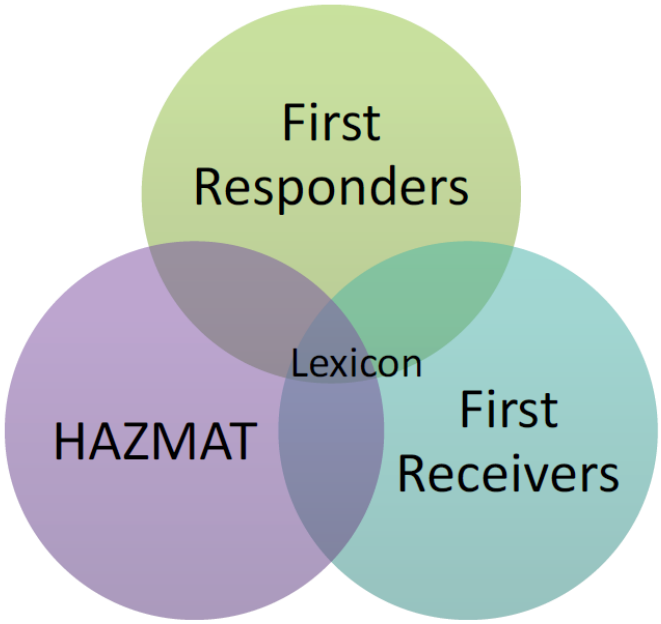
Toxic syndromes are easily identified with only a few observations, such as:

- Vital signs
- Mental status
- Pupil size
- Mucous membrane irritation
- Lung exam for wheezes or crackles
- 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 only a few chemicals with similar toxic effects. By focusing on certain chemicals, specific diagnostic testing and treatment can be 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 (Figure 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, including chemicals that are not specifically named but that may conceivably be used in intentional terrorist releases (i.e., agents of opportunity or chemical warfare agents). The use of toxic syndromes as a diagnostic tool is fundamental to an effective, timely medical response.

Figure 1 Intersection of Toxidrome User Groups.



The scope of the workshop was primarily focused on on-scene and hospital responses in the early phases of a large-scale chemical release. The exposures in this scenario are likely to be inhalation and possibly dermal. Ingestion is less likely. Therefore chemicals that would cause food/water borne outbreaks or covert/delayed poisonings were not considered in this workshop. This workshop focused on developing a decision-making tool that will be used in the early part of a response when information is limited. Delayed effects were less emphasized and the clinical course in its entirety – hours to days was not the focus. This report provides an accurate record for the workshop participants and a reference for the next phases of Lexicon development.

1.3 Intended Use of the Results of the Workshop

The NLM and DHS are working together on this project to improve communication that assures a coordinated and effective response to mass exposure incidents involving toxic industrial chemicals (TICS), toxic industrial materials (TIMS), or chemical warfare agents (CWAs). Jointly with the U.S. Department of Health and Human Services (HHS), DHS/OHA intends to publish products from this

workshop to lay the foundation for a consistent lexicon describing toxic syndromes among State, Local, Tribal, and Territorial (SLTT), as well as federal first responders and first receivers. Communication in a crisis requires accurate and succinct terms which convey the health conditions of patients. As described, the DHS recognizes the myriad of toxic syndrome terms used, particularly between the Department of Defense and the civilian medical and emergency response communities. Bridging this gap, through this workshop and the products produced thereafter, provides a framework to begin using a consistent set of terms and definitions.

The NLM intends to use the results of this project in its CHEMM (Chemical Hazards Emergency Medical Management) program. CHEMM (https://chemm.hhs.gov/) enables first responders, first receivers, other healthcare providers, and planners to plan for, respond to, recover from, and mitigate the effects of mass-casualty incidents involving chemicals. CHEMM provides a comprehensive, user-friendly, web-based resource that is also downloadable in advance, so that it would be available during an event if the internet is not accessible. CHEMM was produced by the HHS, Office of the Assistant Secretary for Preparedness and Response, Office of Planning and Emergency Operations, in cooperation with the NLM's Division of Specialized Information Services, and many medical, emergency response, toxicology, and other relevant experts. Results of the workshop may be used to expand the CHEMM Intelligent Syndromes Tool (CHEMM-IST). CHEMM-IST is a prototype decision support tool developed by experts in medicine and emergency response as an aid for identifying the chemicals in a mass casualty incident and providing guidelines for treatment. Since CHEMM-IST is currently in the prototype phase of development, it should not be used for patient care. This tool is intended for use by basic life support (BLS) and advanced life support (ALS) providers as well as hospital first receivers. More information about CHEMM-IST is available at https://chemm.hhs.gov/chemmist.htm.

1.4 Organization of this Report

The purpose of this report is to capture the key information from the workshop and serve as reference material for further development of the Toxidrome Lexicon.

- Section 1 provides an introduction and background on the need for toxic syndromes and a common lexicon.
- Section 2 summarizes the workshop and results.

2. Toxic Chemical Syndrome Definitions and Nomenclature Workshop

The workshop agenda was designed to be highly interactive to take advantage of the experience and knowledge of the participants. The workshop organizing committee met by teleconference numerous

times prior to the workshop and had extensive discussions to define the scope of the project and identify key individuals and organizations to invite and involve in the project. Research was conducted to identify other organization's lexicons and definitions, and these were evaluated for applicability to this project. A crosswalk comparing and contrasting toxic syndrome systems from over 20 organizations was developed, along with a proposed list of syndromes and definitions for the workshop's initial consideration. The committee sent a package with these materials to the invitees prior to the workshop and solicited input on key questions from the invitees. Invitees provided their initial thoughts and comments regarding the key questions to the committee prior to the workshop. The committee reviewed the responses and modified the workshop sessions to make best use of the workshop time and reach the objective of developing a consensus list of toxic syndromes, definitions, and nomenclature.

Opening remarks were provided by Dr. James Polk and Capt. Joselito Ignacio of the DHS. They described the need to prepare communities who are potentially in harm's way from industrial chemical exposures as well as potential terrorist attack. The DHS has partnered with the NLM to develop a common vocabulary for chemical syndromes that will be readily understood by both civilian and military first responder and first receiver communities, thereby improving communication and ultimately the public health response. Dr. Pertti Hakkinen welcomed participants on behalf of the NLM and briefly described how the workshop results are intended to be incorporated into the NLM's suite of decision support tools (e.g., CHEMM).

The first day's agenda focused on sharing information on key components and issues related to toxic syndrome definitions and nomenclature. Two plenary speakers provided background on issues and current efforts. Dr. Mark Kirk, currently at the University of Virginia, and previously the Director of the Chemical Defense Program at the DHS, explained why toxic syndrome recognition and training is vital and proposed a tiered approach to syndrome recognition and response. Ms. Jessica Cox of the DHS Chemical Security Analysis Center described work on Chemical Terrorism Risk Assessment (CTRA). She presented information on toxidromes that were developed for that program.

Following the plenary speakers, Dr. Andy Maier of TERA led the group through discussions and decisions on key aspects for the workshop, including the ideal number of syndromes, guidance for syndrome names, and elements of syndrome definitions. The group then divided into three breakout groups to discuss and reach agreement on specific syndrome definitions and nomenclature. The breakout groups reported back to the larger group on the second afternoon with a list of syndromes and their definitions. The larger group discussed the breakout group recommendations and key issues, and identified research needs.

2.1 Breakout Groups

2.1.1 Breakout Group Instructions

The workshop attendees divided into three breakout groups to discuss and reach agreement on a list of syndromes and definitions.

Table 1 Breakout Group Assignments

Group	Types of Chemicals and Endpoints
Group 1	Upper and Lower Pulmonary, Vesicants, Irritants, Corrosives
Group 2	Blood Agents, Hemolytic, Metabolic, Anticoagulants, Asphyxiants
Group 3	Convulsants, Cholinergic CWA, Cholinergic pesticide, Opioids, Anxiety

The breakout groups were charged with discussing and reporting on twelve elements for each recommended syndrome.

1. Clinically relevant routes of exposure and types of sources
2. Organ systems generally affected
3. Initial signs and symptoms
4. Progression of signs and symptoms
5. Underlying pathology, biological processes, or modes of action
6. Industrial chemical uses and chemical warfare/terrorism examples
7. Common treatment protocols, specific antidotes, and key supportive measures
8. Recommendation for a syndrome name that would meet the agreed upon criteria
9. A clear and concise syndrome definition that will be readily understood by the target audiences
10. Any issues or concerns about the syndrome
11. Identify data gaps or research that could be done to significantly aid in the rapid identification of a toxic syndrome by first responders and receivers
12. Rationale or reasoning for toxidrome grouping and naming decisions

Rapporteurs from each breakout group reported back to the workshop on their group's discussions and recommendations.

2.1.2 Breakout Group Results

The three breakout groups discussed possible toxidromes. Each group developed a number of syndromes, definitions, and rationales. Section 2.1.3 contains a summary of the nine individual toxidromes that the breakout groups recommended, with consolidation of "Cyanide-like" and "Knockdown/Asphyxiants" agents into one "Knockdown" toxidrome and grouping of "irritants/corrosives" into a single toxidrome irrespective of route of exposure.

2.1.3 Recommended Toxidromes

Table 2. Toxidrome Names and Descriptions: Consolidated Breakout Group Recommendations

Anticholinergic Toxidrome Under stimulation of cholinergic receptors leading to dilated pupils (mydriasis), decreased sweating, elevated temperature, and mental status changes, including characteristic hallucinations.
Anticoagulants Toxidrome Alteration of blood coagulation that results in abnormal bleeding indicated by excessive bruising, and bleeding from mucous membranes, the stomach, intestines, urinary bladder, and wounds, as well as other internal (e.g. intracranial, retroperitoneal) bleeding.
Acute exposure to solvents, anesthetics, or sedatives (SAS) Toxidrome Central nervous system depression leading to a decreased level of consciousness (progressing to coma in some cases), depressed respirations, and in some cases ataxia (difficulty balancing and walking).
Cholinergic Toxidrome Over stimulation of cholinergic receptors leading to first activation, and then fatigue of target organs, leading to pinpoint pupils (miosis), seizing, wheezing, twitching, and excessive output from all secretory cells/organs ("leaking all over" – bronchial secretions, sweat, tears, saliva, vomiting, incontinence).
Convulsant Toxidrome Central nervous system excitation (GABA antagonism and/or glutamate agonism and/or glycine antagonism) leading to generalized convulsions.
Irritant/Corrosive Immediate effects range from minor irritation of exposed skin, mucous membranes, pulmonary, and gastrointestinal (GI) tract to coughing, wheezing, respiratory distress and more severe GI symptoms that may progress rapidly to systemic toxicity.
Knockdown Toxidrome Disrupted cellular oxygen delivery to tissues may be caused by simple asphyxia due to oxygen displacement by inert gases, hemoglobinopathies (e.g. carbon monoxide, methemoglobin inducers) impairing oxygen transport by the red blood cell, and/or impairment of the cell's ability to use oxygen (e.g. mitochondrial inhibitors such as cyanide). All of these situations lead to altered states of consciousness, progressing from fatigue and lightheadedness to seizures and/or coma, with cardiac signs and symptoms, including the possibility of cardiac arrest.
Opioid Toxidrome Opioid agonism leading to pinpoint pupils (miosis), and central nervous system and respiratory depression.
Stress-Response/Sympathomimetic Stress- or toxicant-induced catecholamine excess or central nervous system excitation leading to confusion, panic, and increased pulse, respiration, and blood pressure.

2.1.4 Toxidrome Naming

The breakout groups discussed their reasoning behind grouping chemicals into the toxidromes and the naming of the toxidromes. Note that the initial twelve breakout group toxidromes listed below have been reduced to nine (Table 2). The routes of exposure for "Irritant/Corrosive" were consolidated into a single toxidrome, and the "Knockdown/Asphyxiants" and "Cellular asphyxia (cyanide-like)" toxidromes were combined, in order to simplify training and recall.

Acute exposure to solvents, anesthetics, or sedatives (SAS) Toxidrome

The basis for creating and naming this toxidrome is the existence of a similar clinical presentation in casualties exposed to any of the members of these groups (solvents, inhalational anesthetics, and sedative-hypnotic compounds) following acute exposure. The delayed effects of solvent exposure do not form part of this toxidrome.

Anticholinergic Toxidrome

Exposure to an anticholinergic chemical may result in under stimulation of cholinergic receptors leading to symptoms and signs such as dilated pupils (mydriasis), decreased sweating, elevated temperature, rapid heart rate, and mental status changes, and characteristic hallucinations.

Anticoagulants Toxidrome

This toxidrome is based on the clearly defined underlying toxic mode of action of alteration of blood coagulation.

Cholinergic Toxidrome

This toxidrome name was chosen based upon clinical relevance and accuracy as well as ease of recall. Examples of names initially considered included: SLUDGE, DUMBBEL[L]S, BBB, MTWHF, CCC, organophosphate-like, acetyl cholinesterase, pinpoint pupils, wet all over, twitching, and seizing* (*three seizing toxidromes).

Convulsant Toxidrome

This toxidrome name was chosen based upon clinical relevance and accuracy as well as ease of recall. Examples of names initially considered included: General convulsant toxidrome, Convulsants, convulsions, and seizures nothing else * (three seizing toxidromes).

Knockdown/Asphyxiants Toxidrome

There is a unifying pathophysiological basis (i.e., disrupted cellular oxygen delivery and/or use) for all agents in this toxidrome for the initial presentation; however, some agents have specific treatments or antidotes that are accommodated in the second tier of this toxidrome.

Cellular asphyxia (cyanide-like) Toxidrome

This toxidrome name was chosen based upon clinical relevance and accuracy as well as ease of recall. Examples of names initially considered include the following: Cellular asphyxia toxidrome, Cellular asphyxiants, Cyanide, Cyanide-like, cherry-red, not wet all over, severe arrhythmia early, dilated pupils, and seizing* (three seizing toxidromes).

Opioid Toxidrome

This toxidrome name was chosen based upon clinical relevance and accuracy as well as ease of recall. Examples of names initially considered include the following: Opioids, Sedative, Solvent, and changed mental status unresponsive with or without seizures.

Stress-response/sympathomimetic Toxidrome

This toxidrome name was chosen based upon clinical relevance and accuracy as well as ease of recall. Examples of names initially considered include the following: Anxiety, psychological/stress response, fight-flight-or-freeze response, and sympathomimetic.

Irritant/Corrosive Toxidromes

Substances with significant irritant and corrosive properties were divided into three toxidromes based on the route of exposure as it corresponds to the organ system and/or tissue damaged.

Irritant/Corrosive Inhalation Toxidrome

For the inhalation toxidrome, the spectrum of injury presentation suggests that a combination of upper and lower pulmonary injuries into one toxidrome is appropriate for use by first responders. The initial assessment will focus on general respiratory complaints, which will not differentiate between upper and lower pulmonary injury and the initial treatments will be similar for both upper and lower pulmonary.

Irritant/Corrosive Ingestion Toxidrome

The effects of this toxidrome are immediate, with initial treatment being similar (i.e., supportive care). Additional information (e.g., epidemiological review) will be required given the targeted nature of an ingestion poisoning.

Irritant/Corrosive Topical Toxidrome

Chemical burns, vesicants, and other skin irritants/corrosives are lumped together under this syndrome for the following reasons: treatment (initial emergency medical response) is similar, regardless of the degree of skin or eye effects; differentiation between corrosives and chemical burns could not be distinguished significantly from a diagnostic and emergency medical treatment perspective; and, irritants and corrosives present in a progressive spectrum of injury to the skin and eyes.

2.1.5 Participant Ballots

Within each breakout group, the participants were asked to complete ballots indicating their agreement/disagreement with their breakout group's toxidromes and any additional comments. Seventeen workshop participants completed and returned ballots to record their "votes" and comments on the breakout group recommendations (Group 1: n= 4; Group 2: n= 7; Group 3: n= 6).

A review of the ballots determined that all breakout group participants agreed with their group's recommendations as presented to the larger workshop, with one exception. One participant in Group 3 questioned the inclusion of the Anticholinergic Toxidrome "because there is a low likelihood that any of these chemicals would be encountered by first responders."

2.2 Discussion

A number of general and specific issues were discussed by the workshop participants during the plenary sessions. These are briefly described below.

Use of term "Toxidrome" versus "Toxic Syndrome." The group noted that these terms can appropriately be used interchangeably. Many SMEs favored "toxidrome" – primarily for ease of use in the field and training. There is value in documenting the connection between the term "toxidrome" and its longer form "Toxic Syndrome." Toxidrome, as used for the current application, also avoids confusion with other terms and variants in the medical literature such as "Toxic Chemical Syndrome" or "Toxic Shock Syndrome" which would not be equivalent to a "toxidrome."

Toxidrome name and short definition. The SMEs agreed on guiding principles for toxidrome naming and the need for and key components of a concise name. A toxidrome name must be memorable (applied in the field) and meaningful (to guide a treatment action). The concise definition should be one to two sentences, capturing a constellation of the key observable elements of the clinical presentation as well as key treatments or actions. Format is sufficiently flexible to include other information that facilitates recognition. The SMEs indicated that the use of the toxidrome concept would necessarily entail some misclassification of patients as there is a trade-off between usability in the field and diagnostic accuracy. The allowance for misdiagnosis should typically err on the side of over-treatment, based on the nature of the consequences of treatment.

Toxidrome Packaging, Outreach and Communication: The SMEs discussed the need for packaging of the toxidromes to facilitate field use. The goal of identifying and acting on a constellation of undifferentiated findings was noted as a need in packaging the toxidromes (and symptom constellations) in a meaningful way to users. Suggestions for doing this included a simplified signs and symptoms assessment approach (e.g., speech, sight, skin, seizures) and a matrix concept that allows a process for linking toxidromes and making adjustment in treatment. Other grouping strategies were mentioned.

Learning, Heuristics, Cognitive Biases, and Levels of Expertise: A system that recognizes the different users of the toxidromes and their varying methods for identifying toxidromes, as well as differing levels of expertise, will be needed. The level of understanding of the toxidromes used by first responders, fire and emergency services, law enforcement, emergency medical technicians, will be different and will incorporate cognitive biases that must be understood. This information might be included as part of the learning package developed for the toxidromes. First receivers at the emergency department, primary care physicians, and medical schools/students need a deeper understanding of the toxidromes and ability to consider broader differential diagnoses. Poison Control Centers need a more detailed level of guidance plus direct reachback to Medical Toxicologists. Medical Toxicologists must serve as the final backstop for definitive diagnosis, as well as have the ability to provide specific follow-up or critical information requests and recommendations for refining treatment and response.

Communications and Knowledge Management: The complete package should draw upon the knowledge management/communication systems available. Knowledge management must include two-way communications, leverage current systems (e.g., State Fusion Centers, Poison Control Centers, NLM tools such as CHEMM-IST, Federal reachback centers/Support and Operations Centers [SOCs]) and integrate with local emergency operations centers. Participants suggested resources such as "Power to the Edge" by David Alberts and concepts such as principles of "Netcentric Operations" and "post and smart pull" (where all information is posted to the network which allows for pulling or pushing of relevant information to people who need it). In addition, Dr. Caneva described a concept, the "Trinity of Knowledge," which encompasses three dimensions of how people acquire and develop knowledge: learning, knowledge management, and sense-making. Understanding these concepts can aid in developing the toxidromes and for training users.

Research Needs: A variety of ideas for research needs were highlighted as starting points for future efforts. Research aimed at evaluating the effectiveness of toxidromes in the field as a tool for guiding treatment was viewed as a research need. None of the SMEs were aware of significant research in this area. Suggestions for moving forward included developing a clinical trial-like approach or evaluating data from past incidents with data analytics. Research that provides information of the relationship between field applicability and diagnostic accuracy was also noted as a useful outcome of future analyses. Participants noted that some data (and experience) on effectiveness of training on field retention of toxidromes has been done.

The current effort focuses on mass casualty (exposure) incidents following principally acute exposures to chemical agents (with focus on CWA, TICs, and TIMs). Adding scenarios for mass-scale exposures to commercial pharmaceuticals via ingestion may add additional complications that will need to be explored as this might broaden the array of specific toxidromes needed (e.g., the idea of cardiotoxicants).

Several additional topics were raised but not discussed in-depth. These topics included use of "information mining" strategies or tools and how to adapt to future and changing needs to ensure the product of this workshop is an evergreen resource (i.e., updated and improved to reflect new information and knowledge).

After the workshop, several attendees provided additional materials and suggestions for consideration. An article by Paul Wax and colleagues (Wax, Becker and Curry, 2003) reviews what is known about incapacitating agents such as fentanyl derivatives, their aerosolization, and the rationale for their use as incapacitating agents. A paper by Burklow, Yu, and Madsen (2003) reviews industrial chemicals and their use as chemical weapons or for terrorist attacks, focusing on chlorine and phosgene. The paper discusses large-airways (Type I) damage, damage to small airways and alveolar septa (Type II damage), and both. It also addresses risks to children from these types of chemicals. A third suggested paper was on the topic of acute organophosphate poisoning and medical management (Eddleston et al., 2008).

2.3 Conclusions

A common language to describe and recognize toxic chemical exposures is essential for emergency responders and first receivers to be prepared to provide rapid and appropriate responses to industrial chemical mass exposures, as well as potential terrorist attacks. The current effort and this workshop focused on mass exposure incidents following acute exposures to chemical agents (with a focus on CWA, TICs, and TIMs). The scope of the workshop was primarily focused on the scene and hospital response in the early phases of a large-scale chemical release, with exposures likely to be inhalation and possibly dermal. This workshop focused on developing a decision-making tool that will be used in the early part of a response when information is limited. Delayed effects were less emphasized and the clinical course in its entirety – hours to days was not the focus.

The Toxic Chemical Syndrome Definitions and Nomenclature Workshop was held on May 8-9, 2012 at the Department of Homeland Security offices in Washington, DC. More than forty participants discussed the essential elements of toxic chemical syndromes or toxidromes that would be useful to train first receivers and responders in cases of terrorist attack or industrial accidents. The workshop attendees were a diverse group and included first responders, first receivers, medical directors of poison control centers, and subject matter experts (SMEs) in emergency medicine, emergency response, medical toxicology, and trainers. They came from civilian and military agencies, universities, hospitals, and emergency response entities. The diversity of the participants provided the needed breadth of expertise and backgrounds to develop a consensus lexicon that will be of most value to the intended users.

Workshop participants agreed that the terms “toxidrome” and “toxic syndrome” can be used interchangeably, and that “toxidrome” has a number of advantages that make it easier to use in the field. They agreed upon guiding principles for the naming of toxidromes and for a toxidrome description (i.e., a concise definition of one to two sentences that captures a constellation of the key observable elements of the clinical presentation as well as key treatments or actions). The experts recognized that the use of the toxidrome concept would necessarily entail some misclassification of patients as there is a trade-off between usability in the field and diagnostic accuracy. The allowance for misdiagnosis should typically err on the side of over-treatment, based on the nature of the consequences of treatment.

The expert workshop initially recommended twelve toxidromes to establish a common language for chemical defense planners, policy makers, first responders, first receivers, and hazardous materials (hazmat) stakeholders. These twelve toxidromes were subsequently consolidated to the nine listed in Table 2 in order to provide a common lexicon to assist key stakeholder communities to quickly and accurately identify the broad chemical agent category (if not the specific chemical agent) to which a patient was exposed and to thereby rapidly determine appropriate emergency treatment. The nine toxidromes were built around clinical presentations, rather than chemical grouping or treatment options. The experts focused on describing toxidromes with signs and symptoms that first responders and first receivers would be able to observe in the patients. The focus was on acute exposures. The workshop experts sought to develop names for the toxidromes that were based on clinical relevance and accuracy, as well as ease of recall.

Workshop participants briefly discussed how the information on toxidromes could be packaged for training and communication to the intended users and field use and offered several suggestions including grouping strategies or algorithms for ease of remembrance. In addition, they discussed that different types of users will have differing requirements for levels and types of information that will need to be accommodated. The complete toxidrome package should incorporate available knowledge management and communication systems and include provisions for feedback and revision.

The workshop experts identified a variety of ideas for research needs and future work. These included developing a clinical trial-like approach or evaluating data from past incidents with data analytics and exploring additional scenarios (and relevant toxidromes) for mass-scale exposures to commercial pharmaceuticals via ingestion.

This report is intended to provide an accurate record of workshop preparations, discussions, and conclusions to serve as a resource for participants and others in the next phases of Lexicon development.

2.4 References and Sources

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