ERRORIST ATTACKS ARE INCREASING IN BOTH FREQUENCY AND COMPLEXITY AROUND THE WORLD. IN 2016 ALONE, THERE WERE MORE THAN 13,400 TERRORIST ATTACKS GLOBALLY, KILLING MORE THAN 34,000 PEOPLE.\(^1\) OF EQUAL CONCERN, CHEMICAL-WARFARE AGENTS THAT WERE DEVELOPED FOR THE BATTLEFIELD ARE BEING USED ON CIVILIANS IN MAJOR CITIES AND CONFLICT ZONES. THE RECENT SARIN ATTACKS IN SYRIA,\(^2,3\) THE LATEST IN A SERIES OF CHEMICAL ATTACKS IN THAT REGION,\(^3,4\) ALONG WITH THE USE OF THE NERVE AGENT VX IN THE ASSASSINATION OF KIM JONG-NAM IN MALAYSIA AND THE SOVIET-ERA AGENT NOVICHOK IN THE POISONING OF SERGEI SKIRPAL IN THE UNITED KINGDOM,\(^5\) ALL REPRESENT A WORRISOME TREND IN THE USE OF DEADLY CHEMICAL AGENTS BY VARIOUS ROGUE GROUPS IN CIVILIAN SETTINGS. IN LIGHT OF THE RISE IN COORDINATED, MULTIMODAL TERRORIST ATTACKS IN WESTERN URBAN CENTERS,\(^6,7\) CONCERN HAS BEEN EXPRESSED ABOUT AN INCREASE IN THE USE OF CHEMICAL AGENTS BY TERRORISTS ON CIVILIAN TARGETS AROUND THE WORLD. SUCH ATTACKS ENTAIL UNIQUE ISSUES IN ON-THE-SCENE SAFETY\(^8,9\) AND ALSO REQUIRE A RAPID MEDICAL RESPONSE.\(^10\) AS HEALTH CARE PROVIDERS, WE MUST BE PROACTIVE IN HOW WE PREPARE FOR AND RESPOND TO THIS NEW THREAT.

THIS ARTICLE REVIEWS THE TOXIDROMES (CONSTELLATIONS OF SIGNS AND SYMPTOMS THAT ARE CHARACTERISTIC OF A GIVEN CLASS OF AGENTS) FOR KNOWN AND SUSPECTED CHEMICAL-WARFARE AGENTS THAT HAVE PROPERTIES THAT ARE WELL SUITED FOR TERRORIST ATTACKS — NAMELY, HIGH VOLATILITY AND RAPID ONSET OF INCAPACITATING OR LETHAL EFFECTS.\(^11\) POISON-CONTROL PROCEDURES CURRENTLY USE TOXIDROMES TO IDENTIFY SPECIFIC CLASSES OF AGENTS. ALTHOUGH SYMPTOMS SUCH AS EYE IRRITATION AND COUGHING ARE COMMON TO A NUMBER OF CLASSES, SPECIFIC CLINICAL FINDINGS, INCLUDING FASCICULATIONS, HYPERSECRETIONS, EARLY SEIZURE, AND MIOSIS OR MYDRIASIS, CAN BE RAPIDLY IDENTIFIED AS PART OF AN ACUTE-PHASE TRIAGE SYSTEM AND USED TO DIFFERENTIATE AMONG CLASSES OF AGENTS. THIS SHOULD LEAD TO REDUCED MORBIDITY AND MORTALITY WHILE ALSO DECREASING THE RISK TO RESPONDING HEALTH CARE WORKERS.\(^12\) THE COMBINED GROUP OF CHEMICAL-WARFARE AGENTS EXAMINED HERE INCLUDES NERVE AGENTS, ASPHYXIANTS (BLOOD AGENTS), OPIOID AGENTS, ANESTHETIC AGENTS, ANTAGONYERGIC (ANTIMUSCARINIC) AGENTS, BOTULINUM TOXIN, PULMONARY AGENTS, CAUSTIC AGENTS (ACIDS), RIOT-CONTROL AGENTS, T-2 TOXIN, AND VESICANTS (TABLE 1).

### History

Chemical warfare is not new. As early as 10,000 B.C., rival tribes used various poisons derived from plants and animals to coat their spear tips before battle.\(^13\) The modern world witnessed the first large-scale use of chemical weapons on the battlefields of World War I, where chlorine,\(^14\) phosgene,\(^15,16\) and sulfur mustard\(^17,18\) were deployed, with devastating effects.\(^19\) During World War II, the Nazi regime developed new and much more lethal nerve agents, such as sarin,\(^20\) tabun,\(^21\) and soman,\(^22\) though they were never deployed on the battlefield against the Allied
troops. The Nazis did, however, combine hydrogen cyanide with an absorbent to form Zyklon B, which was then used to kill millions of people in gas chambers. Chemical weapons have also been used in the Iran–Iraq war and present-day Syria. As a response to the development and use of such agents, the Chemical Weapons Convention, essentially an arms-control agreement put into effect on April 29, 1997, prohibits the development, stockpiling, transfer, and use of chemical weapons by state entities.

Late in the 20th century, terrorist groups began to obtain chemical-warfare agents and use them on civilian targets. The most extensively documented case was the use of sarin in the subways of Tokyo by the Aum Shinrikyo group in 1995. During the same period, a number of countries clandestinely developed more advanced and more lethal chemical weapons that were safer to handle and transport yet harder to detect. Such agents include binary agents and lesser known, nontraditional agents. Binary formulations are two chemically stable and nonlethal precursors that are safe to carry separately; however, when combined, they become a lethal chemical agent. VX is an example of a chemical-warfare agent that has two nontoxic binary precursors, and there has been some speculation that the assassination of Kim Jong-nam may have involved the application of two such binary agents. Nontraditional agents such as Novichok are next-generation chemical compounds with varying effects, levels of detection, and mechanisms of action. These newly developed chemicals are considered classified by the United States, so little is known about them outside of the government.

### Agents of Concern

Chemical weapons vary in their onset of action, toxicity, and symptomatology. The characteristics most suitable for use in a terrorist attack include high volatility, fast and effective absorption through the respiratory tract or skin, and rapid onset of lethal or incapacitating effects. Some toxins (i.e., poisons produced by living organisms) can behave like chemical weapons.

### Table 1. Classes of Chemical-Warfare Agents (CWAs) Likely to Be Used in a Civilian Attack.

<table>
<thead>
<tr>
<th>Class</th>
<th>Representative Agents</th>
<th>Last Known Use or Attempted Use as a CWA*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nerve agents (cholinesterase inhibitors)</td>
<td>G-series (sarin, soman, cyclosarin, tabun), V-series (VE, VG, VM, VX), organophosphates</td>
<td>Syria, 2017: sarin; Malaysia, 2017: VX</td>
</tr>
<tr>
<td>Asphyxiants (blood agents)</td>
<td>Hydrogen cyanide, cyanogen chloride</td>
<td>New York City subway, 2003: cyanide</td>
</tr>
<tr>
<td>Opioid agents</td>
<td>Fentanyl, carfentanil, remifentanil</td>
<td>Moscow theater, 2002: fentanyl or carfentanil (used to subdue terrorists)</td>
</tr>
<tr>
<td>Anesthetic agents</td>
<td>Chloroform, halothane, nitrous oxide</td>
<td>No known use as CWA</td>
</tr>
<tr>
<td>Anticholinergic (antimuscarinic) agents</td>
<td>3-Quinuclidinyl benzilate (BZ), Agent 15 (chemically the same as or related to BZ), atropine</td>
<td>Syria, 2012: Agent 15</td>
</tr>
<tr>
<td>Viscant agents</td>
<td>Mustards (nitrogen and sulfur), lewisite, phosgene oxime</td>
<td>Syria and Iraq, 2016: mustard gas</td>
</tr>
<tr>
<td>Caustic agents (acids)</td>
<td>Hydrochloric acid, hydrofluoric acid, sulfuric acid</td>
<td>London, 2017: sulfuric acid</td>
</tr>
<tr>
<td>Riot-control agents</td>
<td>Chloroacetophenone (CN), chlorobenzylidenemalononitrile (CS), bromobenzylcyanide (CA)</td>
<td>Falkland Islands, 1982: “tear gas” used on British troops</td>
</tr>
<tr>
<td>Pulmonary agents</td>
<td>Chlorine, phosgene, diphosgene</td>
<td>Syria, 2017: chlorine</td>
</tr>
<tr>
<td>Botulinum toxin</td>
<td>Botulinum toxin</td>
<td>Tokyo, 1995: botulinum toxin used by Aum Shinrikyo</td>
</tr>
</tbody>
</table>

* Information on previous use of CWAs is from the Global Terrorism Database, University of Maryland, and other sources.
In World War II, botulinum toxin was produced and used by the Japanese; after the war, it was produced by some other countries, which maintained large stockpiles. The two lethal toxins included in this review, botulinum toxin and T-2 toxin (a trichothecene mycotoxin), can be absorbed through the respiratory system or skin and are relatively fast-acting.38,39

The effects of nerve agents such as sarin and VX, asphyxiants such as cyanide, and opioids such as fentanyl and carfentanil, can be countered by the emergency administration of specific antidotes. Nerve agents inhibit cholinesterase at the synapse, leading to a build-up of acetylcholine and requiring atropine and pralidoxime as antidotes. Asphyxiants block cellular respiration, requiring urgent administration of hydroxocobalamin or sodium thiosulfate and sodium nitrite as antidotes, and opioids cause respiratory depression, requiring rapid administration of naloxone. All other agents are incapacitating and potentially lethal but have no specific lifesaving antidote, therefore requiring urgent decontamination and supportive care initially. Anesthetic agents may cause sedation and bradypnea, whereas pulmonary agents cause eye and throat irritation, coughing, chest pain, and shortness of breath. Riot-control agents and caustic agents cause eye and skin irritation, as do vesicants (which also cause skin burns and blistering) and T-2 toxin (which may also cause dyspnea and vomiting). Finally, anticholinergic agents cause confusion, mydriasis, and dry mouth and skin, whereas botulinum toxin causes diplopia and descending paralysis.

In the event of an attack, the classes of chemical-warfare agents that are most rapidly lethal (i.e., nerve and opioid agents and asphyxiants), but not necessarily the agents themselves, should be quickly identified with the use of a toxidrome-based system of rapid triage.10 It is important to understand, however, that any victim may need emergency treatment at any time, and such care should be rendered as required. It must also be understood that in the case of exposure to a rapidly toxic agent, immediate on-the-scene cleansing of contaminated areas of the body (referred to as spot decontamination) may be part of lifesaving treatment, since it removes the offending agent and rescues the victim and caregiver from ongoing exposure.20 Decontamination is a medical countermeasure that mitigates the conversion of an external dose to an internal dose.

### The Problem

Chemical-weapons attacks occur without warning and create chaotic scenes, resulting in confusion on the part of emergency medical responders and hospital-based personnel, most of whom are unprepared and have very little training in the recognition of a chemical attack or in the donning and doffing of personal protective equipment. In addition, the initial scene of a chemical attack may look very similar to other incidents involving mass casualties, particularly if release of the agent is combined with use of conventional weapons as part of a multimodal attack. The chaos of the early phase of such an event may lead to further delay in identifying the chemical agent, placing responders at risk while also delaying potentially lifesaving treatment for the victims. An understanding of the patterns of signs and symptoms (toxidromes) that characterize the classes of known agents, as well as familiarity with the patterns of injuries caused by conventional weapons, are required for a quick assessment of victims of both types of attack, leading to an efficient and safe response.45,46 Nerve agents, opioid agents, and asphyxiants are lethal if the victims are not treated with antidotes quickly, either in conjunction with or before spot decontamination.48,49

In addition, most chemical-warfare agents pose a substantial risk for responding personnel, either through direct exposure to the agent or through secondary exposure to off-gassing (evaporation of the agent from a contaminated victim).50,51 Without quick identification of the class of offending agent, it is not possible to administer appropriate antidotes and other treatment measures or use the correct personal protective equipment.53 Because classes of chemical agents have different clinical presentations, a comprehensive understanding of the toxidrome for each class of agent is imperative (Table 2).54

### The Need

Mass-casualty triage systems in use around the world today are designed primarily to differenti-
ate victims with minor injuries from those with more serious injuries. Few of these systems address the possibility of a chemical-weapons attack. One of the systems that does, the CBRN (Chemical, Biological, Radiological, Nuclear) system, incorporates injuries related to chemical-warfare agents. However, this system uses only the presence of a toxidrome, not identification of the class of agent, to determine treatment categories. When tested in a drill setting, the CBRN system resulted in significant undertriage of victims. Other attempts to include signs and symptoms associated with chemical-warfare agents in mass-casualty triage systems have classified victims on the basis of treatment categories (minimal, delayed, urgent, or emergency treatment), without necessarily confirming the presence of chemical weapons or providing rapid identification of the class of agent. Triage systems that include symptoms either tend to be designed to isolate nerve agents from everything else or are so rudimentary that it is difficult to differentiate among classes of agents. The symptom-based triage system that perhaps comes closest to being both thorough and practical is the Madsen protocol. However, this algorithm is very detailed, identifying individual agents in many cases. Therefore, the Madsen

<table>
<thead>
<tr>
<th>Class</th>
<th>Initial Toxidromes in Order of Onset</th>
<th>Subsequent Signs and Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nerve agents</td>
<td>Mental-status changes, fasciculations, muscle weakness, paralysis</td>
<td>Increased secretions, miosis</td>
</tr>
<tr>
<td>Asphyxiants (metabolic poisons, including cyanide and other “knockdown” agents)</td>
<td>Respiratory distress (including initial gasping)</td>
<td>Seizures</td>
</tr>
<tr>
<td>Opioids</td>
<td>Confusion, miosis</td>
<td>Depression of respiratory depth and rate (bradypnea), sedation, apnea</td>
</tr>
<tr>
<td>Anesthetic agents</td>
<td>Confusion</td>
<td>Bradypnea</td>
</tr>
<tr>
<td>Anticholinergic (anti-muscarinic) agents</td>
<td>Confusion, disorientation, delusions, hallucinations, confabulation, phantom behaviors</td>
<td>Mydriasis</td>
</tr>
<tr>
<td>Vesicants (blister agents)</td>
<td>Eye, throat, skin irritation</td>
<td>Coughing</td>
</tr>
<tr>
<td>Caustic agents (acids)</td>
<td>Skin irritation and burning</td>
<td>Eye irritation</td>
</tr>
<tr>
<td>Riot-control agents</td>
<td>Eye irritation</td>
<td>Throat irritation</td>
</tr>
<tr>
<td>Trichothecene mycotoxins</td>
<td>Skin irritation, rash</td>
<td>Eye irritation</td>
</tr>
<tr>
<td>Centrally acting (large-airway) pulmonary agents</td>
<td>Eye, throat, skin irritation</td>
<td>Respiratory noise (coughing, hoarseness, stridor, wheezing)</td>
</tr>
<tr>
<td>Peripherally acting (small-airways-and-alveoli) pulmonary agents</td>
<td>Few or no initial symptoms except at high doses</td>
<td>Delayed-onset shortness of breath</td>
</tr>
<tr>
<td>Botulinum toxin</td>
<td>Diplopia</td>
<td>Difficulty swallowing</td>
</tr>
</tbody>
</table>

* Signs and symptoms may occur simultaneously in some cases, especially at higher doses. † The knockdown syndrome involves rapid loss of consciousness, collapse, seizures, hypotension, and cardiac arrest.
A chemical-weapons triage algorithm is needed that can be rapidly deployed in the acute phase of an attack, is simple to use, and is based on identification of specific toxidromes. The goal would be to quickly identify victims who require emergency treatment with antidotes along with other therapeutic interventions.

**SAFE AND EFFECTIVE RESPONSE**

A chemical-warfare attack on a metropolitan target may not be immediately identified as such. The use of a chemical agent is likely to be combined with the use of other weapons, such as firearms and explosives, resulting in multiple victims who could be mistakenly identified as casualties of a conventional attack. The first responders must quickly analyze the scene for signs of chemical agents, including more victims than would be expected from a blast or gunfire, multiple victims with no obvious signs of trauma, and clusters of victims collapsing with similar symptoms. If a chemical agent is suspected, the responders must stay at a safe distance and thoroughly analyze the scene. Does the agent appear to be in a gas or a liquid state? Is it contained, or is the scene still active? What are the other safety issues: fire, collapsing buildings, active combatants? All factors must be taken into account as responders prepare to enter the scene and care for the victims. Historical precedent, such as the sarin gas attack in 1995 in the Tokyo subway system and the more recent use of sarin and chlorine on civilians in Syria, has also shown that, depending on the agent used, the venue, and the effectiveness of the attack, secondary exposure to these very dangerous chemicals can make responders susceptible to injury. Therefore, safety at the scene of the attack, including proper use of personal protective equipment, must be the priority for all responders.

An attack involving a single release of a chemical agent is likely to result in a clustering of victims. Victims with the most severe injuries are generally closest to the site where the agent was released; the severity of the injuries decreases with increasing distance from the site of release. A dispersed attack, such as a series of devices resulting in multiple releases over a wide area, will involve more varied patterns. The rule of severity will stand, however, with the most critically injured patients clustered around each site of release, unless exposure to the agent is characterized by a latent (asymptomatic) period before the onset of toxic effects. In this case, the most seriously affected victims may be scattered over a wider range. These patterns of severity will suggest the epicenter of the release, influencing safety concerns and decisions about where responders should initially stage and assess victims.

On arrival at the scene, first responders must rapidly identify the presence of a chemical agent and then determine hot, warm, and cold zones. The hot zone is the contaminated area, the cold zone is the uncontaminated area, and the warm zone (sometimes called the decontamination corridor), which is between the hot and cold zones, is where decontamination units can be staged. In establishing these zones, the responders must identify the event as an isolated or dispersed release and must account for the physical state of the chemical (especially liquid vs. gas), wind patterns, and any other hazards.

After safe staging has been established, it is important to determine which class of agent is present and how best to approach the scene. Some agents carry a higher risk of primary or secondary exposure for the responders than other agents. In addition, a highly volatile liquid or gas poses an immediate risk until it is dissipated, and the presence of vapor or gas is one of the most important and urgent factors to determine once responders arrive at the scene. If either gas or substantial vapor (collectively referred to as a vapor hazard) is present, responders should remain upwind and at a safe distance (at least 150 ft [approximately 50 m] away) until personal protective equipment can be donned. The current Occupational Safety and Health Administration (OSHA) recommendation for an incident with an unknown agent is to use Level A protective equipment, which is the highest degree of protection available. Level A suits include a self-contained breathing apparatus with positive pressure and totally encapsulating (head-to-toe and sealed), chemical protection. Donning Level A suits can be cumbersome and must be practiced before use to maximize efficiency. In light of the recent terrorist attacks on civilian targets, this OSHA policy may require modification to
take into account the need for rapid administration of antidotes or other treatment approaches while preserving safety at the scene.

The most definitive way to identify a chemical agent is to analyze environmental or biologic samples. Handheld devices are available for agent identification, although most have suboptimal sensitivity and specificity and require several hours for definitive classification, leading to false alarms and limiting their usefulness in the field.11 Such devices are also not always readily available in the very early phase of an event and therefore may be more useful in a subsequent phase. During the initial encounters with casualties, clinical suspicion and toxidrome recognition, aided by a rapid-triage system, will be the primary means of determining treatment protocols.

**USING TOXIDROMES TO RAPIDLY IDENTIFY CLASSES OF CHEMICAL AGENTS**

Most chemical weapons are deadly and pose a risk to responders who are tasked with providing care for those who are injured. If at any time a victim requires airway support or other emergency treatment, it should be rendered immediately, within the constraints of on-the-scene safety requirements and mass-casualty triage principles. Exposure to some chemical weapons requires immediate administration of antidotes, and rapid spot decontamination is required in all cases. For these reasons, a rapid-triage system based on the identification of class-specific toxidromes must be used for the acute phase of a chemical-weapons attack, enabling health care responders to both implement appropriate safety measures quickly and begin administering time-sensitive treatments early and rapidly (Fig. 1).

As with any strategy for making decisions in a crisis, the process should be easy to follow. The first step is to determine whether injury patterns can be accounted for by conventional mechanisms alone, such as blast, gunshot, fire, or crush. If so, responders should use traditional mass-casualty triage protocols, while remaining vigilant for the possibility of a delayed-onset chemical attack or the presence of radiation. If symptoms appear to be unrelated to conventional mechanisms of injury, responders should ensure that the scene is safe, don appropriate personal protective equipment, and move to the second step. This step entails rapid identification of toxidromes, with specific patterns matched to classes of chemical-warfare agents.

Responders should identify toxidromes sequentially, beginning with those that match the most rapidly lethal agents (for which exposed persons require emergency antidotes and treatment), followed by those that match agents for which exposed persons should undergo thorough decontamination before or concurrent with treatment (Fig. 2); three examples are provided in an interactive graphic, available with the full text of this article at NEJM.org. The possibility of the presence of nerve agents is considered first. Muscle twitching, weakness, or paralysis and increased secretions suggest that a nerve agent may have been used; atropine and pralidoxime should be administered immediately, and emergency supportive care and spot decontamination should be performed. Bradypnea or apnea, combined with gasping, collapse, and seizures, supports the presence of asphyxiants such as cyanide; hydroxocobalamin or sodium thiosulfate and sodium nitrite should be administered as antidotes, and emergency supportive care and spot decontamination should be performed. If bradypnea or apnea is combined with sedation, then the presence of miosis suggests a class of agents that includes opioids. In this case, naloxone should be administered immediately, and emergency supportive care and spot decontamination should be performed. If miosis is not present, the most likely agent is an anesthetic, which represents the first of the classes of agents for which there are no antidotes and for which decontamination, supportive care, and close monitoring are urgently required. If it is not certain whether the agent is an opioid or an anesthetic agent, administer naloxone. Any patient who has apnea will require emergency airway management.

After ruling out chemical-warfare agents for which antidotes must be administered on an emergency basis, this system identifies toxidromes associated with chemical-warfare agents for which decontamination, supportive care, and close monitoring are urgently required. Such classes include anesthetic agents; pulmonary agents (those that act both centrally and peripherally); vesicant, caustic, and riot-control agents; T-2 and botulinum toxin; and anticholinergic agents.
### Summary

An effective rapid-triage system for chemical-warfare agents need not, and in fact should not, take into account every conceivable toxidrome, since the agent can be definitively identified after the acute phase of the attack. Instead, the triage system should identify those classes of agents that require rapid treatment with antidotes, emergency airway support, and spot decontamination, and then further delineate within that group the class of agent that is present so that the correct antidote can be given.

In the absence of high-quality data, the triage system outlined here is based primarily on expert opinion, with an understanding of mass-casualty triage combined with recognition of...
Can conventional mechanisms of injury alone account for observed effects?

YES

Consider chemical-warfare agents (CWAs), maintain safety at the scene, don personal protective equipment (PPE), assess victims

NO

Treat as conventional mass-casualty incident (MCI), maintain safety at the scene, remain vigilant for possible CWA or radiation

Any patient may require emergency medical treatment at any time. Responders should provide lifesaving treatment when needed, adhering to safety constraints.

Increased secretions or muscle effects (fasciculations, weakness, paralysis), with or without miosis

NO

Bradypnea or apnea

YES

Assume nerve agent; administer atropine and pralidoxime, provide airway support and spot decontamination

NO

Gasing, collapse, and seizures with or without cyanosis

YES

Consider asphyxiants; administer cyanide antidote, provide airway support and spot decontamination

NO

Confusion

Sedation

YES

Miosis

YES

Consider opioid agent; administer naloxone, provide airway support and spot decontamination

NO

Unlikely to be CWA; reassess for conventional injuries and watch for delayed effects of CWAs

NO

Respiratory noise (coughing, hoarseness, stridor)

YES

Consider anesthetic agent (manage airway if needed; if unsure, administer naloxone)

NO

Mydriasis, dry skin, elevated temperature

YES

Consider anticholinergic agent

NO

Skin blistering

YES

Consider vesicant, caustic or riot-control agent, or T-2 toxin

NO

Consider central-compartment (large-airway) pulmonary agent

NO

Consider peripheral-compartment (small-airways) pulmonary agent

NO

Diplopia, descending paralysis, dysphagia, and mydriasis

YES

Consider botulinum toxin

Delayed-onset shortness of breath or chest tightness

YES

Eye, throat, or skin pain

YES

Consider botulinum toxin
the toxidromes associated with classes of chemical-warfare agents. This system uses experience to help address the glaring hole in our civilian-response models for chemical-warfare attacks: the inability to identify the class of agent deployed in time to successfully provide lifesaving treatment. As we witness an escalation in terrorist attacks involving unconventional methods, a toxidrome-based, rapid-triage system may become part of the armament used to prepare for and safely respond to these horrific events.

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Figure 2 (facing page). Flowchart for Toxidrome-Based Rapid Identification of Chemical-Warfare Agent Classes.

A diagnostic algorithm to be used in the acute phase of a chemical-warfare attack allows responders to rapidly detect victims who require emergency antidote administration and treatment first, followed by those who require initial decontamination and urgent treatment concurrently. Centrally acting and peripherally acting pulmonary agents are not mutually exclusive; certain agents (e.g., chlorine and lewisite) or high doses of any pulmonary agent can cause damage to large airways as well as small airways and alveoli. The red boxes indicate that urgent action is required (i.e., administering antidotes, providing lifesaving supportive care, and performing rapid, initial spot decontamination at the site). The tan boxes indicate that it is important to decontaminate immediately and provide concurrent urgent supportive care, as well as reassess frequently.
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