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NERVE Agent ATTACK

By S. Christopher Suprun Jr., EMT-P

A dangerous threat to emergency responders & the public

“If you die, we all die. Inject your heart!”

These words from the 1996 movie *The Rock* were exciting—at the time—as we watched Nicholas Cage’s character attempt to defuse a doll filled with explosives and sarin gas. However, the fantasy world of a movie disappears quickly as front-line EMS providers realize that in the post-Sept. 11 world, they may actually respond to emergencies that include the use of nerve agents to attack everyday citizens.

The excitement further subsides when we realize that our normal job of treating patients will become a secondary priority as we have to take the terms *scene safety* and *personal protective equipment* (PPE) to higher levels to protect ourselves in this new world of danger.

Preparation is the key to effective response to emergencies of this nature and cannot be underestimated. A true nerve agent attack could combine the worst possible parts of hazardous materials and mass casualty incidents. Putting plans into action in the first minutes of fire and rescue response will make the difference in the operation’s success.

Nerve agents

Nerve agents were invented in Germany by Dr. Gerhard Schrader during the 1930s.¹ He developed the first nerve agent, tabun, as a pesticide. The potential military applications of a “weaponized pesticide” became quickly apparent, and, over the years, further testing in Schrader’s laboratory and others produced sarin, soman and VX gases.

Most nerve agents are categorized as organophosphate-based, but are inherently more lethal than their pesticide cousins. They can be dispersed both in liquid and aerosolized forms. Nerve agents are generally separated into two types: G series and V series toxins.



Early recognition and use of PPE are the keys to survival of emergency service personnel.

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- The G series agents, invented by the Germans, include tabun, sarin and soman and tend to be less persistent, acting like vapor. Although most nerve agents are colorless and tasteless, G series agents have been noted to have a slightly fruity odor.
- V series agents include VX, the subject of the movie *The Rock*, and are more persistent (or viscous), like an oil-based product, than G series agents.

Even small amounts of a nerve agent gas or liquid will quickly incapacitate victims, culminating in loss of



A cavalier attitude toward nerve agent attacks, especially combined with inadequate equipment, could lead to disastrous results. Authorities believe that level C+ suits can be used when patients or incidents are located outdoors.

consciousness, apnea and muscular flaccidity.²

William A. Cain, PhD, professor of microbiology at The George Washington University, explains VX toxicity this way: “If you take a penny and drop an amount of VX equal to one one-hundredth of the size of Abe Lincoln’s head, that is the lethal dose of aerosolized VX gas.”

Another example of the toxic effects of nerve agents happened almost a decade ago (1995) when the Aum Shinrikyo cult successfully dispersed sarin gas in the Tokyo subway system. This attack led to 13 lives lost and 5,500 persons requiring treatment at local hospitals.³

Scene stabilization

EMS personnel must realize that a nerve agent attack is an extreme example of a multiple casualty and hazardous materials incident. An emergency response plan will help rescuers meet the challenges posed by a panicked and hysterical public, concern for one’s own safety and the lack of experience EMS providers have with these events. You can start your plan by using the Five Ss as a guide:⁴

- Self;
- Sizeup;
- Send info;
- Set up the medical group; and
- Stabilize.

Self refers to your own safety. Although Sept. 11, 2001, has come and gone, many EMS, fire and rescue organizations are still adjusting to the fact that the new world order includes the likelihood of future attacks on everyday citizens on American soil. You must spend time preplanning your first-, second- and third-due response areas—locations to which your units may be sent by your communications center—for potential attack targets in your area. These can include airports, hospitals, hotels, pharmaceutical manufacturing facilities, shopping centers, theaters and sports arenas.

Learn how many people could be affected by an attack and what hazardous materials might be involved. Then determine what you will need to do and what equipment is necessary to protect yourself and your crew during a response. As we learned in our very first EMT-basic class: Remember, never become a victim yourself.

Scene sizeup should always be your first step when you arrive on scene. As you approach the scene, observe for indications of the type of emergency or safety risks associated with it. Examples include people running away from a building where an obvious explosion has occurred, people lying on the ground seizing or evidence of relatively minor damage from a

small canister explosion but multiple casualties present. These can all indicate a nerve agent attack.

Ask the same questions you would normally ask. After you ensure your own safety and identify the mechanism of injury or nature of illness, determine necessary resources. Find out the number of patients involved and the possible hazardous materials on scene. Determine the need for specialized rescue teams. Sizeup should also include determining the correct address or location of the incident, establishing command and determining the appropriate boundaries of the “hot zone.”

The third S—**send info**—refers to getting your size-up

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information to the appropriate agencies and personnel. It's important to communicate the facts of an emergency to the appropriate agencies as soon as you can. There are many who can and will assist you once they know what's needed.

At a regional level, state law enforcement, environmental agencies and public works departments will need to be mobilized quickly. At a local level, additional EMS, fire and police personnel must be alerted and mobilized.

Local and regional hospitals must be warned so they can prepare for the number of patients—both those injured in the actual attack and others who will seek prophylactic treatment, even if they weren't directly affected by the incident. Hospitals will also need to call in additional staffing and key personnel. Finally, hazardous materials teams and other technically trained teams will need to be activated to confront a nerve agent emergency.

The fourth S is to **set up the medical group or EMS sector**. Use of an incident command system will enable a more successful response. Multiple triage units will be important, but you must be aware that even before first responding units arrive on scene, the lowest priority patients may

leave or attempt to leave the scene and travel to hospitals in their own vehicles. The highest priority patients will likely be in the hot zone awaiting rescue. Using a mass casualty management model will facilitate doing the most good for the most people without relocating the disaster.

The fifth S relates to **scene stabilization**. The scene should be stabilized as soon as possible. Establish hot, warm and cold zones, and limit ingress and egress to control the spread of contaminants. If you don't, people will run toward the scene trying to rescue loved ones and friends and become unknowing victims. Others, possibly contaminated, will run away from the scene in an attempt to reach safety.

Such chaos can complicate the scene and lead to additional injuries. Communications must be established quickly, and the first arriving emergency personnel must control the movement of ambulatory patients to a designated area for triage and decontamination purposes.

Patient symptoms & physiology

Once rudimentary actions have been taken to stabilize the scene, individual patients can be treated. Reactions to nerve

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Mark I kits include auto-injectors of atropine (2 mg) and pralidoxime chloride (600 mg), aka 2-PAM Cl.

PHOTO S. CHRISTOPHER SUPRUN JR.



EMS units should carry a kit with adequate antidote supplies for the crew and multiple patients.

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Severe exposures may require up to three Mark I kits and diazepam to decrease seizure activity.

agent attacks will be similar to, but significantly worse than, those of agricultural organophosphate poisonings. Symptoms may include unconsciousness, seizures, twitching, difficulty breathing associated with heavy mucous production and salivation, diarrhea, emesis and, with vapor agents, pinpoint pupils.

The same acronym we use to identify signs and symptoms for normal organophosphate poisonings, PSLUDGE, can apply to nerve agent attacks as well.

- Pinpoint pupils (present for vapor agents, but not VX);
- Salivation;
- Lacrimation (tearing);
- Urination;

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National Disaster Life Support

An evolving standardized approach to all-hazards

Following the terrorist attacks of Sept. 11, 2001, there was widespread demand for a standardized, all hazards training course that would provide educational consistency and interoperability for the myriad health-care professionals and public safety officials called on to respond to disasters, particularly events involving weapons of mass effect.

Using a congressional appropriation managed through the U.S. Centers for Disease Control and Prevention (CDC), top-level federal officials charged a highly experienced team, representing federal, military, academic health center and public safety groups, to develop such a course in spring 2002.

By Sept. 11, 2002, the team had produced the prototypes for a National Disaster Life Support (NDLS) family of courses. These include:

- *Basic Disaster Life Support (BDLS)*: This "lynch-pin course" offers comprehensive didactics through a one-day lecture format, distance learning,

interactive CD-ROMs or Web-streamed segments;

- *Advanced Disaster Life Support (ADLS)*: This two-day course puts participants through actual and virtual scenarios involving protective clothing, high-fidelity manikins and antidote administration. The course also involves administrative didactics, such as dealing with the media and mass body disposition; and
- *Core Disaster Life Support (CDLS)*: This shorter (multiple hour) seminar presents a didactic foundation for a more diverse audience.

These courses have been formally adopted by the American Medical Association, working in close collaboration with multiple national associations, military and public safety specialists, academic health centers and, in particular, the U.S. Department of Health and Human Services. The courses are currently undergoing updated reiterations following

several successful road-tests. Introductory versions are expected to be available in 2004.

A unifying theme for the NDLS family of courses is a mnemonic referred to as the *D-I-S-A-S-T-E-R* paradigm. It helps responders remember multiple issues that need to be evaluated and reevaluated during major incidents:

- Detection
- Incident command
- Scene safety
- Assess hazards
- Support
- Triage and treatment
- Evacuation; and
- Recovery.

Although developed for systematic implementation, emergency personnel may be called on to simultaneously perform multiple steps in the *D-I-S-A-S-T-E-R* paradigm or perform them in alternative orders. *Example*: Scene safety and recovery need to be performed early in most disasters. Excerpts from the paradigm's application illustrate considerations for rescuers involved in a nerve agent release:

Detection—When a terrorist releases a nerve agent, detection is key. Although detection in most chemical disasters is accomplished through several methods, such as Material Safety Data Sheets (MSDS), transport container placards or chemical sensors at an

industrial plant, a terrorist won't provide an MSDS. Therefore, detection involves the responders' suspicion of a chemical agent when multiple people from a common location become ill at about the same time. Large numbers of dead or dying animals and/or insects may also provide a clue. Many commercial systems are capable of identifying specific chemical agents on scene, but these units are costly and not available to all responding personnel. Therefore, the responders must recognize the signs and symptoms.

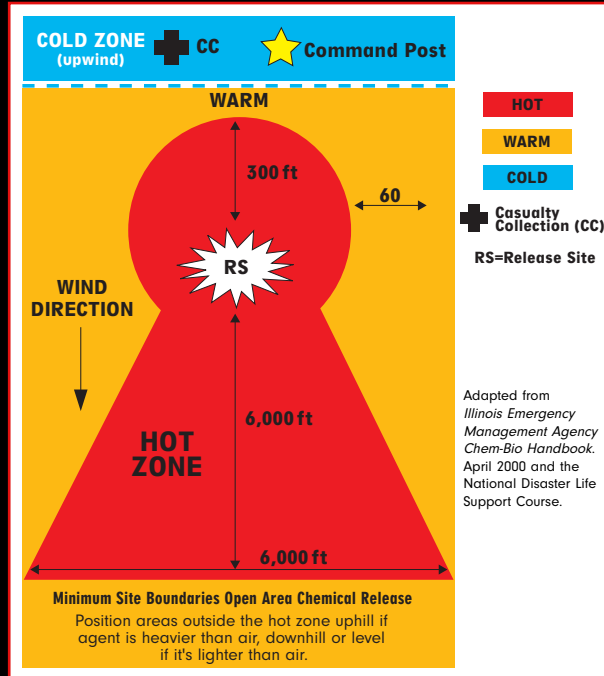
Most nerve agents are cholinergic, so rescuers can expect reports of multiple individuals from proximate locations with one or more of the following symptoms: runny nose, watery eyes, excessive mucous production, bronchospasm, vomiting, diarrhea, urination, weakness and sweating.

Incident command—Incident command (IC) is vital when responding to a nerve agent release. Multiple military, federal, state and local agencies will be involved in the response to a nerve agent release. The com-

mand post should be established at least 500 feet upwind of the release site and even farther in the presence of variable winds. Nerve agent vapors are heavier than air, so command posts should not be downhill from the release site.

Scene safety—Consider scene safety first in suspected nerve agent incidents.

Figure 1



Secondary contamination and victim off-gassing are threats to those caregivers. Therefore, providers called on to care for the suspected victims must wear PPE. The hot zone for a nerve agent event must be evacuated and secured in an area that resembles a triangle at least 6,000' x 6,000' downwind of the release site (see Figure 1). Responders should approach from upwind and enter only if equipped with the appropriate PPE and training.

Assess hazards—This process involves the investigation of potential ongoing threats. These may be existing threats not readily identified in the scene safety assessment or threats that may come from secondary devices or changing winds. Evaluation, reevaluation and mitigation of these potential hazards are fundamental.

Support—Always consider prompt (instructive) notification—through appropriate channels (as discussed elsewhere in the course)—of additional ambulances, hazardous materials teams, law enforcement, federal/state representatives, infrastructure agencies and others.

Triage and treatment—NDLS courses use the M-A-S-S triage (move, assess, sort, send) approach and standard
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military triage categories of Immediate, Delayed, Minimal and Expectant (ID-ME). Nerve agent victims with large exposures will likely die prior to evacuation, decontamination and transport from the scene. However, in the triage of nerve agent victims, one should consider the high resuscitation rate in the 1995 Tokyo subway sarin attack. If resources allow, patients should be treated aggressively.

Evacuation—Evacuation refers not only to victim removal from the scene, but also to the evacuation of the healthy public at large who may be in harm's way in the event of a spreading vapor cloud or other potential threats. The "worried well" and "walking wounded" might be actively managed on scene to prevent them from self-transporting to and overwhelming the local hospital. Effective, prospective plans for preventing this problem will allow better control of patient flow and destination.

Recovery—In a nerve agent release, recovery efforts, including measures to minimize the psychological, economic and environmental impact of the disaster, must begin immediately. Counseling services, adequate rest for personnel and environmental considerations will allow for a faster recovery from the disaster.

- Defecation;
- Gastrointestinal; and
- Emesis.

DUMBELS is another helpful mnemonic, particularly because it emphasizes the most important symptom, breathing difficulty due to bronchoconstriction and bronchorrhea. This is what kills the patient. It's also the endpoint to treatment with atropine. This acronym stands for:

- Diarrhea;
- Urination;
- Miosis (small pupils);
- Bronchorrhea, bronchospasms, breathing problems;
- Emesis;
- Lacrimation;
- Salivation, secretions and sweating.

In a normal nerve function, the body releases acetylcholine (ACh) to bridge the synaptic cleft and carry neural messages. Because the body essentially operates either "on or off," the body's counter to ACh is acetylcholinesterase (AChE). AChE is present on the post-synaptic

membrane and breaks down ACh to keep the body at a functioning level.

Nerve agents inhibit AChE, thereby over-stimulating various receptor sites throughout the body. Symptoms depend on the individual organ receiving over-stimulation. Glands will continue to secrete enzymes, and muscles will continue to contract.

Treatment

Front-line treatment for a nerve agent attack will depend on the severity of the exposure. Both levels of exposure rely on supplemental high concentration oxygen, pulse oximetry, cardiac monitoring, IV access and possible administration of Mark I kits, which include auto-injectors of both atropine (2 mg) and pralidoxime chloride (600 mg), also known as 2-PAM Cl.⁵

Atropine works by its anticholinergic properties; it inhibits ACh production. Pralidoxime chloride binds with nerve agents. This prevents the nerve agent from binding with AChE and allows normal enzyme activity. Specifically, the

Mark I kit auto-injectors were designed to be used in a hostile, dirty environment and can (and should) be used for patients in the hot zone.

Mild exposures result in minor difficulty breathing, runny nose and blurry vision. These patients should receive oxygen via non-rebreather mask and administration of one Mark I kit.

More severe exposures will require aggressive airway support, including intubation, and strong ventilatory support. These patients will need up to three Mark I kits and 10 mg diazepam (Valium), which works by decreasing overall seizure activity in the brain. These patients will manifest acute and severe difficulty breathing, muscle twitching or seizures, or may be unconscious altogether. The diazepam may even be given if the patient is not yet seizing.

For dermal exposures, signs and symptoms may not manifest for hours. Gross decontamination can be achieved by soap and water or a 10:1

water-bleach solution. Providers must take great care in decontaminating any people who were in the hot or warm zones because vapor may become trapped in victims' clothing.⁶ Remove clothing, and complete decontamination to ensure rescuer and hospital personnel safety.

As previously noted, the best treatment for nerve agent attacks is to avoid direct exposure. As in all hazardous materials emergencies, the best way to limit exposure is through time, distance and shielding.

Time will be controlled both by limiting personnel time in hot zones for triage, rescue and patient decontamination and by the constraints of personal protective equipment.

Distance will most easily be maintained by defining hot, warm and cold zones as in any hazmat emergency. The U.N. identification number for nerve agents is 2810 and requires immediate evacuation distances (see sidebar p. 66).⁷

The best treatment for nerve agent attacks is to avoid direct exposure or to limit exposure through time, distance & shielding.

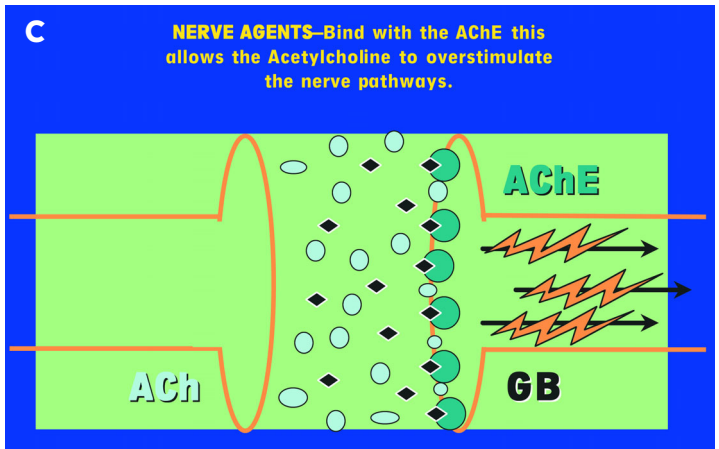
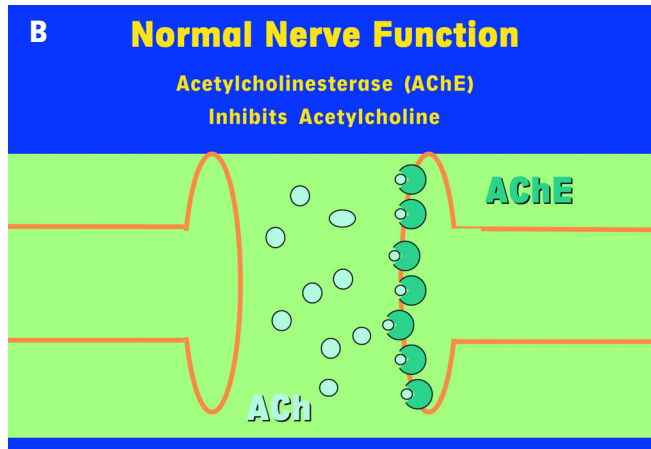
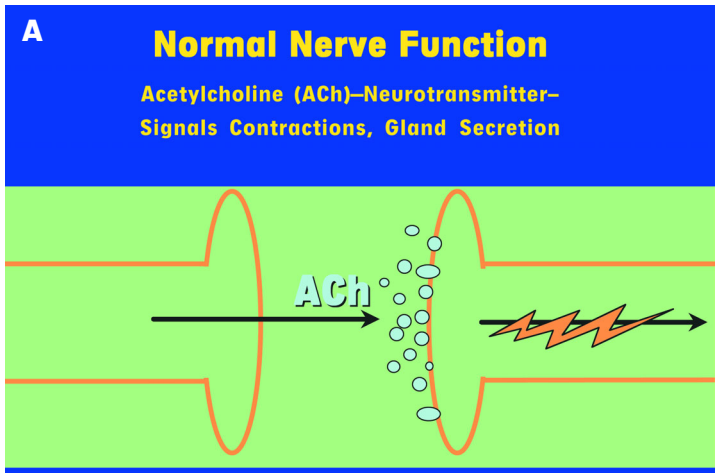
Shielding starts by being uphill and upwind of a vapor attack and includes appropriate PPE. Although some authorities feel it should involve Level A self-encapsulated suits or military chemical agent equipment, others point out that level C+ may be sufficient if the event or victims are outdoors. This reduces the challenges of working in a level A suit. Standard structural firefighting turnout gear with self-contained breathing apparatus (SCBA) will not adequately protect the rescuer during a nerve agent attack in most cases. Although there has been some study of the usefulness of turnout gear in these attacks, data are limited.

The U.S. Army issued a report in August 1999 with guidelines stating "self-taped turnout gear with SCBA

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provides sufficient protection in an unknown nerve agent environment for a three-minute reconnaissance to search for living victims.”⁸ Although this statement would seem to indicate some hope for the possibility of victim rescue, it’s important to stress the importance of having trained providers perform this level of work, with

In normal nerve function, ACh signals contractions and gland secretion (A). When nerve agents are introduced, they bind with and inhibit AChE (B). This causes ACh to overstimulate the nerve pathway (C).



rescuer and patient decontamination available prior to initial entry. This fact makes these types of rescues unlikely, and rescuers are strongly warned against attempting them.

By attempting rescue without appropriate PPE, you open yourself up to injury, illness and increased number of casualties overall. "Not only does traditional structural firefighting gear limit responders' capabilities with its durability, weight and bulk, but research is also suggesting that it is not a very effective barrier for chemical weapons agents," says Lt. Brandon W. Graham, BS, NREMT-P, an EMS supervisor with the Washington, D.C., Fire and EMS Department. Therefore, a cavalier attitude toward nerve agent attacks, especially combined with inadequate equipment, could lead to disastrous results.

Conclusion

EMS systems across the country are racing to purchase PPE and chemical response kits in preparation for the next terrorist attack. Although this recent focus on threats facing us every day is good, we must not forget the lessons we have learned already in managing hazardous materials operations, mass casualty incidents and organophosphate emergencies. By applying our enhanced knowledge relating to these types of chemical emergencies, along with newly developed tools for use

by first responders, we will be able to better respond to these events should the need arise. JEMS

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