Chemical Agent Terrorism

By S. CHRISTOPHER SUPRUN

As I thumb through the book, "How to Perform a Tracheotomy" is on page 88. Not what I'm looking for. On page 91, I find out "How to use a defibrillator to restore a heartbeat." No, not that, either. If I continue on, I can also learn how to deliver a baby in a taxicab. Mind you, this isn't a new EMS textbook; it's the mass-market *The Worst Case Scenario Survival Handbook*.

What I was looking for—in among the multitude of topics ranging from general survival, to golf, work, and even dating—was some information about what to do in a chemical attack. Nothing doing. Unfortunately, that puts the book more or less on even footing with most EMS textbooks. In our world today, response to nerve agent attacks doesn't need to be a mystery and should be part of the training we undertake to protect the public and ourselves.

Suitable response to chemical agents hinges on responders' preparation prior to the attack. Preparation doesn't mean reading a magazine article, either; it means finding resources such as Level A suits, negotiating mutual-aid and training agreements with local and regional jurisdictions, and the preplanning of target hazards.

In fact, without adequate knowledge, preplanning and execution, first responders may themselves become victims of the attack, instead of rescuers. An attack of this sort is a combination of a hazardous-materials and a mass-casualty disaster, creating an awesome new monster of its own. Careful but immediate follow-through by emergency medical services responders can help make or break the operation involving a chemical attack.

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Scene Stabilization

Terrorism combines the worst of mass casualty and hazmat incidents. We will use the Five Ss as a guide to put together a response plan.[1] If you are not familiar with them, the five Ss are:

1. Self
2. Size-up
3. Send info
4. Set up the medical group
5. Stabilize

Self means what you should do to secure your own safety. There is no reason to compromise your safety to become another victim. Any type of warning indicator should make you reconsider your safety. Whether it is an unusual cloud, mist, vapor, or that sixth sense or inner voice that says something is not right—listen to these warning signs.

Scene size-up should be done on the way to the scene and when you arrive. Are there indicators that make you suspect something out of the ordinary from your usual call? Was there a small explosion with a cloud dispersed, with bystanders reporting multiple patients sneezing, coughing, or seizing? Are there multiple patients without trauma or multiple patients presenting with similar symptoms?

Send info involves getting your size-up information to the appropriate agencies and personnel. This includes establishing hot, warm, and cold zones. Remember, multiple agencies will be involved in mitigating terrorist attacks, starting with local fire, EMS, and law enforcement. The circle of those involved will quickly increase to include federal law enforcement, in particular the FBI. Environmental agencies and local or state health departments may also be involved, as will hazmat or other technically based teams.

Remember, too, to alert the local and regional hospitals. As in any mass-casualty situation, it is possible for many people to self-refer to the closest hospital. Imagine if 100 people showed up to your local ER for treatment. Multiply it by 10. Consider that they all may still have contaminant in their clothes when they show up at the hospital, and you can begin to imagine the ramifications both of treating these patients and preventing cross contamination.

"Early warning to the local and regional hospitals is essential to provide hospital personnel an opportunity to protect themselves, their patients, and their facility," said Dan Brunner, the Director of Disaster Preparedness for the Dallas-Fort Worth Hospital Council.

Setting up the medical group is the fourth S. Triage and treatment will be going on as the incident command system is being set up. Many victims may be self-referring to local hospitals in personal vehicles, and family members will rush to the scene after your local television station catches wind of the crisis.

The medical group has several important functions to carry out, from triaging scores of victims to developing a transportation plan to tracking where each of these patients ends up, and following their outcome.

The final S is **start scene stabilization**. Obviously, scene stabilization is a priority. Hot, warm, and cold zones should be determined as quickly as possible. Ingress and egress control should be set up to minimize the spread of contaminants and evidence. Although responsibility for the incident will ultimately fall to whoever is established as the incident commander, other steps such as controlling movement in and out of the scene can be started without someone taking command.

Nerve Agents

You have to wonder why nerve agent attacks aren't covered in *The Worst Case* or in textbooks more completely. Could it be that these are just "alarmist scenarios"[2] that aren't realistic, or have memories of other chemical attacks faded already? Some sources doubt that chemical attacks are likely and say that the tendency is for the government to "exaggerate the threat of chemical and biological terrorism which has been reinforced by sensational reporting in the press and an obsessive fascination with catastrophic terrorism in Hollywood films, best-selling books, and other mainstays of pop culture."[3]

The real possibility of a nerve agent attack exists today. As you may recall, Aum Shinrikyo weaponized and dispersed sarin from a Thermos-style container in 1995. Thirteen lives were lost and more than 5,500 people were treated.[4] Terrorists have access to the chemicals to develop and synthesize these agents and have demonstrated a sophisticated ability to use them against civilians. Data also exist that show the number of injured were inflated because many of the thousands who were treated were actually "well" wounded who thought they were exposed and had other less significant diseases but still crammed emergency rooms and hospitals throughout Tokyo.

These statistics are enormous, and communities should consider the strain on resources that would result if this type of attack should occur. How many more people would self-refer, and how many more events would we respond to for a mist in the air? From a personal standpoint, I know that "white powder" calls taxed the system in Fall 2001 after anthrax had been found at the Brentwood Post Office in Washington, D.C. How many calls would fire and rescue receive for other events if an actual nerve agent attack occurred in America?

Beyond the science of developing a nerve agent, how hard would it be to attack? Using a Thermos-style container with a compressed gas system, a terrorist could aerosolize a nerve agent. Imagine that it is the day after Thanksgiving and you and your crew at the firehouse are settling in for what you hope to be an uneventful day of digestive activity. Out of the blue, you hear the shopping mall's first-due ambulance and fire engine dispatched for a reported explosion. As they race to the scene, 911 receives dozens of calls for a small "firework type" explosion in the center of the mall, near the food court. People are calling 911 because the explosion has "aggravated their asthma" or kicked up dust which is irritating their eyes, which won't stop tearing. Other calls also describe the explosion, and callers say that though it was not that large, it has caused the people closest to go into convulsions, and some even look like they are choking.

As the first-due companies race to the scene, they may request additional units to be dispatched because of the unusually large number of 911 calls being received from separate patients, many with similar symptoms. Victims are having difficulty seeing and trouble breathing; others are seizing uncontrollably, and still others appear dead. These symptoms and others can be remembered by the mnemonic DUMBELS, which stands for:

Diarrhea **U**rination **M**iosis **B**reathing problems

Emesis (vomiting) **L**acrimation (tearing) **S**alivation, secretions and sweating

While DUMBELS does not represent central effects such as weakness, paralysis, and coma, it is a useful mnemonic for remembering many of the other health effects to the body post exposure.

As you may remember from your initial EMS training, the body uses a chemical called acetylcholine (ACh) to operate bodily functions. Acetylcholinesterase (AChE) will stop the bodily function that had just been turned on. While the on/off analogy is a little simplified, it serves a useful purpose in discussing the effects of nerve agents. This on/off seesaw helps keep the body in balance.

Nerve agents attack acetylcholinesterase, making various organ systems receive non-stop "go" messages of acetylcholine and causing an over-stimulation in these organs. All these organs are served by the cholinergic portion of the nervous system and have muscarinic receptors or nicotinic receptors or both. The continuous stimulation of various receptor sites throughout the body causes the body to have any of a number of effects stemming from either the cardiovascular or central nervous systems. These consequences may be as "minor" as sneezing, runny nose and "unstoppable" tearing or blurred vision. However, a more severe exposure could find our patient in the mall unconscious, incontinent for urine and feces, and seizing.

Because of the vast amount of space that would need to

be covered and the number of victims, this first-in unit officer decides to set up the initial triage and decontamination system to help the victims who are alive before risking the lives of his crew. With additional units added to the call, a gross decontamination system is set up; the walking wounded are directed there and washed down with water from a fire engine using tank water and a trash line. (Your department may or may not have a system in place for conducting gross decon, and local SOPs should be followed.) Firefighters have prepared a set of buckets with soap and brushes so that patients can be instructed in self-decon from a safe distance before being moved to awaiting EMS providers.

EMS providers will then start direct care including starting supplemental oxygen, taking patient vitals, and using Mark I kits. Mark I kits include two intra-muscular auto-injectors. The first has 2mg of atropine and the second has 600mg of pralidoxime chloride, also known as 2-PAM Chloride. Mark I kits were designed for the military to be used in hostile "hot" environments and can be used through clothing.

Specifically, atropine is an anti-cholinergic drug and a competitive antagonist of ACh. Atropine will keep the effects of excess acetylcholine from occurring, though it does have a preference for some organ receptor sites—the muscarinic receptors in particular. The second part of the combination, 2-PAM chloride, provides a mechanism to stop the permanent binding of the nerve agent to the acetylcholinesterase, breaking the agent-enzyme bond and restoring normal activity to it.[5] Nerve agents permanently bond after varying periods of time depending on the nerve agent used, but response to these incidents should be occurring before the aging process sets in.

For the most part, unfortunately, Mark I kits that are in fire and EMS tend to be relegated to hazmat units or medical response units. In some cases, individual engines and ambulances or medics have been issued these kits for self-use while evacuating from an area that was inadvertently entered, but they are generally not immediately available in large enough stockpiles to provide care to multiple patients.

More severely injured patients may have to await treatment as hazmat crews set up their technical decon system and prepare for a hot entry to remove victims who were closest to the dispersal. Depending on the resources available, those patients will need aggressive airway support, likely involving intubation and artificial ventilation to support their respiration, and up to three Mark I kits. Because they are likely seizing as well, intravenous access should be obtained as soon as possible, and diazepam or other sedatives should be used to stop or slow the seizure activity. Anticonvulsants can also be administered intramuscularly in some cases to save time.

You will notice that because of the nature of the call, fire and EMS responders did not venture into the mall with reckless abandon, but rather started with a coordinated effort to have the right systems in place first. The first-due engine company officer, who established command using a unified incident command approach, remembered a report from his

Army Reserve training that said self-taped turnout gear with SCBA affords approximately three minutes to perform a reconnaissance to search for live victims in an unknown environment with a possible nerve agent attack.[6]

Ultimately, on what is the busiest shopping day of the year, hundreds of patients would likely be triaged and treated. Some shoppers who had already left the mall when the explosion happened would hear about the events and likely would go to their closest hospital for evaluation of symptoms that concern them. All victims might be saved, but more realistically, some will not, because of the large number of people needing to be treated. Hopefully, no first responders are injured or killed because of a lack of training or by acting without regard for their own safety in this dangerous situation.

The following are a series of separate chemical attacks that might occur and some of the potential difficulties that surround them. They vary from the very deadly to mostly a nuisance, but all might be situations to which you are called at one point or another in your career.

Cyanide

Cyanide gas is a chemical that poses some danger to the community as a terrorist weapon. It was first used in World War I; the French used 4,000 tons over the course of the war.[7] Cyanide, like nerve agents, can be absorbed through the skin or inhaled into the lungs.

Cyanide is most effectively used as a weapon in enclosed spaces as the LD50 (dose capable of killing 50 percent of a population) for skin exposures is 100mg/kg. Inhalation risks can cause death within six to eight minutes at concentrations of 2,500-5,000 mg-min/m^3 or higher. In World War I, the French had limited success because their munitions were one to two pounds each and could not deliver high enough concentrations of cyanide to initiate biological effects.[8] It would take almost 7 grams of cyanide administered dermally to kill a 150-pound person. This would not be very effective but could cause symptoms that, unaided, could bring on death.

Following exposure, cyanide travels throughout the body combining with ferric iron in a component of the mitochondria, cytochrome a3. This enzyme is thereby inhibited and prevents aerobic metabolism. Cyanide also has a high affinity for the ferric iron in methemoglobin. Anaerobic metabolism occurs, and metabolic acidosis becomes a trademark of the cyanide poisoning.

A cyanide-poisoned patient will likely have normal or dilated pupils, whereas a nerve agent victim will have pinpoint pupils (in most, but not all cases). Additionally, a cyanide victim will not have the large amount of oral or nasal secretions that the nerve victim will. A cyanide patient usually is not cyanotic, whereas the nerve agent victim will be.[9]

Treatment for cyanide poisoning should again start with removal to a clean environment. Removal of clothing and decontamination will again follow along with typical BLS or ALS care. Another specific medical antidote is also available in amyl nitrate. Amyl nitrate converts hemoglobin into methemoglobin, which has a higher affinity for cyanide than does cytochrome a3. Because of this, the cyanide and methemoglobin bind and are later enzymatically degraded.[10] This is a non-toxic event and allows the cells to return to normal ATP production.

Sodium thiosulfate is another drug that can assist in acute cyanide poisonings and has similar effects in degrading the cyanide to a non-toxic chemical. Although a number of EMS systems do not carry sodium thiosulfate or even amyl nitrate, patients should still be treated aggressively, as there is some evidence that suggests supportive care alone may help patients to recover, even if initially apneic.[11]

Take particular care, however, if the cyanide patient may also be suffering from carbon monoxide inhalation, as classic cyanide antidotes may exacerbate the effects of the carbon monoxide.

Other Agents

Riot control agents, though not lethal like nerve agents or cyanide, can be used as "prank events." Simply using an over-the-counter pepper spray in a setting such as a school bus can lead to a panic similar to that of an actual nerve agent attack.

We should not cling to outmoded fears of the unknown.

Multiple patients with mild to moderate difficulty breathing can challenge responding EMS providers and create a frenzy among worried parents.

Examples of riot control agents include CN and CS spray. CN, or chloracetophenone (sold under the trade name Mace®), is classified as a lachrymator and will cause pain, burning, tearing, and runny nose.[12] Similar effects will come from CS, or othorochlorobenzalmalonitrile, though it is classified as an irritant. CS is more forceful and a less lethal version[13] of CN.

Decontamination of both of these chemicals will occur naturally and does not necessarily require water, saline, or anything else. The eyes are best decontaminated with tears from the tear ducts, but if particles are lodged in the patient's eyes, washing with copious amounts of water is recommended. Any form of water or saline will also spread the chemical to other parts of the patient's body, causing additional pain and panic. Effects should wear off in minutes when exposed to clean, fresh air.[14]

Even if an entire CS or CN device is dispersed, this is still a minor release, and much of the product will dissipate on its own. The U.S. Department of Transportation's *Emergency Response Guidebook* says the victim should be kept "warm and quiet" and care should be taken to avoid "spreading material on unaffected skin."[15] Treatment should include supplemental

oxygen administration and psychological reassurance to keep the victim calm so that the contamination is not made worse by movement or sweating.

This seems a surprise to many, but if you have ever had the opportunity to participate in police drills and were exposed to CN or CS, you realize how hard it is not to move and how quickly you "self-decon" without external aid.

Conclusion

As EMS systems prepare for terrorist threats, the very real possibility exists that it may involve a chemical weapon of some sort. Some have complained that our Tom Clancy/James Bond society expects far worse than will ever occur, but they seem to quickly forget that Tom Clancy wrote about a commercial airliner being driven into a government building in 1994[16] — seven full years before terrorists attacked the World Trade Center and Pentagon on September 11.

While recent preparation of many communities represents a positive first step, we should not cling to outmoded fears of the unknown, nor rush into situations that by their very nature require careful consideration. Using skills we have already developed in hazardous-materials and mass-casualty incidents, we can take on these threats effectively and appropriately by working to protect the public and keeping ourselves safe too. This will keep our next chemical attack from being our worst-case scenario. ●

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