THE DAY AFTER: RESPONSE TO NUCLEAR-RADIOLOGICAL TERRORISM

BY S. CHRISTOPHER SUPRUN JR.

IN 1983, JASON ROBARDS STARRED IN A MADE FOR TELevision movie called "The Day After" about a surprise attack by the (then) Soviet Union. The movie shocked the audiences who saw it by its intimate portrayal of the horrors associated with nuclear fallout. Many of us have these same images engraved in our minds from a generation of nuclear brinksmanship played out between the United States and its former adversary, the Soviet Union. The story has changed as we fast-forward to 2005 with terrorists who are willing to use nuclear and radiological materials not as a bargaining chip or a bluff at the summit table but as a tool for religious, social, and economic nirvana.

Atomic energy's potential as a weapon gained notoriety when Enrico Fermi discovered how to separate the atom in 1942. The atom is separated into protons, which are positively charged, and neutrons in its center. Atoms also have electrons, whose charge is negative. The electrons rotate around the atom's core in separate orbits about the center based on the atomic weight of the atom in question. Atoms are the building blocks of the universe and when they are separated, or forced together, they can create enormous amounts of energy. The men and women who developed atomic weapons created a creature that we now must carefully control. Atomic energy can neither be held too tightly nor too loosely as disaster awaits us on either extreme. Atomic energy, which saved thousands from continued war during World War II, endangered just as many in the Cold War and today, in what Count de Marenches calls "the Fourth World War," or the war on terrorism.[1] As first responders, our responsibility is to understand the science of atomic energy, just as we understand the science of combustion. With this knowledge we can be proactive in our response and not reactive in fear.

One example of this power, and of the hydrogen bomb in particular, came in 1952 when the Ivy Mike bomb was detonated on Elugelab Island in the Pacific Ocean. The detonation created a fireball five kilometers in diameter and a mushroom cloud that reached 17 kilometers into the atmosphere in 90 seconds. The blast also created a crater 6,000 feet across and 160 feet deep. The cloud from the fireball drew up 100 million tons of debris and the island was obliterated, literally wiped clean from the Earth. This device was approximately 10 megatons, the equivalent of 10 million tons of TNT, or more firepower than had been dropped by Allied Forces during World War II.[2]

■ **S. CHRISTOPHER SUPRUN JR.,** NREMT-P, CCEMT-P, is an the EMS trainer for the Carrollton (TX) Fire Department and a 12-year paramedic/firefighter and instructor. He has taught and written on EMS, terrorism response, and incident management for fire departments, federal and local law enforcement, and private industry. He is an adjunct instructor in emergency medicine at The George Washington University Emergency Health Sciences program in Washington, D.C.

RADIATION TRAVEL/PENETRATION

The way in which radiation travels is an important factor in fire and EMS response to radiological incidents. Just as we select specific personal protective equipment (PPE) for diseases, we wouldn't consider using a mask for a bloodborne disease, because a mask only provides protection from particulates and airborne agents. With radiation, as with disease processes, we need to look at how radiation is transmitted. Radiation is just "out there," but different radiation gets to us in different ways, and we must protect ourselves accordingly.

The four types of radiation are alpha, beta, gamma/x-ray, and neutron. Alpha radiation travels just inches from its source and can be stopped with almost anything from the dead layer of skin to a piece of notebook paper. Beta radiation travels slightly farther, penetrating some skin, but can be stopped by simple materials like wood. Gamma radiation is stopped only by dense metals such as lead and poses a greater risk to fire and EMS responders. Neutrons travel with great intensity and are deflected by water or other dense materials, losing some of their energy in the "collision."

To understand radiation's ability to permeate materials may be easier to understand with the following analogy. Imagine a chain link fence. Alpha energy is akin to a bowling ball rolling toward the fence—the fence will easily stop the ball when it comes in contact. Beta energy is like a tennis ball; if you throw it toward the fence, it may get embedded in the links of the fence, but it will be stopped. Gamma radiation is akin to a bullet fired toward the fence; it will travel through the links without difficulty and continue on until its energy has dissipated or something heavy stops it, such as a lead wall. Finally, neutron radiation is like the light from a flashlight aimed at the fence; its energy will pass through the fence and travel for hundreds of yards beyond.

As in the analogy, note that the alpha and beta radiation travel as solid objects (i.e., particles) such as radioactive dust that can be inhaled into the body. Since this is a possibility, any response to a suspected radioactive incident should include using airborne particle protection with a HEPA 95 filter mask or better, so that particulates are not inhaled.

Gamma radiation, on the other hand, travels as a ray; Level A hazmat suits provide no more protection from gamma radiation than bunker gear—very little to none. Therefore, responders must use the ALARA principle—as low as reasonably achievable. This concept may be unfamiliar to many providers but may be understood as time, distance, and shielding. Whenever we are in a hazardous materials environment, we will want to limit our time, increase our distance from the contamination, and increase our shielding. The same principles apply when dealing with radiation.

ORDINARY EXPOSURES

Because we don't work with radiation every day, there is a natural but needless apprehension in dealing with radiation incidents. Most of our fears are overcome with factual information. The reality of radiation is that although it does pose some dangers, it is a common denominator in all of our lives and, in some cases, less dangerous than other choices we make every day. Radiation has been around since the beginning of time.

We are exposed every day to multiple radiation sources including cosmic, natural, and man-made radiation. An example of natural radiation is radon. Man-made radiation is not limited to nuclear weapons. If you are a police officer, you may have tritium night sights on your pistol. Anyone who has visited the local emergency room or dentist as a patient probably has been exposed to X-ray radiation. Firefighters aren't exempt either. Many departments install smoke detectors for individuals in the community, and they have radioactive sources in them as well. These sources do generate radioactive emissions, but the amount of radiation is so small we don't fear it. Every day we receive approximately 1 millirem (mRem) of radiation simply from radioactive sources affecting us from outer space. This is 365 mRem per year and is considered normal—the U.S. Environmental Protection Agency (EPA) does not even include it as part of the annual radiation dosage people receive.

Let's put the danger of "routine" radioactive exposure in perspective. We know we will be exposed to at least 365 mRem of radiation from outer space annually. The EPA limits additional exposure from natural sources at 100 mRem per year for the general public. If you experience 100 mRem of radiation every year, after 70 years, your life expectancy might be shortened by 10 days.[3]

However, any number of other routine exposures, experiences, or life situations will, on average, shorten one's life by much more. For example, according to statistics, alcohol abuse reduces life expectancy by one year; being 25 percent overweight by 777 days—more than two years; and smoking a pack of cigarettes a day by 2,250 days or roughly six years. Worse than that, being an unmarried male will reduce life expectancy by nearly 10 years, or 3,500 days; an unmarried female's life expectancy could be reduced by 1,600 days (3).

Another area of concern for both the general public and responders is the fear of developing cancer from excess radiation. Accurate information here can also reduce this fear. The EPA reports that in a sample population of 10,000 people, it would expect

2,000 (20 percent) to die from cancer that is not attributed to radiation. The EPA estimates that if the entire group of 10,000 were exposed to one Rem of ionizing radiation over the course of their lifetimes, another five or six would die of cancer. This represents approximately 0.06 percent of increased risk.[4]

These statistics do not imply that you can be less careful when dealing with a suspected radiation event, but it will give you some reassurance that, with good tactical judgment and planning, you can do your job effectively. This preparation is essential precisely because you will not need to use the information day in and day out—all the more reason to have contingency procedures in place. You may think that your first-due will never be the site of a radiological terrorist attack, but, unfortunately, the means and desire are out there to hit you or your neighbors. Joint planning and training is an important component of preparing for a radiation dispersal device (RDD) attack.

"DIRTY BOMB" (RDD) ATTACK POTENTIAL

"In the Washington, D.C. region we are tackling the possibility of a radiological attack with a joint effort, with multiple jurisdictions around Washington working together to attack radiological emergencies that occur here," said Mike Sellitto, deputy chief for special operations with the District of Columbia Fire Department.

Applied as an RDD or "dirty bomb," these effects could be devastating. The United States Code has several definitions of a weapon of mass destruction, but clear among them is the use of "any weapon that is designed to release radiation or radioactivity at a level dangerous to human life."[5]

Is it possible for terrorists to have the ability to strike America with a radioactive dispersal device? Many articles on terrorism discuss the ability of any would-be terrorist to obtain explosive materials at any time and in any city with a quick trip to a local feed/farm supply store. But can they develop an RDD? Although a number of WMD professionals and first responders have said they consider the likelihood of an RDD attack on the United States limited because of the technical knowledge required, one story that came out a few years ago should concern all involved.

In 1995 in Golf Manor, Michigan, a quiet suburb of Township, officials from the EPA were scouring neighborhoods in haz-mat suits with various radiation detectors. In their search, initiated by a curious police officer, they found that a local high school student working toward his Eagle Scout certification had built a nuclear breeder reactor in his backyard. Working with enthusiasm, determination, and a little science knowledge, and employing mostly common household radiological sources, this teenager had built a nuclear reactor and created an environmental mess. Imagine the results of the same scenario involving a terrorist using more powerful radioactive materials and conventional explosives.

How dangerous actually was this reactor? The startling answer is that the reactor was powerful enough to qualify parts of his neighborhood for Superfund status. Dangerous levels of radioactivity were detected five doors down from where the teenager was building this reactor. Although the cleanup only lasted a few days, it cost $60,000. Although this teenager was not building a RDD and did not have bad intentions with this project, this episode should demonstrate that it is possible to synthesize and construct a nuclear device and that a terrorist could conceivably build a dirty bomb.

EMERGENCY RESPONSE

As a first responder, you may be called to respond to an explosion involving the dispersal of radioactive materials. Two types of health effects for victims and responders are physical injuries resulting from the detonation of the conventional explosive and the effects of radiation exposure from the material used in the device. A standardized triage method such as START (simple triage and rapid transport) will help organize victims into appropriate treatment categories, but triage in a radiological incident is different. Patients need to be categorized as *clean* immediate, delayed, walking wounded, or dead; and *contaminated* immediate, delayed, walking wounded, or dead. I know this raises red flags, but patients must be triaged and segregated based on their level of radiological contamination. This will be a complex process of first triaging patients based on the standard method of green, yellow, red, or black and then using a Geiger-Mueller or other radiation detector to locate contamination sources and then direct patient movement into either a decon line or treatment area. For our purposes, patient contamination may be indicated if readings indicate twice that of background radiation readings when responders first arrive on-scene.

Regarding exposure and contamination, consider the following analogy to radiation exposure and contamination. If you are sitting at a bar having a beverage, you are exposed to the beverage. As long as the beverage sits on the counter, there is no contamination. Should you drink it or make an inappropriate advance and it gets poured on you, then you are contaminated.

Since red flags have already been raised about treating patients who have not been decontaminated, let me now add bright, blinking lights to the situation and add that patients requiring immediate treatment should be treated first and even transported to the ER without decontamination, other than clothing removal, if they require immediate treatment to save their lives.

"If you're an EMS responder and your job is to save lives, then save lives," says Major Craig Moss, a member of the Pentagon's CBRN (Chemical, Biologic, Radiologic, and Nuclear) Directorate. "You're getting 80 to 90 percent of the contaminant off just by removing their clothes."

Treating patients without deconning them seems awkward at best, but this is supported by the *U.S. Department of Transportation Emergency Response Guidebook*. If a victim is exposed to even 25 Rem (the EPA's threshold for entering a situation only for lifesaving purposes), then that person has been exposed to one-quarter of the threshold amount at which medical effects for acute radiation exposure are demonstrated and should be evacuated from the danger zone and treated.

"The golden hour clock doesn't stop just because a terrorist uses a dirty bomb. Most of these injuries are going to be from the conventional explosive and will need advanced care. Radiation should not stop fire and rescue personnel from doing what they do best—providing victims the best chance to live," says Moss.

For patients who are not critically injured, decon must be performed carefully and thoroughly. Although decon of radiological victims could take an entire article on its own, I will highlight a few key elements. First, perform a radiological assessment using a Geiger-Mueller or other radiation detector, slowly moving it over parts of the body to locate any radioactive contamination. After this, victims will not be subjected to the typical decon "drowning" that we routinely practice in haz-mat drills. Instead, victims of radiological contamination will be deconned using a "half-dry" decon method.

Typically, with dry decon, we are considering biological exposure. In this case, we use a decon method that will not flush contaminant into the ground, sewer systems, and water tables—the SQIRT method of decon: Spray (the clothes); Quarantine (or protect the airway); Incise (cut) the patient's clothing; Roll and remove the clothing; and Transfer the contaminated material to an overpack drum.

DRY DECON

The dry decon method starts wet; the victims are sprayed with squirt bottles. This is done very minimally and is intended only to keep any radioactive alpha or beta particulates from becoming airborne.

As usual, providers will concentrate on the patient's airway. It is important to keep the victim's airway protected from any dust that does become airborne, so keep the airway "quarantined" and protected by using a nonrebreather mask or HEPA filter mask.

Next, make two symmetrical cuts or incisions down the patient's clothing. Make these cuts layer by layer, not through all the clothes at once.

After cuttting, clothing is rolled down the patient for removal and transferred to an overpack drum. The patients can then be transferred to the next decon stage in which they are wiped down with a tepid liquid solution to remove contaminant.

The patients are then reassessed for contamination with a radiation detector to determine if twice the level of background radiation is still present. If so, they may need to be redeconned or moved to a special casualty collection point for further specialized treatment.

SCENE MANAGEMENT

Additionally, among those things that must be done to manage the scene are the Five Ss: Self, Size-up, Send information, Set up the medical group, and Stabilize the scene. Using a system like this to make sure that all the bases are getting covered is very important.

Self. Nothing has changed from a bombing or chemical attack in dealing with radiation. You should still hold your own safety as the most important scene consideration. Rule One has always been to make it home at the end of your shift—injuring yourself or entering situations that require mitigation of some sort is reckless and inappropriate.

Size-up. Is this a conventional explosive blast or are there any indications of radioactive materials? What do you see; how much of it; and, specifically, where are victims, structural damage, and so forth? Now, before you commit yourself to being the scene responder, stop. Report what you see. What is typical of your scene, and what doesn't fit?

Send information. Obtain and communicate good reliable information so that additional units including haz-mat teams can be deployed, Federal Bureau of Investigation/police resources can be informed, and hospitals can be prealerted. This is an enormous task that must be done; our professional dispatchers can do it with the correct information and appropriate direction.

Set up the medical group. Initiate triage and treatment sectors. Finally, on completion of the initial steps, help get the job done. Remember that victims of an RDD attack will possibly have multiple medical issues. Symptoms could include blast injuries from the conventional explosive used to disseminate the radioactive material and burns from the explosive or from radioactive material.

Stabilize the scene. Control ingress and egress of victims and bystanders who want to help but may injure themselves in their efforts.

• • •

After reading this, fire and EMS responders will be more comfortable providing their services at a radiological incident scene. Training on measuring radiation and providing contaminated victims with dry decon will mitigate this catastrophe more smoothly should it happen in your community. While the great minds of the past century such as Einstein, Fermi, and others made discoveries that eventually led to the development of these horrific weapons, you don't have to be a genius to attack these events successfully and safely, and the day after you can be back at the station house knowing you tackled the task at hand. ■

References

1. De Marenches, Count, and David R. Adelman, *The Fourth World War: Diplomacy and Espionage in the Age of Terrorism,* Morrow, 1992.

2. Clarke, T. "Reflections on the golden jubilee of the first H-bomb test." *Nature*, November 1, 2002. Available at www.nature.com/nsu/nsu_pf/021028-10.html.

3. "General Employee Radiological Training," TMS course ESH738, Advanced Photon Source. U.S. Department of Energy. May 1999. Available at http://www.aps.anl.gov/user/gert/gert1.html.

4. Environmental Protection Agency, "Understanding Radiation," March 4, 2004. Available at http://www.epa.gov/radiation/understand/health_effects.htm.

5. United States Code 18, Part I – Crimes, Chapter 113B – Terrorism, Sec. 2332a, C 2 d.