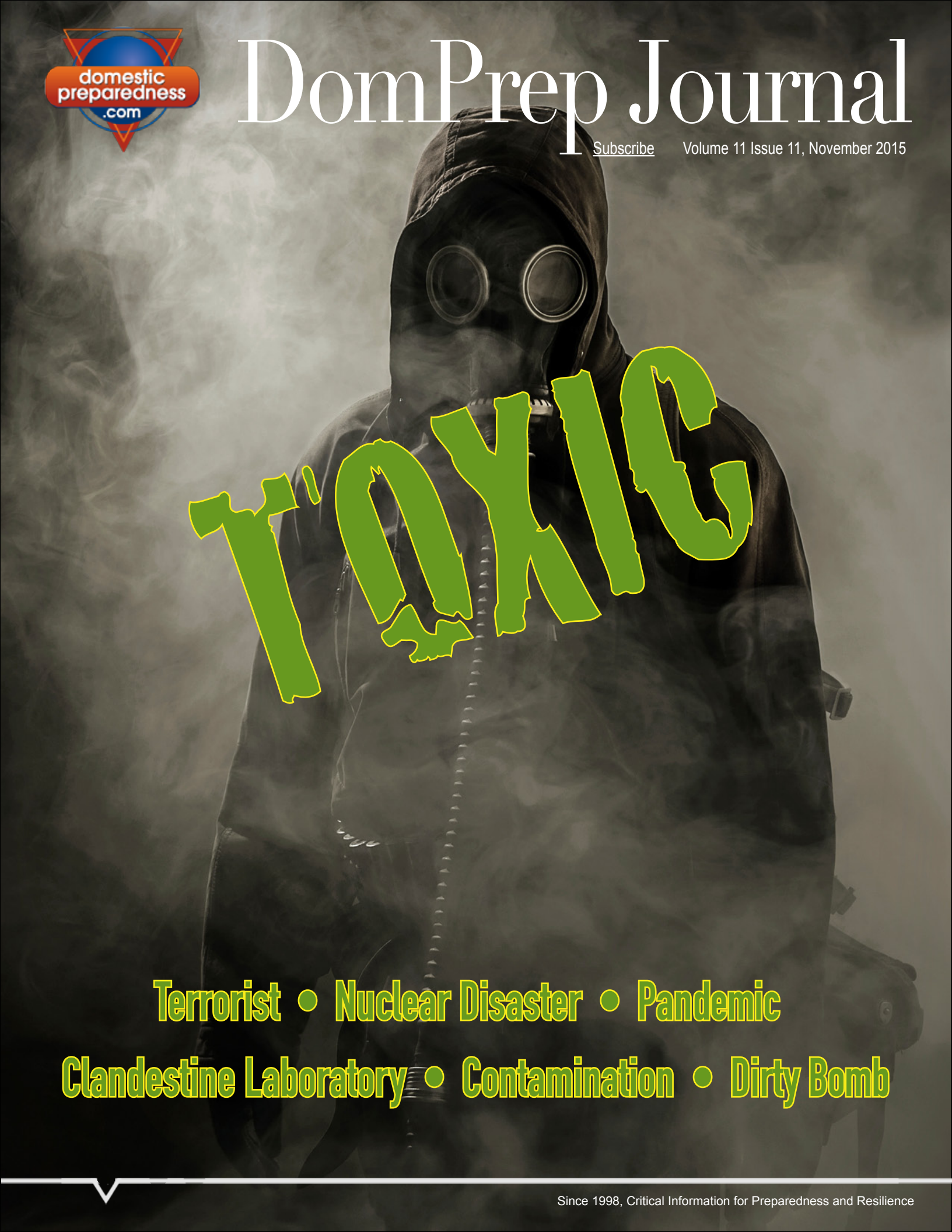
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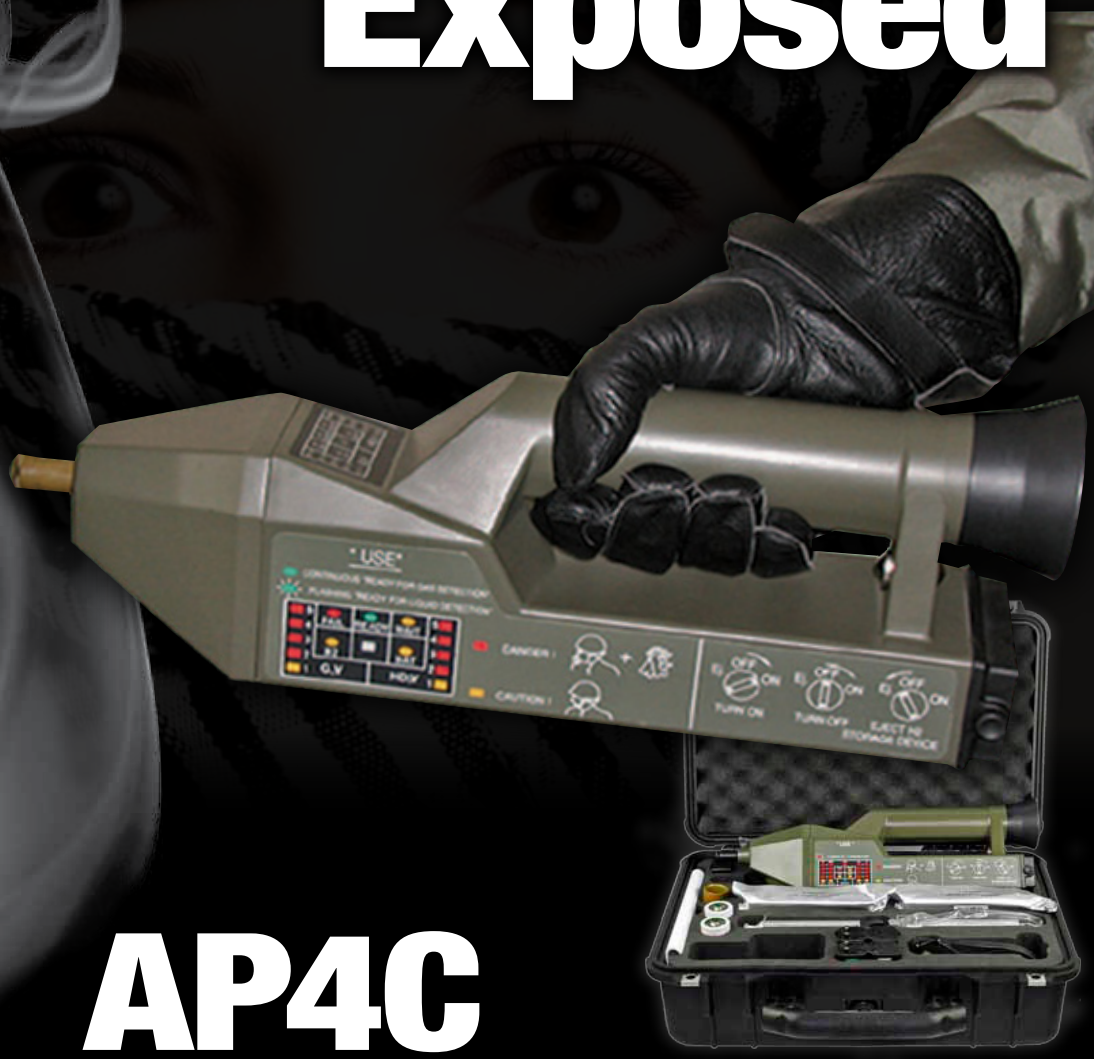

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About the Cover: Chemical, biological, radiological, nuclear, and explosive agents exist in many different forms and with many routes of dispersal – some intentional and some unintentional. When any of these toxic agents fall into the wrong hands, the consequences are deadly. (Source: ©iStock.com/idal)

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Editorial Remarks

By Catherine Feinman

The multiple coordinated terrorist attacks in Paris on 13 November 2015 are a reminder that no community is immune to deadly threats and acts of terror. In Syria, the use of chemical weapons still raises significant international concern. For centuries, biological weapons have been used against enemy states. Unintentional radiological releases from power plants and transport vehicles threaten many local communities. Long after the Cold War ended, nuclear weapon stockpiles still exist – the exact number is difficult to determine. All of these scenarios highlight the fact that "Toxic" environments are everywhere.

Richard Schoeberl leads this issue of the DomPrep Journal with a discussion on the growing threat that terrorists pose to Western societies. A scenario similar to the recent Paris attacks coupled with more-sophisticated weapons would be catastrophic. The availability of radioactive material and other agents of mass destruction on the black market make such threats an imminent possibility.

For this and other catastrophic incidents beyond pandemics and other biological threats, public health professionals and healthcare agencies have the ability to play significant roles in the preparedness efforts. Audrey Mazurek and Raphael Barishansky describe the key functions, roles, and capabilities that public health can offer, but is often underutilized. However, Patrick Rose urges public health and government agencies to make better investments, develop better strategies, and communicate expectations more effectively in order to gain the full benefits that public health has to offer.

Craig DeAtley shares information about a new resource that addresses 65 healthcare preparedness and response topics, one of which is highlighted in his article on decontamination at healthcare facilities. Timothy Moshier also demonstrates the importance of researching options and information with regard to modern technologies. With so many choices and limited amounts of resources, users must be able to choose the right equipment at the right cost. In some cases, this may mean choosing low-cost options to maximize current technology capabilities.

David Cullin and Christopher Petty round out the issue with portable technologies that can detect trace amounts of chemical, biological, radiological, nuclear, and explosive threats. Whether at a security checkpoint, a clandestine laboratory, or a routine traffic stop, law enforcement officers and hazardous materials teams must have access to the most effective equipment available to ensure the safety of responders. All of the articles in this month's issue address critical "Toxic" threats along with viable and cost-effective solutions.

Beyond Paris – A Growing Terrorist Threat

By Richard Schoeberl

Paris is the most recent reminder of the barbaric acts of brutality and terrorism committed by the Islamic State. Although this extremist terror organization has committed despicable acts – such as crucifixions, beheadings, live burnings, and bombings – the threat of its brutality is expanding beyond Europe, with even deadlier consequences.

The fear of terrorist attacks grew after three teams of terrorists staged synchronized attacks at separate locations throughout Paris, France, on 13 November 2015 – including a concert hall, the Stade de France, and multiple restaurants. At least 129 people were killed in the attacks, and 352 people were wounded – 99 of them seriously. The Islamic State has claimed responsibility for these attacks, as it did for the killing of 224 people when a Russian airliner crashed in Sinai on 31 October 2015. To complicate matters, intelligence suggests that the Islamic State has the means to acquire a chemical, biological, radiological, or nuclear (CBRN) weapon.

Implications of the Paris Attack

There must be a unilateral strategy to combat the terrorist threat, both domestically and abroad. As long as the Islamic State continues to maintain a haven in which to operate, train, and spread radical ideology, the world will continue to face acts of terror. On Monday, 16 November 2015, less than 48 hours after gunmen and suicide bombers synchronized attacks across the city of Paris, U.S. President Barack Obama defended his strategy for combating the Islamic State. During a news conference at the G20 Summit in Turkey, Obama stated that sending large numbers of ground troops to Syria and Iraq would be a "mistake." Conversely, the only way to combat this threat is through a sustainable effort that is relentless to diminish the popularity that has ultimately led to the success of the Islamic State.

Most recently, a video purportedly released by the Islamic State shows a fighter standing with his followers, praising the Paris attacks, and threatening the United States, "As we struck France in its stronghold, Paris, we will strike America in its own stronghold in Washington." This new video warns of lethal consequences should the United States, or any country, partner with France against the Islamic State. The video further warned European nations not to block the terrorists' efforts across Syria and Iraq. This new information suggests a major shift in the terrorist group's global strategy. Once content with regional dominance, the Islamic State is now pushing to expand its control throughout the European communities and elsewhere.

The complexity of the Paris attacks suggests extensive planning and preparation with direction from the Islamic State's central leadership. Adding to concern for national security in the United States is the Syrian refugee crisis. European officials say that professional terrorists are joining refugee travels in attempts to enter Europe and elsewhere. One of the suicide bombers at the Stade de France was in possession of a fake Syrian passport and arrived among the refugees on the Greek island of Leros on 3 October 2015. This is a concern

because, in September 2015, the United States agreed to take 15,000 Syrian refugees, with approximately 85,000 total refugees expected by the end of 2016. The rise of the Islamic State, and its leaders' appeals for supporters to carry out attacks around the world, has prompted a sharper sense of caution both domestically and abroad.

The Islamic State has an external agenda and is determined to carry out similar attacks outside of the region it has so quickly dominated. This is not an isolated event, and the Islamic State likely has additional attacks in the queue. This was a carefully planned attack in Paris over the course of several months, with trained operatives in place equipped with weapons such as explosives and suicide belts. The Islamic State has found more utility in trying to recruit and motivate sympathizers in the United States online from abroad. The FBI stated that "hundreds, maybe thousands" of U.S. residents currently follow the Islamic State online. In the past year, at least 49 people in the United States have been charged with terrorist-related crimes.

Many Buyers & Sellers

There is sufficient evidence and intelligence to conclude that an array of terrorist organizations representing various backgrounds and posturing different ideologies have attempted to acquire and have definitely considered the use of CBRN weapons. Although al-Qaida leaders have been outspoken about attempting to acquire or produce weapons of mass destruction (WMDs) for well over a decade, they have had no success in achieving these goals.

In 1998, then al-Qaida leader Osama bin Laden acknowledged that the acquisition and use of WMDs was his Islamic duty. During his leadership, bin Laden urged his top commanders to make efforts to acquire and develop nuclear and biochemical WMDs. However, more concerning is the looming fear that there are active sellers currently seeking Islamic extremist buyers. For example, in Moldova, a former Soviet state in Eastern Europe, 68 percent of the population is low-income or living in poverty, which raises concern about a possible correlation between poverty and ongoing organized criminal activity. Moldovan officials, working in conjunction with the Federal Bureau of Investigation, have thwarted at least four attempts in the past five years by suspected Russian organized crime groups to sell radioactive material to Middle Eastern extremists.

The latest attempt to illegally sell CBRN weapons occurred in February 2015, when a Russian smuggler offered a large cache of cesium 135 to what he thought was a buyer from the Islamic State. According to the investigation, the smuggler offered a supply of cesium 135 in trade for 2.5 million Euros. Fortunately, the buyer was an informant rather than a member of the terrorist organization. According to the Moldovan investigators, most of the criminal organizations in Moldova have connections to the Russian KGB's (former Russian secret police and intelligence agency) successor agency, the FSB (Russia's Federal Security Service), and are flooding the country's black market with nuclear materials.

Dirty Bombs – Blueprints & Isotopes

In 2011, a Russian organized crime group attempted to arrange the sale of bomb-grade uranium (U-235) along with a set of blueprints for a "dirty bomb" to an unknown man from Sudan. The isotope U-235 is significant because, under various conditions, it can easily be split to yield a lot of energy. Therefore, it is said to be "fissile" – capable of splitting and releasing

enormous amounts of energy – according to the World Nuclear Association. The properties of uranium are important for nuclear weapons and nuclear power because of their ability to fission and create the successful chain reaction that causes a nuclear explosion.

According to the Associated Press, in October 2015, authorities in Moldova blame the increase in black market sales of radioactive material on the breakdown in collaboration between Russia and the United States. Authorities claim that smugglers are finding new means to move Russia's vast unaccounted radioactive materials that have leaked into the black market, and these materials are controlled by organized crime. About 140 cases of missing or unauthorized use of nuclear and radioactive material were reported to the United Nations Atomic Energy Commission in 2013.

An official source from the U.S. Department of Energy told ABC News in 2005 that there is simply no way to calculate the amount of material that is missing in Russia. Neither the Russian nor Soviet government had ever used an accurate inventory system to track the quantity of nuclear material produced and the locations where it would be used. The stark reality is that, with a great deal of unaccounted materials after the collapse of the former USSR, coupled with eager buyers manifested by profiteers in the black market, an actual attack is simply a game of statistics.

Closing Statistically Significant International Gaps

Fortunately, the manufacturing of CBRN weapons requires access to bodies of scientific knowledge that, for the most part, have been the invention of western science and research. Although much of this knowledge is now published and available on the Internet, it still requires a certain level of access to training and research institutions to be made most effective. In order for the Islamic State to pursue a rigorous CBRN weapons program, the terrorist group would have to devote substantial resources to the acquisition, production, and, in some cases, tests of the weapon.

The sale of cesium is a concern for anyone in the international community because of the possibility of it being used to create a "Dirty Bomb" and expose large populations to the effects of radiation exposure – burns, acute radiation sickness, cancer, or even death. If the Islamic State were able to procure and weaponize the cesium, it could prove problematic for the ongoing conflict. Without a solid strategy for combating the Islamic State, the threat of Islamic extremists attempting to acquire CBRN weapons continues to be a challenge. Coupled with the fact that opportunists are actively seeking extremist buyers, the statistics game becomes increasingly more difficult with each passing day.

Richard Schoeberl has over 20 years of security and law enforcement experience, including the Federal Bureau of Investigation (FBI) and the Central Intelligence Agency's National Counterterrorism Center (NCTC). He has served at a variety of positions throughout his career ranging from supervisory special agent at the FBI's headquarters in Washington, D.C., to acting unit chief of the International Terrorism Operations Section at the NCTC's headquarters in Langley, Virginia. Before his managerial duties at these organizations, he worked as a special agent investigating violent crime, international terrorism, terrorist financing, cyberterrorism, and organized drugs. He also was assigned numerous collateral duties during his FBI tour – for example, as a certified instructor and member of the agency's SWAT program. In addition to the FBI and NCTC, he is an author and has served as a media contributor for Fox News, CNN, PBS, NPR, Al-Jazeera Television, Al Arabiva Television, Al Hurra, and Sky News in Europe. Additionally, he has authored numerous articles on terrorism and security.

Public Health's Role Beyond Biologicals

By Audrey Mazurek & Raphael M. Barishansky

Public health's role is often synonymous with biological events such as Ebola, H1N1, and SARS, but the field of public health offers many capabilities that are relevant to chemical, radiological, nuclear, and explosive events as well. To leverage these capabilities, a joint effort from the federal, state, and local levels must make public health a national priority.

Over the past decade, a significant focus of public health preparedness efforts has been on biological events. However, to meet the Centers for Disease Control and Prevention's (CDC) Public Health Preparedness (PHEP) Capabilities, much more emphasis is being put on public health's role in other emergency events, which include chemical, radiological, nuclear, and explosives (CRNE) hazards and threats. This does not include or address jurisdictions near nuclear power plants or chemical weapon facilities – as they already have unique and established roles. For other jurisdictions not within these areas, public health plays a key role during CRNE events. For jurisdictions where public health is the lead for Emergency Support Function 8 (Health and Medical Services), it would be unlikely that they would be the sole lead during these types of events but, in some instances, could be part of a joint command and, in all instances, would serve in a key support role to the lead agency(ies).

Public health would continue to perform the key functions that it already does well such as:

- Conducting epidemiological investigations
- Helping to identify the agent and indicators of a release
- Coordinating with laboratories
- Serving as liaisons with hospitals and other healthcare facilities
- Providing public information and partner situational awareness
- Protecting environmental health
- Ensuring food and water safety/quality
- Monitoring health conditions at shelters/mass care centers
- Providing mass prophylaxis/vaccine (if necessary)
- Conducting ongoing/long-term surveillance and health monitoring

Building on Current Capabilities

A 2007 study conducted by William Bell and Cham Dallas, Center for Mass Destruction Defense at University of Georgia, looked at the potential effects of a 20 kiloton and 550 kiloton nuclear detonation and radiological fallout consequences on four major urban cities in the United States. The study shows how fragile the health and medical infrastructure could be in these catastrophic scenarios. Unfortunately, that level of devastation is not necessary

to overwhelm an already taxed public health and healthcare system. Fortunately, studies such as these over the years (and, unfortunately, real events such as the Fukushima disaster, Boston Marathon bombing, fertilizer plant explosion in Texas, etc.) have led to significant steps to improve the capability and capacity of public health to help respond to and recover from CRNE events.

In addition, all of the steps being taken by public health agencies to increase their preparedness for other types of events, such as a biological incident or emerging infectious disease, have significant positive crosscutting effects for responding to CRNE events. These preparedness efforts include, but are certainly not limited to:

- Ensuring interoperability of communication devices
- Planning, training, and exercising regularly with jurisdictional partners
- Improving regional and healthcare coalition response
- Recruiting staff and volunteers with specialized medical backgrounds
- Improving risk communication and public information/warning systems
- Planning for mass casualties and fatalities
- Developing broader use mutual aid agreements
- Understanding and meeting the needs of vulnerable populations within the jurisdiction
- Articulating the health and medical impact and taking necessary mitigation steps based on hazard vulnerability/risk assessments

Public Health's Offerings

Local, state, regional, and tribal public health agencies can also provide these additional capabilities that are often forgotten in the areas of assessment, assurance, and policy development:

- Providing emergency medical supplies and personal protective equipment
- Monitoring responder safety and health
- Providing decontamination support
- Conducting environmental sampling
- Ensuring safe re-entry/use of a facility
- Managing volunteer and donation support
- Conducting public education and trainings
- Establishing and providing support to call centers
- Providing mental/behavioral health services
- Supporting or establishing field treatment sites, mobile medical units, etc.
- Managing family/community assistance centers
- Establishing victim registries

The importance of ensuring the public's health and supporting first responders during CRNE events is highlighted in the numerous guidance, tools, trainings, and plan examples now available. All states have a radiation control program that coordinate planning efforts with locals and federal partners and procure equipment and supplies. Planning for chemical, radiological, and nuclear events is embedded throughout the 2011 Public Health Preparedness Capabilities, further solidifying the importance of building operational capabilities to respond and recover in areas such as emergency operations planning, mass fatality management, mass care, non-pharmaceutical interventions, medical countermeasure dispensing, and public health laboratory testing.

Studies and real events have led to significant steps to improve the capability and capacity of public health to respond to and recover from chemical, radiological, nuclear, and explosive events.

Next Steps

It is important to remember that CRNE events are a public health and medical issue – in addition to being a national security threat, devastating to infrastructure, etc. – and will require a multidisciplinary approach to preparedness, response, and recovery efforts. Many state, regional, and local jurisdictions are incorporating CRNE issues into their all-hazards planning, developing dedicated CRNE plans, and integrating these scenarios in workforce/volunteer trainings and exercises. More guidance, trainings, modeling tools, and toolkits are being developed by local jurisdictions (particularly those that have identified CRNE as a priority in their threat/hazard vulnerability assessments), public and private sector, nonprofit organizations, and academia. These come in many different forms and are readily available.

However, future initiatives should include:

- *Chemical and explosives guidance* – Much of the guidance still focuses on radiological and nuclear events, so more of a shift is needed to incorporate chemicals and explosives as well.
- *Resource sharing* – More sharing of gray literature (e.g., plans, after action reports) is needed and should be more readily available for public health planners. Following are some examples of federal sites that provide a comprehensive list of resources, but more needs to be included regarding public health:
  - The U.S. Department of Health and Human Services (HHS), Assistant Secretary for Preparedness and Response's Technical Resources, Assistance Center, and Information Exchange (TRACIE), which includes public health and healthcare collections focused on radiological and nuclear, chemical, and explosives and mass shooting topics
  - The currently updated HHS Radiation Emergency Medical Management site
  - The Center for Disease Control and Prevention's Radiation and Chemical Emergencies site

- *National-level discussions on best practices and lessons learned* – In 2013, the Institute of Medicine (now National Academy of Medicine) and the National Association of County and City Health Officials (NACCHO) conducted a workshop focused on response requirements faced by public health and healthcare systems in response to an improvised nuclear device (IND) detonation. A report was subsequently published that included the key presentations and messages from the presenters. More national dialogue like this is needed for CRNE events.
- *Useful and applicable trainings and tools* – Before the end of NACCHO's Advanced Practice Centers program, a few of the jurisdictions developed helpful tools and trainings specific to public health response. More tools and resources such as these are needed to help promote preparedness efforts.
- F*ormal mutual aid agreements between local health departments for utilization of personnel, equipment, facilities, services, supplies, and/or other resources* – It is critical to remember that an event that threatens public health could quickly overwhelm the public health resources of a particular municipality, county, state, or region, even if that event does not constitute a declared emergency.

Clearly, public health entities have a significant role in emergency preparedness and response; a role that has come to light even more since the events of 9/11 and the 2001 anthrax attacks, as well as subsequent numerous natural disasters, food-borne outbreaks, and other public health emergencies, such as SARS and H1N1. Local and state health departments are more prepared for emergencies now than they have ever been. Since 2001, these preparedness capacities have improved consistently and significantly. In order to ensure forward movement and acknowledgment of successes, the implementation of the aforementioned areas is paramount.

Despite victories with regard to public health and its preparedness and response efforts to various emergencies, a strong commitment must still be made at the federal, state, and local levels to maintain and improve public health preparedness capabilities and to make this effort a national priority.

Audrey Mazurek (pictured) is a deputy program manager with ICF International, specializing in public health and healthcare preparedness. Previously as a technical specialist for ICF, she served as a public health preparedness planner for the Prince George's County and Montgomery County (Maryland) Health Departments. Prior to this position, she was an analyst at the Homeland Security Studies and Analysis Institute (HSSAI), and program manager at the National Association of County and City Health Officials (NACCHO). She is also the managing director for TSG Strategies, LLC. She can be reached at Audrey.mazurek@icfi.com.

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Next-Generation, Layered Security Screening

By David W. Cullin

Security checkpoints help law enforcement officers enhance public safety by detecting chemical, biological, radiological, nuclear, explosives, and other threats. With advancements in multiplexed luminescence technologies, the detection of trace amounts of explosives can expand beyond stationary checkpoints using handheld tools that are cost-effective and simple to use.

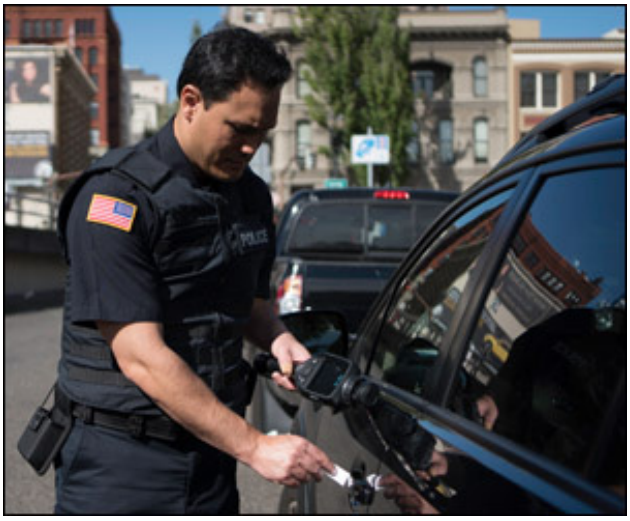
Of the potential chemical, biological, radiological, nuclear, and explosives (CBRNE) threats faced by law enforcement, the threat from explosives is pervasive. Modern security checkpoints provide an opportunity to detect, interdict, and deter the use of an explosives threat. Desktop explosives trace detectors (ETDs) are broadly deployed in checkpoints due to their ability to detect invisible amounts of explosives quickly. However, they are plagued with high false-alarm rates and time-consuming maintenance.

Although critical to public safety, checkpoints operate with some level of predictability, which make them more vulnerable to CBRNE threats. Mobile trace detectors provide the opportunity to introduce random screening protocols that increase the likelihood of threat detection. Until recently, law enforcement did not have access to a handheld tool capable of detecting a broad range of explosives threats at true trace levels. Recent technological advancements provide performance upgrades and cost advantages that will make ETD tools accessible to more first responders, adding a new layer of protection to security screening.

More Accurate Fixed-Site Screening Tools

A variety of complementary explosives detection technologies are currently used in checkpoints to address both visible (bulk) and invisible (trace) explosives threats. They range from X-ray and colorimetric indicators to ion mobility spectrometry (IMS) and canines. Trace residue can be left behind on first-touch areas such as bags, cellphones, mass transit cards, personal identification cards, and event tickets. Trace residue found on surfaces can indicate contact with actual explosives or incendiary devices. Desktop ETDs are widely deployed as the last line of detection for many screening checkpoints. When bulk threats have been eliminated using other technologies like millimeter wave or X-ray systems, a desktop ETD presents a final chance to detect invisible amounts of explosives.

Desktop ETDs provide high-fidelity threat identification and are designed to quickly screen a high number of items per day. They are best-suited for permanent installations, where the security infrastructure can support extended use. IMS-based desktop trace detectors are widely deployed in security screening checkpoints due to their speed of detection and sensitivity. One of the challenges with IMS technology, though, is a high number of false alarms. Each alarm must be resolved to determine if a true threat is present. IMS technology also requires both weekly and monthly maintenance. Not only do these deficiencies negatively impact throughput and tie up resources, these first-generation technologies struggle to keep pace as adversaries adapt their tactics and introduce new explosive threat materials.



Handheld explosives trace detector. *Source:* FLIR Systems Inc. (2015).

In recent years, mass spectrometry-based desktop trace detectors have been introduced specifically to address these concerns in security screening missions. Mass spectrometry brings the accuracy and confidence of laboratory instrumentation to the field, significantly reducing the potential for false alarms in operational environments and providing an enhanced layer of security. Mass spectrometry technology has an inherently larger library capacity over IMS technology. As new threats are realized, the library can expand without negatively impacting existing sensitivity or false alarm rate.

Manufacturers have placed an emphasis on simplifying the user experience and eliminating data interpretation typically associated with lab-based instrumentation to minimize training and deployment costs. To further lower the cost of ownership, recent mass spectrometry-based product introductions have reduced maintenance to just a few hours per year. This is a significant improvement in system operational availability and helps reduce operational costs.

Mobility as the Enemy of Predictability

Handheld ETDs are commonly used by the military. However, the need for next-generation ETD solutions extends beyond the battlefield. Although fixed-site checkpoints are critical to safeguarding lives, they can also present a level of predictability that is probed by extremists for weakness. Trace detectors that are mobile help law enforcement randomize their interdiction efforts and bring the deterrent to the threat, adding an enhanced layer of security beyond the fixed-site checkpoint. Finding the explosive is important and can prevent one explosion; however, finding the bomber, bomb maker, or the weapons cache has a larger effect in security applications. Random checkpoints, temporary roadblocks, or foot patrol can uncover trace evidence that can be used to seek bulk explosives threats and defeat a terrorist. Trace evidence collected during mobile missions fills in the intelligence picture and increases the likelihood of detecting a threat.

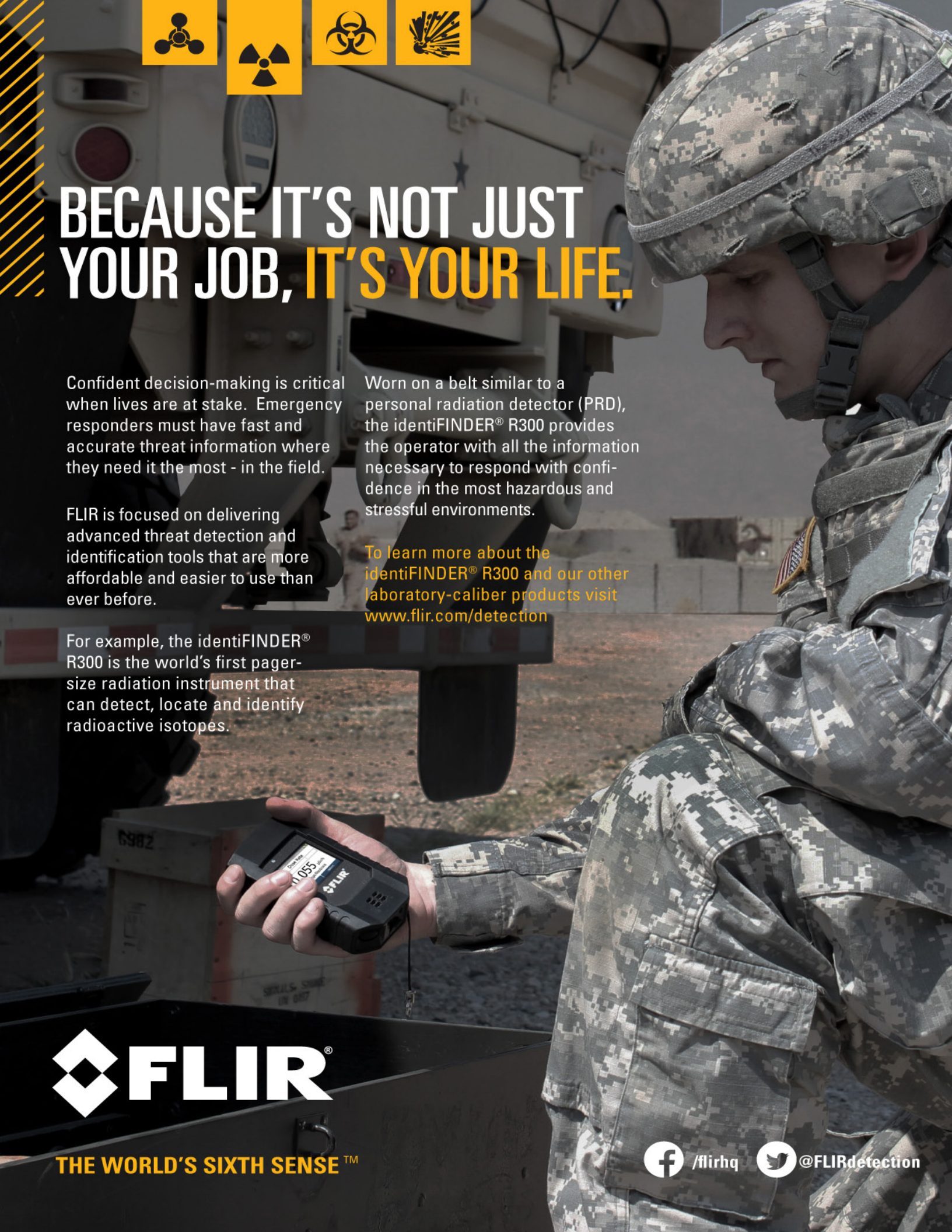
Multiplexed luminescence technology field-proven by the military fills this capability gap in the law enforcement tool kit. This technology enables handheld trace detectors to provide broad threat detection with best-in-class sensitivity in an ultra-lightweight form factor for maximum portability. It offers the ability to detect threats in less than ten seconds, so officers can quickly complete their screening mission. Products are now being fielded that feature on-screen guidance, simple go/no-go alarms, and on-device video training that provides real-time help and reduces the cost and logistical burden of recurrent training. An emphasis on ergonomic design and durability has resulted in highly portable tools that support a mobile mission. For the first time, handheld explosives trace detectors capable of the trace detection mission are available for under $10,000.

Upgrading the Future of Security Screening

ETD technology has advanced significantly in recent years due to focused investment by the CBRNE community. As a result, higher-performing sensors are accessible to more first responders. These tools are designed to expand deployment scenarios, simplify daily operations, and reduce costs. With increased budget constraints, manufacturers have focused more than ever on producing affordable sensors. Recent technology advancements and product innovations have broken price barriers, allowing handheld explosives trace detection to truly become a key capability in the future of policing.

Checkpoints soon will be equipped with next-generation screening tools that are designed to address shortcomings of existing technologies, with increased accuracy, ease of use, and lower cost of operation. From interdiction missions to actionable intelligence, the deployment of next-generation handheld and desktop ETDs will provide an added layer of security that maximizes coverage and disrupts the explosives threat.

David W. Cullin is the vice president of research, development and programs for FLIR Detection. Previously, he served for seven plus years in the U.S. Department of Defense's Chemical and Biological Defense Program. As the Director of Technology at the Joint Program Executive Office for Chemical and Biological Defense, he focused on new technology that would help the U.S. armed forces counter weapons of mass destruction. Before that, he directed the DOD Critical Reagents Program and led the technical team in the development of what is now the Department of Defense's (DOD) Portal Shield BW detection system. He joined the Defense Department in 1991, as a research chemist with the Naval Surface Warfare Center in Dahlgren, Virginia, after earning his Ph.D. in Chemistry at The Ohio State University.



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Keeping It Simple – Low-Cost Technologies With High Payoffs

By Timothy Moshier

Detection of hazardous materials can be a very costly endeavor. However, there are ways to simplify the process, reduce costs, and increase the performance of previously purchased legacy equipment. Leveraging the operating environment and informing personnel to make better decisions are two methods for achieving these goals.

When addressing a detection problem, there are four interconnected, top-level "components" of the system to consider: the candidate technologies, the operating environment, the threat, and the personnel that are operating, sustaining, and making decisions based on the sensor's performance. Available technology defines the limits of what is possible to accomplish with hardware only for any given system. These limits can be pushed with creative implementation of systems engineering and operational protocols. The environment channelizes and steers the agent plume, which affects the threat's ability to effectively hit its target. The environment can create signal clutter that degrades different technologies' abilities to identify threats. Personnel need information about the detected threat that allows them to make knowledgeable decisions in time to make a difference.

All four components must be addressed in system design, but the most important part of the system is the people, and the best way to ensure that part of the system works is to keep the design simple. Using simplicity as a principle of design can improve system performance, user suitability, and life-cycle costs.

Incorporating Sensor Node Networks for System Self-Repair

One of the challenges inherent in detecting a biological or chemical threat cloud is that these clouds concentrate in low areas and in eddies behind large structures. In effect, this demonstrates how the threat and the environment become part of the system design. Clearly, the best chance of detecting an attack is to have the sensor nodes in those areas, but placing the nodes there complicates radio connection to the base station. The task of establishing a wireless sensor network, while ensuring best sensor placement can be simplified by incorporating a mesh network radio into each sensor node. The sensors automatically establish a wireless network that is also capable of repairing itself if a sensor fails. All the operator has to do is emplace the sensor and turn on the power. The sensor node does the rest of the work.

Using Better Toxin Assays for Cost-Effective Sample Collection

One challenge of biological agent identification is achieving the sensitivity and specificity of Polymerase Chain Reaction (PCR) based technology, but without the PCR's susceptibility

to common environmental interferents (like salts and humic acid from soil) that can shut down the PCR chemistry. Using assays that are tolerant of interferents eliminates the need for costly and time-consuming sample cleanup, and accelerates the overall time to go from sample collection to identification result.

> ***"All four components must be addressed in system design, but the most important part of the system is the people, and the best way to ensure that part of the system works is to keep the design simple."***

In addition, using activity-based toxin assays that work on PCR not only reduces the amount of equipment required to identify the full spectrum of bioterrorism agents, it also provides a critical piece of information for decision makers on the spot – that is, "Is the toxin still a hazard, or has it degraded to a benign state?" The faster decision makers know what the true threats are, the faster they can make accurate decisions on protecting those who have potentially been exposed. These are some examples of how building simplicity into something as seemingly minor as bioidentification chemistries can produce significant enhancements for the users in terms of cost to employ the technology, and ability to make timely, accurate decisions.

Reducing Signal Clutter for Trace Detection

The final example of how simplicity in design can create high-performance payoffs involves detection of trace levels of chemical and biological agents. Rather than purchasing a completely new system, existing technologies that already have excellent identification capabilities can be optimized by improving the contaminant collection process. Essentially, reduce the signal clutter so the already capable instruments get a clear read of the target. It is much more cost effective to improve the sampling process for trace contaminants – including explosives, drugs, chemical warfare agents, and biological agents – on a wide range of surfaces than to replace costly Raman spectrometer equipment. Among the many advantages of this simple solution to a refractory problem is the ability to rapidly evaluate the presence of trace contaminants in order to improve situational awareness.

According to at least one of the interpretations of Occam's Razor, "If you have two equally likely solutions to a problem, choose the simplest."

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New Decontamination Resource – Information & Expertise

By Craig DeAtley

A new federal resource equips healthcare providers with a valuable information repository. This resource also offers a way to request technical assistance and provides a forum for peer-to-peer discussions. Decontamination is just one of the many in-depth topics addressed by subject matter experts in the healthcare field.

Patient decontamination is a complex problem faced by emergency medical services (EMS) and hospital personnel. Preparing to manage this situation requires both groups to stay current with rule changes and best practice recommendations. In September 2015, the U.S. Department of Health and Human Services (HHS) Office of Assistant Secretary for Preparedness and Response (ASPR) launched an Internet-based program intended to advance public health disaster preparedness, and one topic included in its scope is patient decontamination.

Anatomy of an Information Gateway

ASPR TRACIE (Technical Resources, Assistance Center, Information Exchange) is an emergency preparedness information gateway that offers three forms of assistance:

- The *Technical Resources* section consists of topic-related collections of materials such as journal articles, textbooks, fact sheets, reports, plans, tools, templates, and webinars screened for inclusion by subject matter experts.
- The *Assistance Center* connects people seeking assistance via phone (toll-free number), email, and online with subject matter experts for technical consultation on a range of topics.
- The *Information Exchange* provides a password-protected forum where stakeholders can discuss and share information about present or pending health threats and best practices.

In developing ASPR TRACIE, HHS solicited the assistance of subject matter experts across a wide spectrum of specialties and locales to eventually address 65 topics that fall under the following seven primary subject areas:

- Emergency management foundations
- Healthcare coalition development and organization
- Disaster operations
- Disaster research and modeling
- Specific hazards/patient care topics
- Communications
- Disaster veterinary issues

One subsection within the "Specific hazards/patient care topics" contains a vast amount of information on hospital victim and pre-hospital victim decontamination. The types of resources categorized under the topic collections include:

- Must Reads
- Chemical Decontamination
- Education and Training
- Guidance Documents
- Lessons Learned
- Pediatric Considerations
- Plans, Tools, and Templates
- Radiological Decontamination
- Resource Allocation
- Responder Health and Safety

"New equipment, the best ways to perform decontamination, and specific state and federal performance expectations are just some of the information that those responsible for performing and supervising decontamination need to know."

Each resource is annotated and includes a hyperlink that takes the user to the listed item for immediate viewing. The user also has the opportunity to rate the value of the resource, which is archived for future users. Also available in both collections is a section that lists agencies and organizations that have a page, program, or specific research on the subject.

Exchanging Information With Experts

The assistance center offers more personalized information about decontamination (and other topics) with in-house experts and external subject matter consultants answering questions received. Once the requested support is completed, the question(s) (without personal identification) and answer(s) are then posted on the Information Exchange for other interested persons to access.

The Information Exchange is a password-protected site that is operational 24 hours a day and allows interested participants to connect with one another in near real-time conversations to:

- Discuss important issues they are confronting – for example, how responders plan to prioritize patients for decontamination in large-scale incidents or how to decontaminate patients with special needs
- Share lessons they have learned – for example, what works for doing dry decontamination and how to decontaminate non-ambulatory patients
- Share plans and other written material

Decontamination is an often-practiced skill performed by hospital and fire/EMS personnel. New equipment, the best ways to perform decontamination, and specific state and federal performance expectations are just some of the information that those responsible for performing and supervising decontamination need to know. ASPR TRACIE provides three easily accessible ways for the prehospital and hospital practitioner to access peer-reviewed material, talk with experts online or in person, and chat with one another about decontamination as well as other disaster preparedness topics.

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How the Nation Is Failing in Public Health Preparedness

By Patrick Rose

As public health funding and staffing continue to decline, communities are left more vulnerable to the next catastrophic public health emergency. The United States is failing in its public health preparedness efforts. The nation's resilience depends on the government and public health making critical changes to reverse this downward trend.

When, not whether, the next biological incident of national significance occurs, it will rival other historical mass casualty events. Since the United States is not heeding its own lessons learned – for example, the 2009 H1N1 pandemic or even the domestic Ebola incidents – it is time to motivate government leaders to rethink the nation's posture on public health preparedness, using the 2014 domestic Ebola response as a point of measure. A catastrophic public health emergency is defined as an emerging or a re-emerging infectious disease outbreak with a high fatality rate, an ability to quickly spread, and few or no available pharmaceutical interventions. In the event of such emergencies, public health response will falter and struggle to contain the outbreak in a timely manner.

Poor Investments With Significant Consequences

Instead of the positive outcomes expected from lessons learned and best practices inherited from the international Ebola epidemic, a future, deadly infectious disease epidemic (or pandemic) would result in a high fatality rate, a coinciding high morbidity rate, a crippled healthcare system, and an unstable economy. The reason for this argument is based on three assumptions:

- The return on investment from the hundreds of millions of dollars spent, and still being spent, on the Ebola epidemic and on improving healthcare response capabilities overall have been shortsighted and marginally effective.
- The public health security structure, which includes public health, emergency management, behavioral health, and social services, remains vulnerable and unable to meet community needs in order to save the maximum number of lives, which is exacerbated by receding funding levels.
- Sensible investments are replaced by financially consuming and ineffective applications. A window of opportunity is closing to instill, for example, a culture of clinical astuteness in current and future healthcare professionals to be able to quickly identify an unusual, but potentially deadly, case of disease presentation that might be indicative of a deadly disease outbreak.

The point here is not to criticize public health officials who suffer from many chronic handicaps while heroically trying to save lives; rather, the lack of focus and poor understanding of government officials about the importance of appropriate public health investments – that

is, providing stable and sustainable funds – is draining essential resources. Fatigue is also setting in because public health agencies have been waiting anxiously for another biological attack while public resonance with this issue is waning.

At the same time, political rhetoric is crowding out substantive risk communications to the public on the importance of public health preparedness. It is not helping that, in instances where a robust public health response is needed to provide sensible mitigation strategies, the public endures an awkward approach intended to provide short-term political gains through costly activities, which ultimately result in irrational expectations of the public. There are three key examples that underscore weaknesses within preparedness resulting directly from this flawed approach.

Example 1 – Ineffective Strategies & Other Lessons Not Learned

Implementing ineffective and costly response and recovery methods drains resources and limits effective mitigation strategies. The government's responses to public health emergencies (i.e., those that garner attention from the public) generally involve an automatic, nonstrategic reaction in terms of providing solutions – for example, conducting surveillance on passengers arriving from West Africa. What many learned over the past year, but experts had known for years, is that costly surveillance methods at ports of entry are ineffective and provide no more than a placebo effect to the public.

More than 30,000 travelers entering the United States at five international ports of entry screened for Ebola since October 2014 did not result in any detection of Ebola and missed a case of Lassa fever – another virus that similarly results in viral hemorrhagic fever. This lesson could have been learned previously from attempts to screen travelers during the 2003 Severe Acute Respiratory Syndrome (SARS) virus epidemic or the 2009 H1N1 Influenza Pandemic.

> ***"Poor return on investment, or cost/benefit analysis, and underfunded/unfunded mandates with high expectations are a default setting for failed public health emergency response and recovery efforts."***

Instead of calling for more funding for such inefficient programs, better individual monitoring programs should be implemented using state-of-the-art technologies and requiring automatic opt-in procedures for all travelers returning from areas of ongoing epidemics. The key is to provide realistic surveillance practices for monitoring individuals, while limiting the burden on strapped health departments. This approach can be accomplished through mobile applications, similar to other crowdsourcing technologies already in use for many different aspects of disaster response and recovery operations.

Example 2 – Unrealistic Expectations & Ineffective Communication

Succumbing to the hype and fear on the implementation of nonpharmaceutical interventions – for example, quarantine and isolation strategies, infection control measures, decontamination, and waste management – is resulting in unrealistic expectations when responding to a biological incident. Media reports and imperfect forecasting of the Ebola epidemic raised anxiety levels without a solid foundation to back them. That hype led to

increased pressure on public health officials and government representatives to react excessively. Case in point: the Ebola response and recovery efforts in Dallas, Texas, resulted in hundreds of thousands of dollars spent disproportionately on a few individuals.

Nobody should expect that level of investment, especially in the case of a true catastrophic incident. Similarly unsustainable and unrealistic are the solutions for recovery – for example, decontamination and waste management of the apartment where the Dallas Ebola patient lived. In the event of a real public health emergency of national significance, each apartment that houses a person who contracts a deadly disease would not be equipped with 140 drums for waste disposal. The current approach to a biological incident reflects a poor job of the government to deescalate hyped coverage by the media and public health's inability to reduce the public's anxiety about diseases and infection control.

To remedy these issues, notes should be taken from the playbook on radiation emergency preparedness to develop clear and simple messages – on a complex issue – that resonate with the public. Simply providing basic hygiene recommendations is not good enough. Public health officials and government representatives need to:

- Manage expectations
- Better explain the characteristics of a biological incident
- Not just quote exaggerated case fatality rates, which can raise fears
- Describe what an emergency response to a biological incident would look like
- Reveal the challenges that exist
- Explain how the public can help mitigate these challenges
- Emphasize how a timely response would save many lives

A radiation emergency is a low-probability, high-consequence event for which agencies drill at the highest level of preparedness. An emerging, naturally occurring, catastrophic biological incident has a much higher probability of occurring – with potential high-consequence outcomes – yet agencies lack fundamental communication strategies to inform the public about their concerns related to the biological incident.

Example 3 – Funding Gaps & Ignored Burdens

Poor return on investment, or cost/benefit analysis, and underfunded/unfunded mandates with high expectations are a default setting for failed public health emergency response and recovery efforts. It can be difficult to measure success in public health, but not impossible. Examples that have taken a page from economic cost-benefit analysis – such as Marcozzi et al. (2015), "An Economic Analysis and Approach for Health Care Preparedness in a Substate Region" – find only little improvements, are not acceptable, and would be seen as a catastrophic failure for the investor under any other standard.

Compounding this effect are continued reductions in public health preparedness funding, whereas expectations remain high that the front line defenders are able to protect their communities. With few resources in its toolkit, limited staffing, and unfunded mandates, the public health system is bound to break under continued pressure. The increasing burden that communities bear for emerging infectious disease – with increased mortality and

morbidity rates – can no longer be ignored. The solution is maintaining sustainable funding levels, requiring concrete outputs to measure the success of investments, investing heavily in public health professionals and healthcare workers, and institutionalizing the ability to identify extraordinary threats and raise concerns about other potential threats.

The pieces are all there, but the proper approach to make sound investments has been lacking. Like the aging infrastructure of interstate highways and bridges or the miles of neglected rail lines, an ongoing disregard for a strong foundation would continue to weaken the public health infrastructure and leave gaping holes, resulting in catastrophic outcomes measured in terms of unnecessary lives lost.

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Bringing the Gold Standard to the Front Line

By Christopher Petty

Clandestine laboratories are just one evolving threat that first responders face at unexpected times. As this and other types of threats evolve, so must the technology to monitor, detect, and analyze these seen and unseen dangers. High-pressure mass spectrometry is one such technology that is helping first responders perform these tasks in real time while in the field.

When arriving at the scene, first responders are typically met with more questions than answers, so the right tools are crucial when piecing together the puzzle presented. Although there is an ongoing need for laboratory analysis, the unfortunate increase of extremist activity, both domestically and abroad, has highlighted the ever-present need to keep evolving technology for field use to protect first responders and communities. Portable tools at the scene enable responders to quickly monitor for harmful hazards as they work, allowing them to quickly move through rooms and buildings to conduct analysis on seen and unseen targets and to discern illicit activity.

Despite breakthroughs over the years, which have placed a breadth of new chemical analysis devices directly at the scene, capability gaps still exist. Today, threats are becoming more advanced and unexpected, from the use of commercial materials to make homemade and improvised explosive devices, to the latest developments in chemical warfare. As a result, there is an ever-increasing need to create robust and evolving tools that can keep pace with the dangers first responders now encounter, which are beyond what they have been accustomed to combating. They need tools that can keep pace with these evolving threats and better assemble the puzzle pieces when they arrive at the scene.

Unshackling the Gold Standard

Mass spectrometry is considered the "gold standard" for laboratory analysis across a wide range of industries and applications including safety and security, food science, biotechnology, environmental hazards, and petrochemicals. Traditional mass spectrometers are expensive, bulky, power hungry, and fragile. Additionally, because they are designed to accommodate a wide variety of needs, their complexity limits their use and maintenance to a small group of highly trained professionals.

Realizing the need to evolve the applicability of this important analysis technique, several companies have explored bringing mass spectrometry out of the central laboratory and into the hotzone. For example, there are transportable instruments that still have the size and weight of laboratory systems (around 150 lbs.), but are sufficiently hardened to be movable. In addition, a few person-portable systems, or "luggables" as they are often referred, have been introduced within the last 20 years enabling some mass spectrometry analysis in the field.

The introduction of these luggable mass spectrometry instruments into the safety and security industry was an undeniable step forward and an important demonstration of demand for analysis in the field. Despite these advances, widespread adoption remains limited by the remaining complexity and relative fragility of these implementations. However, with a new technique called high-pressure mass spectrometryTM (HPMS), mass spectrometry can now be used for truly handheld operation.

Making a Difference

Quite literally, HPMS refers to mass spectrometry being performed at much higher pressures – 10,000 times the pressure of conventional mass spectrometry – and, therefore, utilizes significantly less vacuum. This high-pressure approach has made handheld, portable mass spectrometers that perform at the push of the button possible. This is achieved through the miniaturization of the molecular traps used to analyze the input, which have been reduced from the size of a large office printer to the size of a tangerine through much smaller vacuum pumps, ionizers, detectors, and electronics overall. At under five pounds for a fully functioning handheld system, this is a game changer for the safety and security industry: no more need to send samples out for testing, then awaiting the results.

HPMS expands the first responder toolkit to include chemical and precursor material identification and detection capabilities beyond traditional tools. HPMS devices are purpose-built to fill technology gaps and meet the unmet needs of today's response mission. Handheld mass spectrometry complements the capabilities of other fielded tools by adding focused chemical analysis capabilities to the survey mission. Devices powered by HPMS have multiphase capabilities that enable rapid chemical analysis on materials from surface residues to ambient and headspace gases.

> ***"Today, threats are becoming more advanced and unexpected, from the use of commercial materials to make homemade and improvised explosive devices, to the latest developments in chemical warfare."***

The selectivity of mass spectrometry allows HPMS devices to detect low-level quantities of critical threats with incredibly low false alarm rates even among myriad interferents that plague other less selective technologies. As a result, civilian, federal, and military responders now have expanded identification and detection capabilities for chemical warfare agents, toxic industrial materials, and precursors at the point of action.

Filling Capability Gaps

The clandestine laboratory is a common scenario where first responders would use an HPMS device and provides a better understanding of how HPMS works in the field. In this scenario, the number of unknown threats is abundant. When approaching the situation, responders need the right tools to identify potential threats – from drugs to chemical weapons to explosives – and time is critical. The right tools enable responders to quickly and safely

monitor the air for harmful airborne hazards and to conduct analysis on seen and unseen targets to discern threats and protect lives.

Although presently fielded tools are critical to the first responder toolkit, each has limitations. For example, while working their way through a clandestine laboratory, responders use a device powered by ion-mobility spectrometry (IMS), which has been successfully used to give responders early warning of the presence of potentially harmful chemicals and explosives. This technology has its limitations, though, as it suffers from frequent false positive measurements, meaning it alarms for serious threats such as chemical weapons that are not actually present. These frequent false alarms are notoriously triggered by benign and common substances – such as diesel fumes, cologne, or household cleaning products – and can cause responders to ignore the notifications, which may have serious consequences.

HPMS technology fills the gap with devices that are selective enough to decipher dangerous chemicals from similar, benign ones, and notify responders only when threats are present. The dramatically increased selectivity of HPMS over IMS allows for a much broader list of target materials and for identification of threats without false alarms, even when background or interferent compounds are present.

As first responders penetrate a suspected hotzone and IMS devices alarm, an HPMS device provides fast confirmation whether there is, in fact, a threatening chemical in the atmosphere. Once the suspicious laboratory has been safely entered, HPMS devices can be used to further secure the site by analyzing headspace vapors, suspicious residues, and a selection of bulk materials to determine the threat level. The key to filling this capability gap is gathering fast actionable intelligence on whether the team needs to be concerned with the worst potential threats.

The need for more diverse technology in the field is being driven by the increased risk and varying degree of CBRNE threats that require immediate and accurate detection. In the pursuit of new technologies for CBRNE and hazardous materials detection, the powerful capabilities of HPMS provide the speed, power, and accuracy required for today's first responders, civilian support teams, and military personnel at the point of need.

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