

# **Chemical Agents of Opportunity for Terrorism Workshop**

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## **IMPORTANT INFORMATIVE STATEMENTS**

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# SUMMARY AND EVALUATIONS REPORT

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## **Chemical Agents of Opportunity for Terrorism Workshop**

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## Workshop Overview

The workshop on chemicals agents of opportunity for terrorism - a two day event was co-sponsored by Health Canada's Chemical Emergency Preparedness and Response Unit and the Canadian Safety and Security Program (CSSP). The two day workshop was put together by the American College of Medical Toxicology (ACMT) for the first time in Canada. The workshop was well-received with positive engagement between participants from the medical community, first responders, international community, federal government including Department of National Defence (DND), Public Health Agency of Canada (PHAC), Health Canada, Transport Canada, Royal Canadian Mounted Police (RCMP), and Environment Canada.

To address the growing concern about the most likely threats of chemical terrorism, an appreciation of the myriad of potential toxic chemicals readily available in our society is crucial if we are to optimally prepare, identify and defend against chemical threats. Both common and unusual industrial agents may pose a considerable threat as potential terrorist weapons particularly since many of these toxic industrial chemicals (TICs) are easily obtainable from multiple sources in our communities and pose a serious threat to health if accidentally released or intentionally disseminated.

Norman J Yanofsky, Head CBRNE Threats and Hazards and Andrew Adams, Director General Environmental and Radiation Health Sciences, Health Canada welcomed everybody to the workshop and provided a brief background on the eminent terrorists threats faced by our society – some deliberate and some accidental. Whether a hoax or not, each threat is taken seriously and dealt with aptly. These incidents provide us with a setting to envision the unlikely and the unknown threats as we prepare for the future.

## ACMT Chemical Agents of Opportunity for Terrorism: TICs/TIMs

*Charles McKay, MD, FACMT*

A brief introduction to the structure of ACMT, fellowship programs and courses was provided by Dr. Charles McKay. ACMT is comprised of some 600 physicians certified in medical toxicology. It is a branch of medicine focusing on diagnosis, management and prevention of adverse health effects from medications, occupational & environmental toxins, and biological agents.

Fellowship programs offered by ACMT are generally affiliated with poison centers and academic medical centers. At present there are 57 certified Poison Centers in the US responsible for the entire American population. There are designated ACMT representatives within the Environment Protection Agency (EPA) and Agency for Toxic Substances and Disease Registry (ATSDR) regions who are responsible for maintaining contact with ATSDR. These medical toxicology physicians are available to ATSDR and other public health entities through a cooperative agreement with CDC as another resource to interact and provide consultation on issues of chemical exposure and health Dr. McKay led the group through basic toxicology principles to set the stage for the various course modules that followed.

## Toxic Warfare: Beyond Conventional Chemical Weapons

*Paul Wax, MD FACMT*

TICs are toxic industrial chemicals and TIMs are toxic industrial materials. These terms were first introduced by the military to distinguish industrial chemicals of concern from the traditional weaponized battlefield agents such as sarin and mustard gas that were designed to kill in large numbers. TICs and TIMs are chemical substances capable of producing toxic effects if given in enough quantity (right dose). The exposure routes may be through inhalation, ingestion, or dermal absorption. TICs and TIMs are ubiquitous. Two seemingly innocuous sources of highly toxic chemicals are farm and garden supply stores and college laboratories. Given the wide availability of industrial chemicals throughout the world, and the proximity of industrial operations to large urban centers, the civilian population is clearly at risk of chemical terrorism by these chemical agents of opportunity.

The Sarin subway incident in Tokyo in 1995 and the 1984 Bhopal gas tragedy in India are two historical examples to shed some light on how industrial chemicals can/were used to create panic and economic losses. The tragedy at Bhopal in December 1984, followed by a subsequent release of aldicarb oxime from a facility in Institute, West Virginia, resulted in great public concern in the US about the potential danger posed by major chemical accidents. This public concern triggered the passage of three different legislative programs - Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA; Public Law 99-499). The other two legislative programs addressing chemical accidents were enacted under sections 304 and 112(r), respectively, of the Clean Air Act Amendments of 1990 (Public Law 101-549). The first of these was the Occupational Safety and Health Administration's (OSHA) Process Safety Management (PSM) standard (29CFR Part 1910), which required facilities having specified hazardous chemicals to implement accident prevention measures designed to protect workers. The most recent program, arising from section 112(r)(7) of the Clean Air Act Amendments, was the U.S. Environmental Protection Agency's (EPA's) Risk Management Program (40 CFR Part 68), issued on June 20, 1996.

An ultimate goal of these legislative efforts is to reduce the risk to surrounding communities by encouraging "hardening" of facilities and decreasing the available "dose" of toxic compounds. Of note, these laws were developed based on concern regarding accidental chemical releases. Recently, the US Department of Homeland Security (DHS) has established risk-based performance standards for the chemical industry that focus more on plant security and preventing intentional acts of chemical release.

The number of chemical incidents occurred from 1987-1996 is in upwards of 60,000. About half of these incidents occurred during transportation and did not occur at fixed facilities - a tanker spill by direct hostile action or otherwise remains a major concern.

One of the first attempts to come up with a prioritization list was undertaken by NATO in 1996. Known as the NATO ITF-25, this group performed a Hazard Vulnerability Assessment prioritizing chemicals of concern based on the amount produced, their inherent toxicity and their vapor pressure. They determined a Hazard Index (HI) based on these three factors. This list had more than 20 compounds. In 2002, the USACHPPM (U.S. Army Center for Health Promotion and Preventive Medicine) group undertook a reassessment of the earlier NATO prioritization and the chemicals of concern were

expanded to include less volatile chemicals as well as chemicals that were inherently reactive and flammable.

In this reformulation - a hazard ranking and a probability ranking are determined and then summed to create a Risk Ranking. The hazard ranking not only considered the underlying toxicity and health impact, but also took into account the flammability and instability of the chemical. The probability ranking, which had equal weighting to the hazard ranking, considered the likelihood of use. Factors influencing likelihood took into the account the physical state, such as whether it was a gas, but also included the number of producing countries and any history of prior use.

The Monterey Institute in California has developed a database on chemical and biological terrorist incidents. Data collection between 1975 and 2000 shows about a 1/3 of the incidents reported (n=342) involved actual use of some chemical or biological agent. A larger number involved hoaxes, plots, and possession with threats. Nonetheless as discussed previously, just the threat can clearly terrorize and significantly impact infrastructure, the economy and psychological health.

Given large variety of potential agents and often non-specific initial presentations, we need to look for additional clues to suspect the use of TICs/TIMs. While some chemicals cause a typical toxidrome, more often the initial clinical presentation may not be diagnostic of any specific chemical agent. Often the symptoms are GI in nature. At times the immediate symptoms might be mild or non-existent or a delayed syndrome.

Awareness about TICs and TIMs is a must if we were to prevent their use as chemical weapons. To do this, we can utilize the historic examples, regional hazard vulnerability assessment and response, and clinical recognition of patterns consistent with various chemical classes.

## **Clinical Neurotoxicology of Chemical Terrorism**

*Marco Sivilotti, MD FACMT*

Due to its complexity and the ease of disrupting its function, the *human* brain makes a great target for terrorism. The thought of someone interfering with our ability to function is very disturbing and highlights the power of the psychological effects of terrorism. The Central Nervous System (CNS) is central to both our functionality and our thinking. Despite its complexity, the brain displays its dysfunction in a small number of ways namely - CNS depression (sedation), CNS excitation (seizure) and possibly altered thoughts (hallucinations).

The brain is a fine balance of excitatory and inhibitory influences - slight alterations in either direction are significant. Each stage is mediated by neurotransmitters. There are neurotransmitters that influence our mood, our ability to think, remember, and so on.

Too much inhibition causes sedation or coma. On the other hand, too much stimulation causes convulsions. Altering the smooth flow of information in our brain results in hallucinations.

The Moscow theater hostage crisis was the seizure of a crowded Moscow theatre on October 23, 2002 by about 40 armed Chechen – taking 850 hostages and demanding the withdrawal of Russian forces from Chechnya and an end to the Second Chechen War - resulted in a pandemonium. After a couple days of the siege situation, Russian KGB pumped an unidentified chemical agent into the building's ventilation system and raided it. Officially, 39 of the terrorists were killed by Russian forces, along with at least 129 of the hostages. The investigation failed to provide any information on the gas agent that killed hostages. It is thought that the security services pumped an aerosolized anesthetic into the theatre - later reported to be weaponized Fentanyl (possibly carfentanil) - it is available as a large animal tranquilizer. Most central nervous system depressants are associated with some degree of respiratory depression. Some like the opioids are associated with deep respiratory depression, explaining the high fatality rate in the Moscow Theater.

Illegally imported foreign products can result in domestic exposures to unusual toxic chemicals, and health-care providers might not be able to provide appropriate therapy because the chemical ingredients might not be listed or recognized even after translation of the product label. The case of a 15 month old child who developed status epilepticus describes the first known case in the US of exposure to a rodenticide brought in from China containing the toxin tetramethylene disulfo tetramine (TETS), a convulsant poison. This case highlights the need to prevent such poisonings through increased public education, awareness, and enforcement of laws banning the importation of illegal toxic chemicals.

Although the actual mechanisms by which hallucinogens act on our brain vary, the clinical syndrome produced is qualitatively similar - we lose the ability to interpret and interact with our environment. Examples of hallucinogens include LSD, tryptamines, and some amphetamines.

In conclusion, the CNS is a unique target for terrorism and there are many historical examples of its use to create social panic and fear. The use of neurotoxins as agents of terrorism however, will result in a limited number of acute clinical syndromes.

## **Q & A**

**Q - Why did all the perpetrators of the Moscow theatre siege succumb to the aerosolized attack while only few civilians?**

**A - With an aerosolized gas attack one would expect a uniform dispersion – the official figures may not reflect exactly how those individuals died but clearly the intention was to take control of the situation and there was no administration of supportive measures to revive the individuals who were perpetrators. And you can very well imagine that in such a situation when you have the Russian General among the hostages and you have the choice of administering the antidotes - which is likely to receive it.**

**Q – What is currently being done to screen chemicals at the airports? What kind of chemicals are of interest and what is being done to prevent chemicals like the tetramine rodenticide from entering the country?**

**A – At the airport emphasis is on explosive type of chemicals.**

## Toxic Industrial Gases as Terrorist Threats

*Sophie Gosselin, MD*

Chemical legislation worldwide grew out of concern following large-scale exposures such as Bhopal disaster and so on.

Toxicity of a gas is determined by inherent toxicity, volatility, water solubility, warning properties, and pH. Following toxicants and incidents involving accidental spill or deliberate use were discussed – Ammonia (NH<sub>3</sub>), Methyl isocyanate (CH<sub>3</sub>CNO), Chlorine (Cl<sub>2</sub>), Phosgene (Cl<sub>2</sub>CO), and Hydrogen fluoride (HF).

The major property to look for is high water solubility. Toxicants with water solubility will present with irritation of the mucous membrane (eye, nose, and throat) and upper airway symptoms are expected to predominate, while low water solubility gases will often show up with lower respiratory symptoms only except in cases with high dose exposure. Warning properties or the olfaction properties is also important consideration. A toxic gas has poor warning properties when such properties are only noticeable at or above harmful concentrations - basically warning properties are inadequate to prevent harmful exposure. By the time you can smell the gas you will have accumulative exposure.

There are various regulations in place in Canada to mitigate the impact of such incidents such as the Canadian Environmental Protection Act (CEPA) 1999, Chemical Management Plan 2006, and Environment Canada CRAIM List of Hazardous Substances. Canada also supports Strategic Approach to International Chemicals Management (SAICM).

### Q & A

**Q - How much info is available at the Poison Centers?**

**A - We do have the information available to us especially when we know what chemical we are dealing with but what we don't have is the complete info on which industry has what chemicals. I think among the first responders it is the firefighters who have the most knowledge. The knowledge is out there but certainly not easily accessible.**

**Comment – There is a database comprising of information on some 2000 chemicals produced by the industry and declared to the federal government. This database is shared with people who are responsible for risk management plans such as first responders. But still a lot of work needs to be done when it comes to data sharing.**

## DHS Chemical Terrorism Risk Assessment and Desktop Tool

*Jessica Cox, DHS*

Chemical Terrorism Risk Assessment (CTRA) are focused on a broad range of risks incorporating hazards, emerging technologies, available countermeasures, evaluating the acute risk to human health due to a chemical, biological, radiological or nuclear attack in the US. CRTA has so far ranked 125 chemicals and

these are representative of the millions of chemicals that are available (tens of thousands in commercial use).

Critical components of CRTA includes a whole suite of parameters such as looking at terrorists organization, insider attributes, possible targets, types of chemicals, exposure mitigation strategies, countermeasure effectiveness, scenario probabilities and consequences. The vulnerability factor comes from elicitations or best guesses from intelligent communities (IC) – big driver for the risk equation. This helps in providing a relative risk ranking of compounds, targets, classes of compounds, scenario, etc. Each section represents a significant data collection and generation effort with input data obtained through inter-agency coordination.

From 2008 to 2013 target areas have increased from 8 to 37. Food has been an interesting target area. The National Center for Food Protection and Defense (NCFPD) and the CSAC Decision Analysis Team (DAT) performed a cluster analysis using a binary scoring system of food and food process characteristics to identify a set of clusters representative of the food supply chain.

Basically, it is the first end-to-end probabilistic risk assessment that is all inclusive and provides a detailed look at the entire chemical risk including threat, vulnerability and consequences. It provides relative risk ranking of chemicals, toxidromes, and targets. It allows resources to be prioritized based on quantitative risk, predicts impact of a vast array of scenarios, provides the ability to vary pre-event measures (e.g. security posture, forward placement and stockpiling of medical countermeasures) and post-event responses (mitigation, medical response) to determine impact, provides the ability to determine data/knowledge gaps as well as sensitivities in which risk may be able to be reduced, and allows pre-operational decisions to be made based on risk.

All these different outcomes allow decision makers and risk managers to inform policy and examine risk mitigation strategies from terrorism risk and impact.

## **Q & A**

**Q - Why are schools, universities and colleges not considered as representative targets?**

**A - It can certainly be modeled but it wasn't done by us because of political reasons than anything else as such a thing wouldn't be taken favourable by general population and also we look at young and healthy population and not subpopulations such as children. But schools can be represented by some of the indoor models and food models. Also using the desktop tool we can change the toxicity parameters and make an assumption values for consequence to meet the subpopulations such as children, older and immune-compromised population.**

**Q Your work is on modelling and obviously preparedness so we have real life event like the West Texas disaster who actually studies the ramifications of it? Did the modelling predict accurately what's needed in such an event?**

**A - We actually do some operational work as well. With our reach back the CRTA and consequence tool is often used. We were heavily involved in the recent West Virginia water incident showing - how it would work out with the chemicals that were used, potential exposures using our tool. Any time an incident happens with one of the CRTA chemicals we take the data we can get and we model the**

scenario as it played out and compare the results. If the results are not favourable, we have to track down the reason why – sometimes there are data gaps, sometimes different chemical characteristics are considered and sometimes the model needs adjustment.

**Q - How does personnel factor into the modelling outcomes and predictions?**

**A – Currently, it's the weakest part of the modelling work. It's hard to guess what people are going to do. Insider attributes are important - how we egress? You model what a normal person would do and not actually what plays out in reality.**

**Q - Can this modelling be used in the Canadian context?**

**A - Yes, this modelling has been used for some Olympic venues; military operations; food supply. The desktop tool gives us lot of flexibility to change our parameters such as venues. We can work with you specifically on your parameters and situations rather than drawing assumptions from our models.**

## **Cyanide and Fumigants**

*Robert Hoffmann, MD, FACMT*

Cyanide and fumigants constitute a threat to the general population because these are easily weaponized, highly toxic when inhaled, and widely available due to their extensive use in the agriculture and pest-control industries. While accidental exposure is not uncommon, the US Department of Homeland Security is concerned about their potential use as weapons of mass destruction. Though public attention has focused on past incidents of drug tampering, a more imminent danger is these agents' suitability for dispersal through forced air ventilation systems.

Since cyanide is easy to obtain, plentiful, requires no specialized knowledge to deploy or convert into gaseous form, is capable of causing mass casualties and social disruption, and requires large quantities of resources to control its effects, it is ideally suited for use as a weapon. Also any event which produces fire will invariably generate cyanide as a combustion by-product.

Focus will be on inhalation exposures to hydrogen cyanide gas because that constitutes a bigger threat. Hydrogen cyanide gas is readily absorbed through mucous membranes resulting in rapid onset after exposure and more severe clinical effects. It is a systemic poison with no single target organ. Cyanide acts by inhibiting specific enzymes – predominantly cytochrome aa3 in the mitochondrial electron transport chain – resulting in the complete arrest of cellular respiration and chemical asphyxiation of affected cells. In simple terms, the cells suffocate. The heart and CNS system, being the most oxygen-sensitive organs in the human body, are most affected by cyanide poisoning. The gaseous form is more lethal than the salt form.

Cyanide has long been used in battlefields as a weapon of mass destruction, mass murder, mass suicide, homicide, for terrorism (economic, environmental) activities. The treatment of cyanide poisoning starts with oxygenation and supportive care. Specific antidotal therapies exist and need to be applied as soon as possible after exposure. Currently two different antidote kits are available in the US: one comprising nitrites and sodium thiosulfate, the other hydroxocobalamin.

The three most common commercial fumigants authorized by the US Environmental Protection Agency (EPA) are sulfuryl fluoride (Vikane 7), methyl bromide, and phosphine. Although fumigants are very toxic and their distribution regulated, they remain surprisingly easy to obtain. While not generally available through retail locations or Internet ordering sites, these agents can be purchased directly from chemical supply companies. These are used in the home and numerous agricultural and industrial industries for the extermination and control of a variety of pests (termites, fungi, nematodes). All exposures to fumigants should be treated with immediate removal from source, thorough skin and eye decontamination, oxygenation, supplemented by symptomatic and supportive care. No specific antidote is available for any of these fumigants.

## Chemical Contamination of Food, Water & Medication

*Charles McKay, MD FACMT*

Mainly ingested route of exposure were discussed i.e., through food, medication, and water. All of these are produced products.

In the US, Environmental Protection Agency (EPA) and its state representatives regulate public drinking water via the Safe Drinking Water Act. The common water treatment steps include coagulation/flocculation, sedimentation, filtration, and disinfection. The public drinking water system is vitally necessary and spatially diverse providing numerous possible attack vectors and targets. Apart from providing potable drinking water, in most cities fire fighters depend on the public water system for fire control and suppression. These reasons, among others, make the public drinking water system a tempting target for terrorist attack.

An ideal contaminant should be resistant to existing water treatment methods, difficult to detect through routine surveillance/monitoring, difficult to clean contaminated equipment, be colorless, odorless, and without taste, water soluble and water stable, and cause illness that is both unexpected, delayed in onset, and difficult to diagnose (i.e., non-specific symptoms/signs).

Relative water toxicity is calculated as a ratio of an agent's water solubility to the dose required to cause death. A higher relative water toxicity value (R) indicates it would be easier to dissolve a toxic dose in water. Botulinum Toxin has a very high R value – only about 28 kg of botulinum toxin would be required to contaminate 200 million liters of drinking water compared to 110 tons of cyanide to contaminate the same amount of water. Currently there is no systematic evaluation of drinking water other than routine testing required by the EPA. Since most water treatment and distribution facilities have some measure of security, many incidents may be detected by eye witness report or – as with the Seattle case – detected by a perimeter breach. Barring the possibility of catching a culprit in the act of contaminating the water supply, detection of a terrorist attack would be dependent on noting obvious abnormalities of the water or an illness cluster. Some novel biologic sensors for water contaminants were described.

Food and Drug Administration (FDA) regulates all foods (about 80% of US food supply) except meat, poultry, and shell egg/processed egg products, which are regulated by United States Department of Agriculture (USDA). Currently, many regulatory agencies or other authorities have a role in maintaining food safety. In 2011, the Food Safety Modernization Act was enacted in an attempt to improve

oversight. Essentially there are four areas that are consistently associated with foods at a higher risk for terrorism: large batches, uniform mixing, short shelf life, and ease of access.

The US drug production system is large and complex involving multiple production and distribution phases; each providing many opportunities for interference. A terror attack could occur anywhere from the production of the raw materials to the packaging and distribution of the final product – examples were discussed such as the 1982 Tylenol murders in Chicago (laced with KCN). After these prominent events, in May 1983, Congress approved the "Tylenol Bill", making malicious tampering with consumer products a federal offense. FDA established a national requirement for tamper-resistant packaging of over-the-counter products making triple-seal, tamper-resistant packaging a norm. Another case example was the recurrent Diethylene Glycol poisoning in pain medications (as a substitute for glycerol) leading to renal failure in children.

Past cases of tampering have resulted in closer government oversight and strict product safety and distribution standards for the US. While historical examples of contamination highlight the potential impact of such events, the numerous safeguards enacted in recent years drastically limit the possibility of such a large-scale terrorist attack.

## **Terrorism by Fear and Uncertainty: Delayed Toxic Syndromes**

*Paul Wax, MD FACMT*

Unlike the general concept of chemical poisoning, in which the onset is rapid and the source identifiable, some toxins may have a delayed onset. This complicates the epidemiology (difficulty in figuring out the cause of the problem and source) and makes clinical management more difficult.

More exposures may occur because there are no warning properties of exposure. For toxins with particularly long onset, such as those chemicals that cause cancer, the long term psychological effects may be very consequential. Delayed onset toxins highly mimic biological agents (particularly non-contagious ones such as anthrax). This further complicates the diagnosis. Chemicals to be focused on include thallium salts, methyl mercury, dioxin, and so on.

Thallium has a long history of use in homicidal cases – is very inexpensive and is needed in low quantities to poison (lethal dose is ~ 1 g/adult.)

Mercury provides a nice example of an agent to use to raise fear and concern. Depending on the specific organic mercury compound, these can be absorbed by virtually every route, including dermal. Lethal dose is ~ 400 mg (5 mg/kg). The most devastating consequence is to the unborn fetuses and breast feeding infants. As a toxin it interferes with cellular, particularly neuronal, development, and readily crosses the placenta and into breast milk; the children are at greatest risk.

Intentional mass exposure to dioxin or Polychlorinated Biphenyls (PCBs) would be difficult to detect, induce wide-spread fear, and tax our resources for decades at an enormous cost.

## The Public Health Management of Chemical Incidents

*David Russell, WHO Collaborating Centre for Chemical Incidents, Centre for Radiation, Chemicals & Environmental Hazards, Cardiff Metropolitan University, UK*

In 2009 the global turnover of the chemical industry was €1.87 trillion (exclusive of pharmaceuticals) with 200-300 new chemicals added per year in the EU.

Various case studies including the Hungarian mud spill in October 2010; Mass bromide poisoning in Angola, 2007; Heavy metal poisoning from mining, Zamfara, Nigeria; toxic waste dumping, Cote d'Ivoire, 2006 were discussed to emphasize the need to identify hazards, assess, prioritize and mitigate risks, subsequent planning and preparedness provide the basis for a coordinated, efficient and effective response as timely response precedes recovery.

### Q & A

**Q - Could you speak a bit more on “BLEVEs” (boiling liquid expanding vapor explosions)?**

**A - It's to do with how the chemicals are stored and transported. These chemicals are basically gaseous at normal room temperature and pressure. By increasing the pressure substantially you can force the gas into liquid state and store larger quantities (basically an economic reason). If the storage container leaks the pressure decreases rapidly changing the liquid into gas rapidly. The gas expands rapidly causing devastating explosion.**

**Q - In your opinion what are some of the bigger challenges developed nations have in better managing the public health aspect in an event of a chemical incident.**

**A - We face a number of challenges – dearth of good risk assessments. We currently have 60 million chemicals and we keep on adding yearly to that list but we don't have the toxicology data on most of them particularly chronic exposure so we don't have accurate risk assessments to provide to the public in event of an incident involving such a chemical. Secondly, we know less and less about mixtures of chemicals. Lot of work needs to be done. EU is certainly ahead with the REACH program where new chemicals can only be introduced into the market after being toxicology evaluated so it's a forward looking program but does not look retrospectively into some of the past issues.**

**Comment - Canada has a similar program in terms of environmentally hazardous substances.**

**Q - Can you talk about integration of toxicologists into chemical disaster and preparedness?**

**A - It is essential to have this kind of an interface. Clearly it is an extension of toxicology. So it's important to have people who understand both points of view. According to World Health Organization (WHO) data 25% of the global burden of disease is not associated with infectious diseases but to the exposure of environmental hazards. And as the number of chemicals increases we will see more burden of disease attributable to chemicals so it's important that we work in this multidisciplinary fashion to address the public health issues.**

**Q - I am an emergency physician and have been tasked with my team to develop a national CBRNE training program for health professionals. Since the public health system of UK is similar to Canada - Do the hospitals in the UK have special CBRNE teams to deal with such an incident?**

**A - Chemical inflicted injuries or incidents are not commonly seen. Our emergency physicians and staff have received training in terms of recognizing a chemical attack/ injuries but the issue is the high turnover of the junior staff in hospitals and rare occurrence of these events.**

**Q - Do you face the similar budgetary constraints as we do here?**

**A - Clearly there are budget constraints and a need to prioritize (their goals). But that being said – they are expected to deal with a major CBRNE incident.**

**Q - How does medical toxicology and poison centers integrate with public Health in the UK?**

**A – UK has a series of National Poison Information System (NPIS) centers which has a mix of medical consultants called SPIS (Specialist Poison Information Scientists). There is close collaboration between public health and NPIS. They are trained in recognizing chemical incidents; they form a part of emergency preparedness with respect to contacting the public health. If we have a chemical incident (with knowledge of which chemical has been used) our colleagues at the NPIS are contacted to help us with the toxicological aspect –to work that interface between treating individual causalities and providing a broader risk communication message to the communities. They are an important conduit. Without which we would not be able to deal with the crisis that enfolds a chemical incident.**

**Q – How would you deal with an incident covering multiple jurisdictions?**

**A – All incidents are logged and all the procedures are in place. It comes down to acumen at the end of the day. There is nothing better than the human receptor for recognizing something is amiss.**

## **Observed Behaviors during Mass Chemical Exposures**

*Mark Kirk, MD FACMT*

Sorting out physical responses to a toxic exposure from physiological and psychological responses to a stimulus can take time and may not be always explainable. Physiologic response to a perceived threat is traumatic and can lead to a range of symptoms. It is often difficult to understand the psychological impact of mass chemical exposures and requires appropriate response to the mental health needs of victims of real and perceived events.

Strategies to help victims suffering from fear or strong emotions following a real or perceived toxic chemical exposure must be in place as psychological symptoms mimic that of Poisoning. Early diagnostic & management decisions are critical to the success of the emergency response – planning for such an incident is always recommended. Inter-agency coordination and effective risk communication should also be a priority in planning. Also evidence based planning based on social-behavioral observations is a must. To achieve this, partnerships with behavioral care experts, epidemiologists, and medical toxicologists should be pursued.

This was further illustrated using various case studies.

## Acute Exposure Guideline Levels (AEGL)

*Daniel Krewski, Risk Sciences International, former Chair of the US National Research Council's Committee on Acute Exposure Guideline Levels*

Health risks from hazardous chemicals range from mild irritation that immediately subsides to acute reversible effects to long-term irreversible effects. AEGLs provide estimates of airborne concentrations for a range of exposure durations to hazardous substances. These guidelines are useful in estimating the risks and magnitude of health effects resulting from exposures to accidental or terrorist events.

There are three AEGLs that represent increasing severities of adverse health effects: AEGL-1 (Irritation and other reversible effects), AEGL-2 (Irreversible or disabling effects), AEGL-3 (Lethal effects). Establishing AEGL values requires a very rigorous procedure - review of all relevant published and unpublished information on a chemical such as chemical-physical relationship, structure-activity relationship, in vitro toxicity, animal toxicity, controlled human studies, observations of humans involved in accidental exposures, epidemiologic studies and so on.

It is useful for both emergency planning and emergency response.

### Q & A

**Q - Can you provide us with a ball park figure it would take for deriving the AEGL values per chemical?**

**A – You are looking at 0.5 - 1 million dollars per volume.**

**Q – You mentioned the use of Categorical Regression for chemicals having deficiency as well as toxicity issue. Has this been used to derive AEGL values for perchlorate salts and Iodine status for thyroid effects?**

**A – I was involved with the first five volumes and do not recall such a chemical (showing toxicities on both sides of the spectrum) being reviewed. But I just showed you the methodology does exist and it will only be a technical extension of the same.**

**Q – You mentioned in the Sarin example – one of the guidelines you have used is 60% inhibition of RBC-ChE for AEGL-2. But when we look into the literature the value is all over the place. Did the authors used this value – how did you arrive at this value?**

**A – An adjustment factor was applied to whatever value was used by the authors to be protective.**

**Q – You can use the cards with the AEGL values but is there any field detection equipment that can measure the AEGL values?**

**A -The Committee made a big deal about planning and not just emergency response in the Standard Operating Procedures (SOPs) - if you were to have an emergency release around a new chemical plant with a certain parameter what would be the maximum release and would you be below certain AEGL levels that would be within your design parameters.**

## Post-Event Medical Monitoring

*Charles McKay, MD FACMT*

The goal of medical monitoring is to identify (or maybe even prevent or treat) an adverse effect after an exposure which is generally delayed in presentation.

Risk-based interpretation of monitoring results is preferred but is not always available. However, for many compounds, this has to be extrapolated from animal data or other data. In doing that, the appropriate caveats should be emphasized regarding nature and intensity of exposure setting, and validity of animal model extrapolation to humans, as well as validity of extrapolation to lower dose exposures.

Effective communication of the results of medical monitoring is of utmost importance.

### Q & A

**Q - After the September 11 incident in US, there was a risk registry would you want to comment on that?**

**A - There was a World Trade Centre registry set-up after the September 11 terrorists attack that enrolled people who were exposed, thought were exposed, lived in the neighborhood and are being followed till date. The idea behind is to study disease and disease progression....there are lot of underlying post-traumatic stress disorder and real psychiatric illness that was a direct result of such a traumatic event. We do see people with lung disease and so on.**

**For a discrete event, I think it is worthwhile to have a registry so that you can follow people over time.**

### TABLETOP Exercise

The two day workshop was concluded with a tabletop exercise or a brainstorming session where an emergency situation was simulated to facilitate discussion amongst the participants regarding general problems and procedures in the context of the emergency scenario. The focus of the exercise was on training and familiarization with roles, procedures, or responsibilities in emergency situations.

Risk Management Program /Plan (RMP) Requirements/Regulations – In Environment Canada there are emergency regulations in place to conduct risk analysis (maybe not be full blown), use of the best practices is recommended.

Public health disaster plan or RMP for a community should include measures to decrease the risk by hardening the facility, decrease the quantity stored, know what chemicals are kept on site and what a release will look like for that community and have mitigation strategies in place.

## Scenario – Spill in Sarnia

In the event of a spill you will have to inform the Ontario Spill Action Centre (provincial) – the designated agency to take action in the event of environmental emergencies. This will trigger the information to fan out to Environment Canada, Health Canada, Public Health Agency of Canada, and CANUTEK. But it's different in Quebec. In Quebec you will have to call 911, provincial public Health, and Environment Canada. Then EC will fan out the information to its federal partners.

Ontario and Quebec have a van with GCMS capable of doing real time monitoring. There is an escalation procedure in place in case if it is beyond the capacity of any one of the agency.

Alerting the media can also be important – information will go out instantly. Social media is the most rapid form of information dispersion.

In Ontario, three fire departments (Ottawa, Toronto, and Windsor) are designated as level 3 HAZMAT response team. As soon as such a release or spill happens the local fire department will get in touch with the HAZMAT team in Windsor (Sarnia being closest to Windsor). But in a rapidly evolving situation, the local response team should be well equipped to do the needful.

As per the Environmental Emergency (E2) Plan under Canadian Environment Protection Act (CEPA), Any person who owns or manages a “listed substance” in a quantity at or over the prescribed minimum quantity is required to provide Environment Canada with information on the quantity of the substance, along with the facility location, a report that an environmental emergency plan has been prepared and a notice indicating that the emergency plan has been implemented within 90 days, six months and one year of the coming into force of the Regulations, respectively.

Some readily available resources for emergency response were provided including Radiation Emergency Medical Management (REMM); Canadian Transport Emergency Centre (CANUTEK); Emergency Response Plan, Chemical Hazards Emergency Medical Management (CHEMM). All these sources have valuable information on tools and guidelines for emergency planning. It is advisable to make use of these resources beforehand perhaps as a drill or tabletop exercises.

## Evaluations Report

### **Background**

A two day workshop on Chemical Agents of Opportunity for Terrorism (CAOT) was delivered during the period of February 5-6, 2014. The Chemical Emergency Preparedness and Response Unit (CEPRU) of Health Canada, in partnership with the American College of Medical Toxicology (ACMT) and with sponsorship from the Canadian Safety and Security Program (CSSP) developed a training program that aimed to provide an in-depth understanding of the concept of chemical agents of opportunity, toxic industrial chemicals (TICs), and develop an appreciation for the basis for increased public health preparedness. The CAOT workshop was based on an intensive awareness-level course developed by the ACMT, approved by the US Federal Emergency Management Agency (FEMA) and delivered in various forms 100 times in the U.S. over the last 11 years. This was the first time this course was offered in Canada. Experienced medical toxicologists from the U.S. and Canada delivered the course and facilitation, while course administrative support was provided by Risk Sciences International (RSI). The course was complemented by many presentations from international subject matter experts to provide participants a rich learning and networking opportunity followed by a tabletop session.

### **Data Collection**

#### **Method of Registration**

Participants were sent an invitation by CEPRU of Health Canada and registered through RSI or by using the registration form accompanying the invitation. Data collected from the registration forms helped RSI to develop a better understanding of the expected audience for the course.

#### **Pre-/Post-Workshop Knowledge Assessment**

A pre-course knowledge assessment consisting of 14 questions covering a range of topics including major concepts and specific chemical threats was completed by 84 registrants. The correct scores on these individual questions averaged 60%. Correct response rates ranged from 24% [on a question pertaining to a specific threat analysis posted by the US DHS] to the 40-60% correct range on topics covering fumigants, hazard ranking systems, the importance of water solubility in determining nature of an inhaled irritant's clinical effects. A question asking for recognition of ammonia as a toxic industrial chemical was answered correctly 94% of the time. A post-workshop knowledge assessment consisting of 40 questions was completed by 32 participants. The average correct score was 90% with a range of 74-100% of the questions answered correctly. We do not have a person-to-person specific comparison, but it would appear - in concert with the evaluation comments - that participants' knowledge base increased.

A higher completion rate of the post-course knowledge assessment would allow better objective assessment of new knowledge. As these assessments could be completed on-line, participants were not held at the site pending completion. The time allotment for such an activity (average of 30 minutes on line to complete the test) would likely be prohibitive in the larger class setting. It appears that 1/2 of those completing the test did so within the week of the course, while the remaining 1/2 completed the test the following week. No additional test responses were received after that (1 month assessment). There were reports of difficulty accessing the site, which may have been attributable to institutional firewall issues. In the future, reminder emails or on-site completion with discussion might increase rate of return. In addition, we are beginning to do follow-up assessments (6- and 12-months) of the impact of

the course on work or planning. Knowledge-based questions could be incorporated into these follow-up emails, if desired.

### Informal Feedback

Throughout the course, participants offered informal feedback to the course administrator. This feedback was recorded for future reference with regards to course evaluation and future course development.

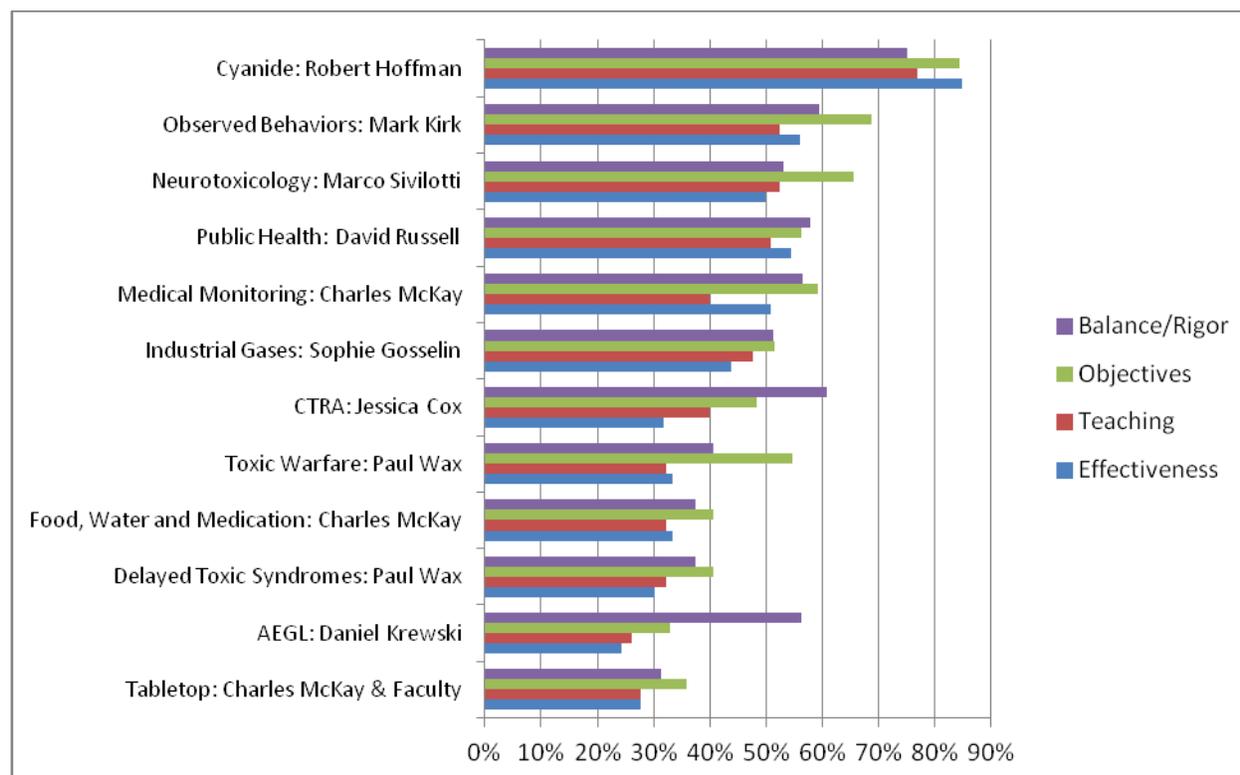
### Evaluation Forms

The course evaluations consisted of quantitative questions where participants were asked to rank their reaction on a scale of 1 to 5, where 1 is the minimum and 5 is the maximum. This scale was used to evaluate several factors, including:

- Content / teaching effectiveness
- Presentation / teaching methods
- Relevance of content to objectives
- Objectivity, balance, scientific rigor

Figure 1 below provides a percentage breakdown for each factor, as well as the average for each presenter. This average was used to determine the best rated overall presenters, displayed in Table 2.

**Figure 1**



The evaluation also contained open-ended general questions, allowing participants to provide feedback in their own words with regards to potential improvements to the course, and to describe what they found most enjoyable about the course.

### **Interpretation of Evaluations**

#### **Informal Feedback**

In many instances the informal feedback offered by participants to the course administrator was affirmative and all agreed that the course was extremely educational, challenging the ways in which they thought about public health preparedness.

Many participants found the interactive component and the tabletop to be very informative and interesting. Participants indicated that the overall course was a great learning experience that provided excellent exposure to the many different approaches to public health preparedness.

#### **Course Evaluations**

The average daily number of participants in attendance was 120. Of the participants, a total of 59% provided completed evaluation forms.

Table 1 below provides a breakdown of the responses to questions one through seven, including the percentage of those respondents who agree or strongly agree with the statements.

**Table 1**

Question No.:	Response
1.	62% of respondents Strongly Agree that the overall focus of the workshop was useful and appropriate
2.	35% of respondents Agree and 49% of respondents Strongly Agree that the workshop provided an appropriate balance of information.
3.	26% of respondents Agree and 53% of respondents Strongly Agree that the instructors made the concepts taught in the workshop understandable.
4.	75% of respondents Strongly Agree that the instructors were knowledgeable and able to answer questions.
5.	52% of respondents Agree while only 22% of respondents Strongly Agree that enough time was allotted on each topic.
6.	39% of respondents Agree and 39% of respondents Strongly Agree that the workshop material was appropriate to enable the lecture.
7.	32% of respondents Agree and 46% of respondents Strongly Agree that The workshop materials will be a valuable resource when I return to my job.

#### **Overall Course Rating**

The overall participant rating for the course was 4.5 out of 5. The participants indicated that although some of the lectures did not apply to their specific roles, a large portion of the program offered information, insight and real-life examples of situations that could be applied to their work.

#### **Excerpts of Participants' Comments**

##### **What did you like best about the workshop?**

- *"Multidisciplinary audience and presenters; well-rounded topics, interesting lectures."*

- *"I Appreciated hearing from some very knowledgeable and experienced/qualified speakers. I liked the approach of assessing medical need/response through toxidromes. It was also very kind of Dr. Hoffman to provide the talk on the Role of the PCC and Disaster Management."*
- *"The range of presenters and topics presented. The less formal talk by Dr. Hoffman was great and very useful."*

#### What did you like least about the workshop?

- *"Presenters who spoke very rapidly."*
- *"Was not able to be there in person. but Webinar worked."*
- *"Some speakers exceeded allowed time. Some lectures were loaded with information that interfered with effective teaching"*

#### What would you recommend to be done to improve this workshop for future participants?

- *"Quality over quantity. Some lectures have large number of fully loaded slides - ideas not delivered effectively."*
- *"Have a better reference to Canada's Acts, regulations and emergency management system/process."*
- *"A time keeper that keeps the speakers on their time."*

#### Please provide any additional comments or observations you wish.

- *"I truly enjoyed the workshop and learned a great deal. My sincere thanks to the speakers and sponsors of this project for the tremendous effort and obvious care to provide this learning experience!"*
- *"It was great to do a tabletop with the large amount of different agencies in the room. Excellent speakers."*
- *"Thank you for this great opportunity! It would be nice to have the list of participants available. I think the table-top exercise could have used the clickers more. Also, it would have been nice to get the "right answers" on how to respond to the situation (in writing on the slides & on reading material e.g. summary and learn more about the USA response structure as the Canadian one is not fully established."*

As mentioned above, Figure 1 provided a percentage breakdown for each factor relating to the presentations for each presenter. The averaging of these data was used to determine the best rated presenters, displayed in Table 2 below.

**Table 2 Best rated overall presenters**

80%	59%	55%	54%	51%
Robert Hoffman	Mark Kirk	Marco Sivilotti	David Russell	Charles McKay

#### **Lessons Learned**

As noted in the Excerpts of Participants' Comments, the two most common complaints received from participants in this workshop were related to presenters exceeding their allotted time, and to the slide presentations containing too much information or not enough. These two issues are very common when

delivering a course of this nature; however, RSI will gladly work with Health Canada to implement strategies to address and reduce these issues for future course offerings.

For example, in order to address the issue of speakers exceeding their timeslot, RSI could help with the implementation of a tighter moderation approach with planned interval warnings (e.g. 5 minutes, 2 minutes, 1 minute) as the speaker approaches the end of their allotted time. In order to address participants' concerns regarding the course materials, RSI could also encourage speakers to maintain a specified limit on the number of slides within a deck, and that slide decks are not modified once sent to ACMT for publishing online. This way, participants will have a more consistent experience.

In terms of logistics, there were a few items that, if addressed, could make the next session or any other training session even more successful.

***Venue:***

Characteristics of the potential or chosen workshop venue(s) should be carefully considered. In this case, although the venue was beautiful and functional, it was also isolated, providing limited options for participant meals and snacks. Unfortunately, parking also became problematic on the second day of the workshop. Selecting a venue that is easy to access, provides plenty of parking and a variety of options for lunch and break time snacks would reduce the general discomfort or inconvenience some participants experienced.

***WebEx***

Ensure familiarity with web conference software prior to workshop. Although the technical difficulties experienced on day one were quickly resolved, there were still a few participants who had difficulty with the audio or the video. This could be a direct result of their internet connection, or it could simply be because the presenter was speaking too rapidly, or softly. Those participating remotely would benefit from the use of a tool with which the tech support and course coordination teams were more familiar. Additionally, some remote participants felt excluded from the activities that included the use of clickers. Perhaps using an online survey tool can be considered for future events.

***Multiple Stakeholder Coordination***

Ensure regular, clear, and collaborative communication amongst all stakeholders, with clear assignment of responsibilities. Course coordination can be very complex. When coordinating a course with multiple stakeholders clear, concise communication amongst the entire coordination team is paramount. Although many aspects of the workshop went well, we were presented with a few challenges. Generating a workshop management task list, assigning those tasks to the appropriate individuals and sharing this list amongst all members of the team managing the workshop or course could prevent or reduce the number of issues that arise. Openly communicating with specific members of the team while copying the rest of the group would also be extremely beneficial in ensuring that all team members have the same understanding of responsibilities, timelines and expectations. The availability and flexibility of the on-site administrative support as well as the on-site AV personnel and others to address problems and needs as they arose was very important to the overall success and smooth flow of the program.

***Course Evaluations***

Additional contextual details could be considered in formulating a course or workshop evaluation questionnaire. Participant evaluations can serve as useful tools for adjusting course or workshop content, as well as receiving feedback on other aspects of the course, such as presenter ratings and opportunities for improvement. This kind of constructive criticism is essential in ensuring the quality of workshop or course offerings is maintained. We have found that the opportunity for free text comments is frequently utilized to provide both significant constructive criticism or suggestions, and also serves to assess the involvement/investment of the participants in the subject matter. Many suggestions for future course venues or topics have come from these comments.

### **Summary**

Overall, with an average participant rating of 4.5/5, the Chemical Agents of Opportunity for Terrorism workshop was received positively. The course featured a variety of world-class speakers, and provided an opportunity for individuals from a large range of backgrounds come together on a common theme. While in some instances portions of the material may have been too technical for certain participants, many attendees generally felt it had a useful impact on their current position. Several participants expressed a desire to see this course or variations of it offered on an annual or by-annual basis. Requested course offerings included: First Responders focused program, Transport specific program, Environmental Damage Assessment program and Risk Management, Risk Modeling and Resilience program. There was a suggestion that a course or presentations of this nature would be beneficial if offered to the International Associate of Fire Chief's Conference on HazMat held annually in the US. Other participants expressed interest in participating in a more advance course of this nature. In closing, many of the comments and suggestions contained within the evaluations data indicate courses or workshops of this nature are extremely useful and sought after.

## Agenda: Chemical Agents of opportunity for terrorism Workshop

111 Sussex Drive, Ottawa

### Day 1 – Wednesday, February 5<sup>th</sup>, 2014

8:00-9:00am	<b>Registration</b>
9:00-9:15am	<b>Introduction &amp; Welcome - Workshop Overview</b>
9:15-9:30am	<b>Sponsor Canadian Safety and Security Program</b> Norman J. Yanofsky, Acting Head CBRNE Threats and Hazards
9:30-9:45am	<b>Project Champion:</b> Andrew Adams, Director General Environmental and Radiation Health Sciences, Health Canada
9:45-10:30am	<b>Toxic Warfare: Beyond Conventional Chemical Weapons</b> Paul Wax MD FACMT
10:30-10:45am	<b>Break</b>
10:45-11:30am	<b>Clinical Neurotoxicology of Chemical Terrorism</b> Marco Sivilotti MD FACMT
11:30-12:15pm	<b>Toxic Industrial Gases as Terrorist Threats</b> Sophie Gosselin MD
12:15-1:15pm	<b>Lunch Break</b>
1:15-2:00pm	<b>Chemical Terrorism Risk Assessment (CTRA)</b> Jessica Cox, DHS Chemical Security Analysis Center
2:00-2:45pm	<b>Cyanide and Fumigants</b> Robert Hoffman MD FACMT
2:45-3:00pm	<b>Break</b>
3:00-3:45pm	<b>Chemical Contamination of Food, Water &amp; Medication</b> Charles McKay MD FACMT
3:45-4:30pm	<b>Terrorism by Fear and Uncertainty: Delayed Toxic Syndromes</b> Paul Wax MD FACMT
<u>Optional Social Event:</u> 18:00-20:00	<b>Poison Centers and Disaster Management</b> Robert Hoffman MD FACMT Courtyard Marriot Hotel ( <b>Bistro Room</b> ) 350 Dalhousie Street, Ottawa, Ontario K1N 7E9

### Day 2 - Thursday, February 6<sup>th</sup>, 2014

9:00-9:15am	<b>Day 2 Workshop Overview</b>
9:15-10:00am	<b>Public Health Management of Chemical Incidents</b> Professor David Russell, WHO Collaborating Center for the Management of Chemical Incidents
10:00-10:15am	<b>Break</b>
10:15-11:00am	<b>Observed Behaviors During Mass Chemical Exposures</b> Mark Kirk MD FACMT
11:00-11:45am	<b>Acute Exposure Guideline Levels (AEGl)</b> Dr. Daniel Krewski, Risk Sciences International, former Chair of the US National Research Council's Committee on Acute Exposure Guideline Levels
11:45-12:45pm	<b>Lunch</b>
12:45-1:30pm	<b>Post-Event Medical Monitoring</b> Charles McKay MD FACMT
1:30-1:45am	<b>Break</b>
1:45-3:45pm	<b>Tabletop: Response to Mass Chemical Release</b> Charles McKay MD FACMT and faculty
3:45-4:15pm	<b>Conclusion and Evaluations</b>