Why Are We Concerned About Toxic Industrial Chemicals as Terrorist Weapons?

Module 2 for DHS Demonstration Cities 2015
By the American College of Medical Toxicology
Course Overview

1. Introduction / Making Sense of Toxicology
2. Why Toxic Industrial Chemicals?
3. Inhalation of Toxic Industrial Gases
4. Agricultural Chemicals of Concern
5. Cyanide and Fumigants
6. Psychological Consequences of Mass Exposure
7. Risk Communication
8. Neurotoxins
9. Water, Food & Medication as Vectors
10. Delayed-Onset Toxins
11. Post-Event Medical Monitoring
12. Tabletop Exercise

www.acmt.net
Please help us improve this course by filling out the module evaluation.

You will receive an email with instructions following the conclusion of this presentation.
Faculty Disclosure

• Dr. McKay is the Vice-President of the American College of Medical Toxicology, a professional association of physician toxicologists

  – Disclosures:
    • Principal Investigator for clinical trial (Alere)
    • Member, Science Advisory Council, Environmental Health Research Foundation

• Dr. McKay’s presentation should not be taken to represent the views, opinions, or policy of the U.S. Department of Homeland Security or the American College of Medical Toxicology, nor is it intended to promote any commercial product or service.
Participant Question:

- How many people are in attendance at your site (including yourself)?
Objectives

• Distinguish TICs/TIMs from “traditional” warfare agents
• Review historical examples of toxic terrorism
• Practice toxidrome recognition
• Discuss hazard ranking and legislative response to chemicals of concern
Confusing Scene
Module Two – Why TICs and TIMs?

http://xnet.nextcentury.com/wiser/Chemmist/chemmist.htm
Patient 1

• 45 year old man complains of burning pain in his hands – beginning immediately after pulling Patient 2 out of truck. He is alert, with normal vital signs, and has no complaints of breathing difficulties. His hands are beefy red and a bit swollen. He notes that his eyes are beginning to hurt now.

http://xnet.nextcentury.com/wiser/Chermist/chemmist.htm
Patient 2

• 30 year old truck driver having significant breathing trouble. He is auditibly wheezing, anxious and tachycardic (P 130). He cannot speak in full sentences - but complains of burning eyes, face, throat, and chest.

http://xnet.nextcentury.com/wiser/Chemmist/chemmist.htm
Patient 3

- 60 year old leaning against his car near the crash. He is anxious and seems to be having some breathing difficulty. He is mildly tachycardic (100), a bit sweaty for the weather, and a bit tremulous. His lungs are clear. He doesn’t complain of burning pain in the eyes or skin, but does have some chest aching.

http://xnet.nextcentury.com/wiser/Chemmist/chemmist.htm
## Implications

<table>
<thead>
<tr>
<th>Patient</th>
<th>Toxidrome</th>
<th>Diagnosis</th>
<th>Treatment</th>
<th>Other Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Irritant gas, but uncertainty</td>
<td>Chemical burns</td>
<td>Skin &amp; eye decon/burn care</td>
<td>Responder skin protection on scene; low risk to providers if adequate patient decon</td>
</tr>
<tr>
<td>2</td>
<td>Irritant gas, high likelihood</td>
<td>Corrosive inhalation</td>
<td>Active management of airway, oxygen, bronchodilators, skin&amp;eye/burn care</td>
<td>May deteriorate rapidly. Clothing likely source of ongoing exposure to patient &amp; others</td>
</tr>
<tr>
<td>3</td>
<td>No clear “winner”, but systemically ill</td>
<td>Anxiety with complicating MI</td>
<td>Transport w/EKG, aspirin</td>
<td>Medically ill – not exposed. Does not need decon; poses no threat to others</td>
</tr>
</tbody>
</table>
Chemical Agents of Opportunity for Terrorism: TICs & TIMs

Chemical Agents

Purpose-Designed Warfare Agents
• *Nerve* (e.g. Sarin, VX)
• *Blister* (e.g. Mustard)

Dual-Use Industrial Chemicals
• *“Blood”* (e.g. Cyanide)
• *Choking* (e.g. Phosgene)

Toxic Industrial Chemicals and Toxic Industrial Materials
Chemical Agents of Opportunity for Terrorism: TICs & TIMs

TICs and TIMs
Scenarios

- Large-scale outdoor release of toxic gas or fumes, and/or an explosion, from an attack on a mobile or fixed tank or vessel
- Targeted release of a toxic gas into a confined space (e.g. a subway, theater, or building) or against specific individuals or groups
- Acute or delayed poisoning by contamination of food, water, or a highly trafficked venue
Chemical Terrorism

• Definition – the use of chemicals to harm or alter the behavior of an adversary
• Utilize existing stored chemicals – exploiting weapons of opportunity
• Who’s at risk
  – Civilians
    • Wide availability of toxic materials in most countries
    • Proximity of industrial operations to large urban centers
  – Military abroad
Goals of Toxic Terrorism

• Health Effects
  – Incapacitating vs killing

• Damage / contamination of infrastructure

• Psychological effects resulting from actual or threatened use of toxic substances - *terrorizing*
  – Asymmetrical
  – Create *uncertainty*, fear and panic
  – Uncertainties provide tactical and/or psychological advantages
Why Use Industrial Chemicals?

- Low cost
- Wide availability
- Potential for attack on multiple aspects/processes
- Impact
Limitations with Purpose-Designed WMD
Aum Shinrikyo – Matsumoto 1994, Tokyo 1995 (Sarin)

• ~$30 million spent on chemical weapons research
• Employed many scientists
• Killed 19
• Problems with
  – Production
  – Ineffective Delivery System
Chemical Agents of Opportunity for Terrorism: TICs & TIMs

Much More Effective
Bhopal - 1984

• Methyl isocyanate
• > 2,500 deaths
• > 60,000 injuries
Participant Question:
Which of the following would best be characterized as a toxic industrial chemical?

a) Ammonia
b) Anthrax
c) Mustard Gas
d) Sarin
e) Water
What Is the Potential Scope of the Problem in the U.S.?

- ~ 850,000 U.S. businesses use, produce, or store TICs
- EPA report – 123 chemical plants across US have enough toxic chemicals to kill/injure 1 million people in terrorist attack
- 750 other plants have enough chemicals to kill/injure at least 100,000 people in an attack
- U.S. Army study - terrorist attack on chemical plant in densely populated area could result in 2.4 million fatalities or injuries
High Volume Chemical Production and Use at Facilities with 100,000 Pounds or Greater Onsite Reporting Year 2000

Facility reporting at least
- 100,000 pounds of substances onsite at any given time

Amount of TRI-Reported Substance Present in Area*
- Of Concern
- Of Greatest Concern

18,893 records analyzed (out of 89,904 total)

Density Analysis Parameters:
- One mile grid cell size
- 50 mile search radius
- Kernel estimation technique

*The depicted density grid was compiled from the locational information provided by EPA's TRI. It indicates where the largest quantities of substances are present in the continental US. The scale of danger is a compilation of millions of pounds at a few proximate sites on the low end, to billions of pounds at multiple sites in close proximity at the high end.
US Legislative Response to Major Chemical Accidents

• Emergency Planning and Community Right-to-Know Act (EPCRA) 1986
• Clean Air Act Amendments of 1990
  – Occupational Safety & Health Administration’s (OSHA) Process Safety Management (PSM)
  – Environmental Protection Agency’s (EPA) Risk Management Program (RMP) 1996
Emergency Planning & Community Right-to-Know Act (EPCRA)

• Required chemical facilities to provide
  – Information necessary for emergency planning to Local Emergency Planning Committees (LEPCs) and
  – annual hazardous chemical inventories to State Emergency Response Commissions (SERCs), LEPCs and local fire departments.

• Required SERCs & LERCs to prepare emergency response plans for chemical accidents.

• Established Toxics Release Inventory (TRI), which requires facilities to annually report quantities of their emissions of toxic chemicals to TRI database.
US EPA Risk Management Program

- Aim: Prevent/minimize consequences of accidental chemical releases from fixed facilities.
- Facilities that manufacture, process, use, store, or otherwise handle any of 140* listed substances at or above specified threshold quantities (range from 500–20,000 pounds) must submit a Risk Management Plan (RMP).

* The number of chemicals has been increased to 650
Risk Management Programs
(61 CFR 31667, 06/20/96)

- Hazard vulnerability assessment
- Accident prevention program
- Emergency response program
- Specified facility information

- Make info available to: EPA, state & local governments, FD & public
Worst-Case Scenario: Likelihood of Occurrence?

• WCS are considered unlikely because:
  – Assume a very large release occurring during worst-case atmospheric conditions
  – Does not include active release mitigation such as water deluge systems and automatic shutoff valves
    • Passive mitigation efforts included, such as containment dikes and building enclosures
• However, with a terrorist attack, more than one process likely to be affected
Acute Exposure Guideline Levels (AEGL)

www.epa.gov/oppt/aegl/
Goal: Reduction in Hazards/Vulnerabilities

Before:
- Vulnerable zone
- Storage tank
- Many lives in the community are at risk from accidental or intentional chemical releases.

After:
- Using safer materials, reducing storage volumes, adding barriers, and relocating nearest neighbors eliminates major community vulnerability.

Safe Hometown Guide
Chemical Agents of Opportunity for Terrorism: TICs & TIMs

DHS Chemical Facility Antiterrorism Standard (Interim Final Rule 2007)

- Risk-based focus on facility security and improvements
- Security Vulnerability Assessments and Site Security Plans
- Mandates audits and inspections
- Penalties for non-compliance
- Confidential information – preventing “inappropriate public disclosure”

http://a257.g.akamaitech.net/7/257/2422/01jan20071800/edocket.access.gpo.gov/2007/E7-6363.htm
Not Just Fixed Facilities

Total Transportation and Fixed-Facility Incidents 1987-1996

- 1996
- 1995
- 1994
- 1993
- 1992
- 1991
- 1990
- 1989
- 1988
- 1987

Legend:
- Fixed Facility Incidents
- Transportation Incidents
Rail links transporting chemical tanker cars travel through or near major cities

Photo: Jim Dougherty
July 9, 2004
Participant Question:
The Acute Exposure Guidelines Levels (AEGLs) identify:

a) Safe levels of chemicals to work with as AEGL 3
b) Levels of increasing health concern from 1 to 3
c) The chronic consequences of workplace exposure to chemicals
d) A measurement of chemical concentrations in water
Ranking Chemicals of Concern

- **NATO ITF-25 (1996)**
  - High Production Volume Chemicals (HPVs)
    - produced in quantities $> 30$ tons (60,000 pounds) in a single facility
  - High Toxicity
    - $LCT_{50}$ by inhalation $< 100,000$ mg/min/M$^3$
  - Appreciable vapor pressure at 20°C
    - Thus, airborne hazards only
  - Hazard Index $= \{(toxicity) \times (state) \times (distribution) \times (producers)\}$

- **U.S. Army CHPPM (2002)**
  - Incorporated a number of other agents, considering corrosivity, reactivity, flammability (included less volatile chemicals)
CHPPM Ranking Method

• **Hazard Ranking (HR)** = Max Score [health (1-4) or flammability (0-4) or instability 0-4)]

• **Probability Ranking (PR)** = Sum [# of producing countries (0-4) + physical state (1-solid; 2-liquid; 4-gas) + history (2-involved in catastrophic incident; 3-CWC 2-3; 4-intentional use as weapon)]

• **Risk = HR + PR**
Types of Terrorists Activities
(Chemical n=207  Biological n=135)  1975-2000

**Concern**
- Hoax/prank/threat 120 (35%)
- Plot only 28 (8%)

**Serious Concern**
- Attempted acquisition 9 (3%)
- Possession 48 (14%)
- Threat with Possession 11 (3%)

**Grave Concern**
- Use of agent 126 (37%)

Monterey Institute Database, 2000
## CHPPM Risk Assessment

<table>
<thead>
<tr>
<th>CHEMICAL</th>
<th>HAZARD</th>
<th>PROBABILITY</th>
<th>RISK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen Cyanide</td>
<td>Catastrophic</td>
<td>Occasional</td>
<td>High</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>Catastrophic</td>
<td>Likely</td>
<td>Extreme</td>
</tr>
<tr>
<td>Acetylene</td>
<td>Catastrophic</td>
<td>Frequent</td>
<td>Extreme</td>
</tr>
<tr>
<td>Nitromethane</td>
<td>Catastrophic</td>
<td>Seldom</td>
<td>High</td>
</tr>
<tr>
<td>Phosgene</td>
<td>Critical</td>
<td>Occasional</td>
<td>High</td>
</tr>
<tr>
<td>Methanol</td>
<td>Critical</td>
<td>Occasional</td>
<td>High</td>
</tr>
</tbody>
</table>
### CHPPM Risk Assessment Results

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Total Number of Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme</td>
<td>39</td>
</tr>
<tr>
<td>High</td>
<td>322</td>
</tr>
<tr>
<td>Moderate</td>
<td>354</td>
</tr>
<tr>
<td>Low</td>
<td>325</td>
</tr>
<tr>
<td>Unranked</td>
<td>716</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1756</strong></td>
</tr>
</tbody>
</table>
Chemical Agents Employed by Terrorists

- Corrosives - Acid / alkalis
- Metals
- Cyanide
- Rodenticides
- Pesticides
- Poison gas

Monterey Institute Database, 2002
Limitations of Ranking Efforts

• Extensive ranking efforts are unable to evaluate every chemical
• Use of “agents of opportunity” and changing methods of delivery continue to be challenges
• Potential for early recognition of an occult release is limited
Unusual but Easily Available Agents

‘Very Nasty’
Potential Bomb Plot Involved Deadly Chemical

By Brian Ross and Christopher Isham

April 5 — British authorities believe terror suspects arrested last week were planning to make a bomb that would include a highly toxic, easily obtained chemical called osmium tetroxide, ABCNEWS has learned.

Used primarily in laboratories for research, osmium tetroxide is known to attack soft human tissue and could blind or kill anyone who breathed its fumes. (ABCNEWS.com)
 module two – why TICs and TIMs?
Participant Question:
Which of the following is not a factor in a Hazards Ranking process?

a) Inherent toxicity of a chemical
b) Availability of a chemical
c) History of prior use of a chemical as a terrorist weapon
d) Meteorologic conditions at the time of a release
e) Amount of a chemical released
Chemical Terrorism Risk Assessment (CTRA)

• Homeland Security Presidential Directive (HSPD22)
  – Models intelligence, chemical compounds, and medical countermeasure availability and effectiveness
Assessing Risk and Risk Perception

• Assessing risk in situations of uncertainty can be challenging

• Individual’s (and Organization’s!) assessment of risks is often skewed by perception
  • What was particularly recent
  • What was particularly sensational
  • What was particularly impactful
  • What is getting attention/talk right now
Participant Question

- Which of these Natural Disaster Types represents the highest fatality risk (worldwide) over the last 100-120 years?
  a) Earthquake (Seismic Activity)
  b) Miscellaneous Accident
  c) Drought
  d) Volcano
  e) Epidemic
  f) Transport Accident
  g) Industrial Accident
  h) Storm
  i) Flood
  j) Mass Movement Wet
  k) Extreme Temperature
  l) Wildfire
  m) Mass Movement Dry
Quantifying and Identifying Risk

- Scenarios that drive risk can be identified and quantified

Quantitatively, identify where the risk lies

by Contamination Point

by Contaminant

by Contaminant & Contamination Point

Contamination Point One

Contamination Point Two

Contamination Point Three

Chemical A

Chemical B

Chemical C

50

10%

8%

16%

30%

60%

76%

10%

Chemical A

Chemical B

Chemical C

0%

10%

20%

30%

40%

50%

60%

Contamination Point One

Contamination Point Two

Contamination Point Three

Chemical A

Chemical B

Chemical C

50
Chemical Agents of Opportunity for Terrorism: TICs & TIMs

Assess Current Response Capabilities

• Such a modeling capability permits assessment of the existing medical response system and allows for the examination of alternative mitigation strategies.

Baseline Public Health Response System – Known Event

![Boxplot and Heatmap Diagram]

- **Saved (%)** vs **Event Size (Total Number of Injured Victims)**
- **Legend**: 99th, 5th, Median, Interquartile Range

![Baseline Public Health Response System Heatmap](chart)

- **Baseline Public Health Response System – Known Event**
- **Legend**: Percentage of Injured Victims Receiving Treatment
- **Color Scale**: 0, 20, 40, 60, 80, 100

Module Two – Why TICs and TIMs?
Inform Mitigation Strategies

Beverages Impact Analysis
Challenges of Chemical Agent Identification

- Symptoms similar to common diseases (e.g. gastroenteritis)
- Immediate symptoms might be mild or nonexistent
- Staggered reports over long periods / different locations
- Mixed clinical presentations
- Health care providers may be less familiar with certain chemical-induced presentations
Chemical Agents of Opportunity for Terrorism: TICs & TIMs

Module Two – Why TICs and TIMs?

Clues to Chemical Exposure

• Unusual number seeking care for chemical-related illness
• Unexplained deaths among young, healthy people, plants, animals
• Clusters of illness with common source (e.g. water)
  – Surveillance methods including PCC, pharmacy sales
• Presence of a clinical pattern or toxidrome
### Selected Clinical Syndromes (Toxidromes) and Potential Chemical Etiologies

<table>
<thead>
<tr>
<th>Category</th>
<th>Clinical Syndrome</th>
<th>Potential Chemical Etiology</th>
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<td>Abdominal pain, emesis profuse diarrhea, shock</td>
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<td>Cholinergic crisis</td>
<td>SLUDGE symptoms, Fasciculations, weakness</td>
<td>OP insecticides, nicotine</td>
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<td>Cellular hypoxia</td>
<td>N/V, headache, AMS, shock, seizures, dec pH</td>
<td>CN, SMFA, CO, Azide</td>
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<td>Peripheral neuropathy</td>
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<td>Lip / mouth / pharyngeal ulcerations; burning pain</td>
<td>Paraquat / Diquat; caustics, Hg</td>
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MMWR 10/3/03
49 yo man suddenly develops leg pain while walking

- Day 1 - fever, nausea, vomiting
- Day 2 - tachycardia, lymph node swelling and shock
- Day 3 - kidney failure, vomited blood, heart block
- Day 4 - death

Presumed Cause of Death – Septic Shock
## Selected Clinical Syndromes (Toxidromes) and Potential Chemical Etiologies

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MMWR 10/3/03
Module Two – Why TICs and TIMs?
Chemical Agents of Opportunity for Terrorism: TICs & TIMs

Module Two – Why TICs and TIMs?
Questions?

- Please click on the “raise your hand” icon and the host will unmute your phone line; or type your question into the “chat” box for the host to pass on to the presenter.

- If you have registered for the course, you will receive an evaluation survey (SurveyMonkey) from Info@acmt.net
  - Please complete the evaluation so we can improve these webinars.
Next Webinar: July 8, 2015

Toxic Industrial Gases
Appendix

• Additional CTRA-related slides
Understand Risk Contributors

- Understanding of risk drivers: consequence or frequency
- Appreciation of uncertainty and expected range

Narrow uncertainty in consequences, significant uncertainty in frequency
Chemical Agents of Opportunity for Terrorism: TICs & TIMs

Understand Risk Contributors

Understanding of main contributors to overall risk will guide strategy in buying down risk. Inventory control is very different than securing facility assets.
Chemical Terrorism Risk Assessment

Transform into a flexible and fast analysis tool

Standard Laptop

Requested by CSAC’s customers and stakeholders

CTRA Desktop Tool

Enhanced Capability
- Intuitive
- “Explore the Edges”
- Beta version transitioned to customers