

Chemical Agents of Opportunity: The Medical and Psychological Consequences of TICs and TIMs

Satellite Conference
Thursday, August 12, 2004
12:00-1:30 p.m. (Central Time)

Produced by the Alabama Department of Public Health
Video Communications Division

Faculty

Erica L. Liebelt, MD, FACMT
Associate Professor of Pediatrics and
Emergency Medicine
University of Alabama
School of Medicine
Director, Medical Toxicology Services
University of Alabama Hospitals

Objectives

- Understand the concept of chemical agents of opportunity, Toxic Industrial Chemicals (TICs) and Toxic Industrial Materials (TIMs), and appreciate the basis for increased public health preparedness.
- Identify chemical agents of opportunity that could be used by terrorists and different modalities by which they can be distributed or released.

Objectives

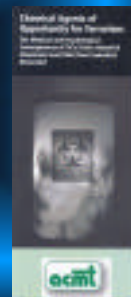
- Describe the major health effects of selected TICs, TIMs, and other important non-volatile chemical agents that could be used by terrorists.
- Understand the behavioral responses of people to mass chemical exposures.

American College of Medical Toxicology

- Professional association of physicians with recognized expertise and board certification in medical toxicology.
- Sub-specialty focused on the diagnosis, management and prevention of human poisoning and other adverse health effects due to medications, occupational and environmental toxicants and biological agents.

Course

- National: 5
- Regional: 5
- International: 1
- Planned
7 Regional courses



**"Terrorists can make the
'unlikely' happen."**

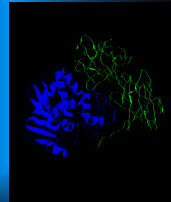
Ricin and al-Qa'ida?

Jan 20, 2003

CNS Reports

Ricin Found in London: An al-Qaida Connection?

By Jeffrey M. Ryan, Ph.D., and Michael S. Smith, Ph.D., School of
Public Health and Biomedical Sciences,
University of Washington, Seattle, Washington



October 22, 2003

Toxic ricin found at U.S. postal facility

WASHINGTON, October 22, 2003 (UPI) -- 11:11 PM EDT (10:17 GMT)

WASHINGTON (UPI) -- The FBI and postal authorities are investigating traces of the deadly toxin ricin found last week in a sealed envelope at a postal handling facility in Greenville, South Carolina, the Department of Homeland Security said Wednesday.

Based on the evidence obtained so far, we do not believe it is related to terrorism but is related to threats against the nation," DHS spokesman Brian Kohn said Wednesday.



The postal handling facility in Greenville, South Carolina where the ricin was reportedly found.

AP Wirephoto

Even Defensive Surprises

October 27, 2002



Doctors try to solve gas mystery

By Neil, October 26, 2002 (UPI) -- 1:34 PM EDT (10:34 GMT)

Rescuers 'probably used nerve gas'

October 29, 2002

By Nick Paton Walsh
Moscow

The gas used in the Moscow theatre siege by the Russian military was most likely a rare form of nerve agent developed by US forces in the 1970s, Western chemical warfare experts said yesterday.

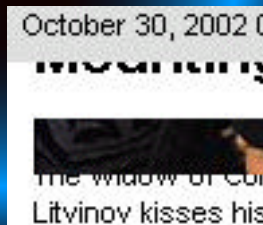
Russian and UK Experts Believe Moscow Gas Was BZ

The world wants to know why 117 hostages died as a result of the operation.

english.pravda.ru

Doctors Try To Solve Gas Mystery

Monday, October 28, 2002
Posted: 1:34 PM EST (1834 GMT)



Official "Battlefield" Chemical Warfare Agents

- Purpose Designed
 - Nerve (eg. Sarin, VX)
 - Blister (eg. Mustard)
 - 1^o focus of chemical defense programs in past
- Dual Use Industrial Chemicals
 - Blood (eg. CN)
 - Choking (eg. Phosgene)
 - Less emphasis on industrial chemicals as a military threat

TICs and TIMs

- Toxic Industrial Chemicals (TICs)
Any chemical substance that can render troops ineffective under normal MOPP (mission oriented protective posture) conditions. Primarily an inhalation hazard but troops can receive a dosage through ingestion or absorption of the skin.

TICs and TIMs

- Toxic Industrial Materials (TIMs)
Any substance that in a given quantity produces a toxic effect in exposed personnel through inhalation, ingestion, or absorption.

International Task Force-40 Industrial Chemical Prioritization

- Selected Acutely Toxic Airborne Hazards
- Acrolein
- Ammonia
- Arsine
- Chlorine
- Cyanogen Chloride

International Task Force-40 Industrial Chemical Prioritization

- Phosgene
- Nitrogen Dioxide
- Sulfur dioxide
- Selected Acutely Toxic Ingestants
- Organophosphates
- Cyanides
- Arsenic compounds

Other Chemical Concerns

- Metals
- Pharmaceuticals
- Illicit / Substances of Abuse
- Toxic Waste

Toxic Warfare

- Definition – the use of chemicals (or industrial waste) to harm or alter the behavior of an adversary
- Utilizes existing stored chemicals – exploiting weapons of opportunity

Toxic Warfare

- Who's at risk
 - Military abroad
 - Civilians in U.S.
 - Wide availability of toxic materials throughout U.S.
 - Proximity of industrial operations to large urban centers

Goals of Toxic Warfare

- Health Effects
 - Incapacitating adversary vs. killing adversary.
- Damage / contamination of military or civilian infrastructure.
 - Halt or delay military logistics
 - Disrupt functioning of urban infrastructure

Goals of Toxic Warfare

- Psychological effects resulting from actual or threatened use of toxic substances - terrorizing.
 - Asymmetrical warfare
 - Create uncertainty, fear and panic
 - Uncertainties provide tactical and/or psychological advantages

Why Use Industrial Chemicals As WMDs?



Limitations with Purpose-Designed WMD Aum Shinrikyo - Tokyo 1995 - Sarin

- Spent ~\$30 million on chemical weapons research
- Employed many scientists
- Killed only 19
- Problems with
 - Production
 - Effective delivery system

Much More Effective Bhopal - 1984

- Methyl isocyanate
- > 2500 deaths
- 60,000 injuries

TICs/TIMs vs. CW Agents

- TICs/TIMs
- Greater available volume offsets lower toxicity
- Accessible
- Much less secure
- Inexpensive
- May be legally available
- Difficult detection
- Effective without lethality

TICs/TIMs vs. CW Agents

- Acute and/or chronic effects
- Purpose Designed WMD
- Higher toxicity
- Lack of accessibility
- Tight security
- Known threat
- Designed to create casualties
- Primarily acute effects

Why Should We Worry

- ~ 850,000 U.S. businesses use, produce, or store TICs.
- EPA report – 123 chemical plants across the U.S. have enough toxic chemicals to kill/injure 1 million people in terrorist attack.

Why Should We Worry

- 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.

Deadly Possibilities

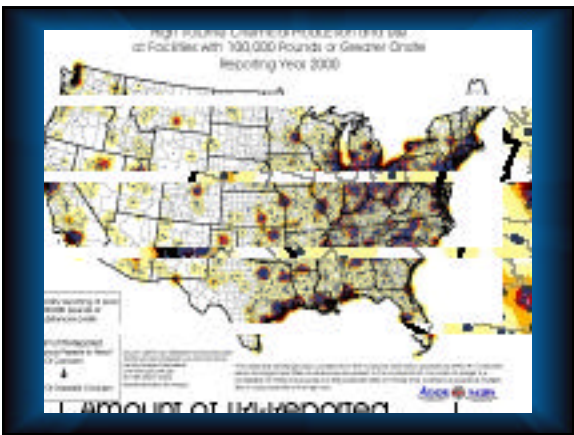
- California chemical plant routinely loads chlorine into 90-ton railroad cars - rupture could poison > 4 million people in surrounding counties.
- Philadelphia refinery stores 400,000 pounds of hydrogen fluoride - could asphyxiate nearly 4 million nearby residents.

- ## Deadly Possibilities
- California chemical plant routinely loads chlorine into 90-ton railroad cars - rupture could poison > 4 million people in surrounding counties.
 - Philadelphia refinery stores 400,000 pounds of hydrogen fluoride - could asphyxiate nearly 4 million nearby residents.

Deadly Possibilities

- West Virginia plant (Union Carbide) stores as much as 200,000 pounds of methyl isocyanate - could emit a toxic fog over 60,000 people.
- Tennessee chemical plants stores 500,000 pounds of sulfur dioxide - release - as many as 60,000 people living within reach of the ensuing vapor cloud are at risk of death or serious injury.

- ## Deadly Possibilities
- West Virginia plant (Union Carbide) stores as much as 200,000 pounds of methyl isocyanate - could emit a toxic fog over 60,000 people.
 - Tennessee chemical plants stores 500,000 pounds of sulfur dioxide - release - as many as 60,000 people living within reach of the ensuing vapor cloud are at risk of death or serious injury.



Sources of TICs and TIMs (1)

		
Airports	Glass Plants	College Labs
		
Farm and Garden Supply		Toxic Waste Dumps



Sources of TICs and TIMs (1)

		
Airports	Glass Plants	College Labs
		
Farm and Garden Supply		Toxic Waste Dumps



Sources of TICs and TIMs (1)

		
Airports	Glass Plants	College Labs
		
Farm and Garden Supply		Toxic Waste Dumps



Sources of TICs and TIMs (1)

		
Airports	Glass Plants	College Labs
		
Farm and Garden Supply		Toxic Waste Dumps



Sources of TICs and TIMs (1)

		
Airports	Glass Plants	College Labs
		
Farm and Garden Supply		Toxic Waste Dumps




Sources of TICs and TIMs (1)

		
Airports	Glass Plants	College Labs
		
Farm and Garden Supply		Toxic Waste Dumps

Sources of TICs and TIMs (2)




Photographic Supplies



Propane Tanks



Medical Facilities




Railroads



Transformers



Sources of TICs and TIMs (2)



Photographic Supplies



Propane Tanks



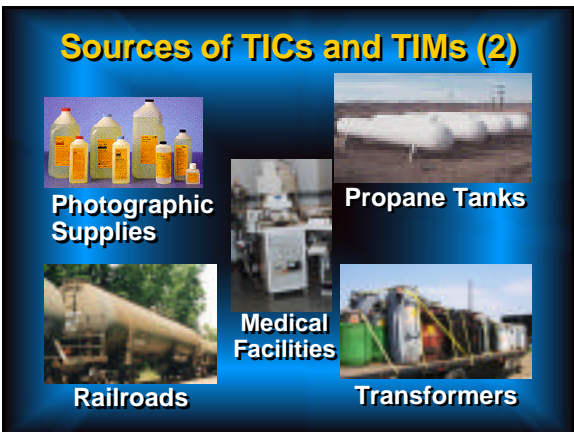
Medical Facilities



Railroads



Transformers




Sources of TICs and TIMs (2)




Photographic Supplies




Propane Tanks



Medical Facilities




Railroads



Transformers




Sources of TICs and TIMs (2)




Photographic Supplies



Propane Tanks



Medical Facilities



Railroads




Transformers



Sources of TICs and TIMs (2)



Photographic Supplies



Propane Tanks



Medical Facilities




Railroads




Transformers




Sources of TICs and TIMs (2)




Photographic Supplies




Propane Tanks



Medical Facilities



Railroads



Transformers

[illegible]

Another Source

Deadly But Legal: Poison On The Web

BALTIMORE CITY, Md., January 9, 2003



Suspect Ryan Farquhar, 10, 5.

The suspect information he found his mother's e-mail sent and the Internet to buy a small amount of poison was obtained from a chemical supplier in Kentucky.

Police investigators are looking for an almost 10-year-old boy who is a resident of the Baltimore area. The boy is a white male, 10 years old, 5 feet tall, 110 pounds, with brown hair and blue eyes. He is a resident of the Baltimore area. He is a resident of the Baltimore area. He is a resident of the Baltimore area.

Police officers are looking for a 10-year-old boy who is a resident of the Baltimore area. The boy is a white male, 10 years old, 5 feet tall, 110 pounds, with brown hair and blue eyes. He is a resident of the Baltimore area. He is a resident of the Baltimore area. He is a resident of the Baltimore area.

*Police are looking for a 10-year-old boy who is a resident of the Baltimore area. The boy is a white male, 10 years old, 5 feet tall, 110 pounds, with brown hair and blue eyes. He is a resident of the Baltimore area. He is a resident of the Baltimore area. He is a resident of the Baltimore area.

[illegible][illegible]

Another Source

Deadly But Legal: Poison On The Web

BURLINGTON CITY, N.H., January 9, 2003



Susan Marie Furlough (CBS)

Police investigators are looking for an almost 15-year-old girl who took her own life by drinking Cyanide potassium salt. Local CBS News Correspondent Jane Olson reports, popular high school athlete Stephanie Harpell was allegedly persuaded by a friend who viewed the victim as a rival for a girl's affection.

But critics say 15-year-old Susan Furlough obtained the cyanide because she had no idea how from a vast red sea of net sites.

"Age alone isn't young enough yet a little to obtain them over the Internet. So they are not illegal. They are used for things like rat poison and other things," says a 30-year Lowell, N.H. resident. Central Police spokeswoman.

[illegible][illegible][illegible]

of Terrorist Cases Involving Chemical Substances 1975- August 2000

- Domestic: 46 (22.2%)
- International: 161 (77.8%)
- Total: 207

Monterey Institute Database, 2000

Types of Terrorists Activities (Chemical n=207 and Biological n=135)

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

Methods Employed by Terrorists for Delivery of Chemical (N=126)

- Casual/direct contact 33 (30%)
- Aerosol/spray 21 (19%)
- Food/drink 13 (12%)
- Unknown 12 (11%)
- Product tampering 10 (9%)
- Explosive 6 (5%)
- Water supply 5 (4%)

Monterey Institute Database, 2000

Methods Employed by Terrorists for Delivery of Chemical (N=126)

- Jug/jar/canister 1 (1%)
- Mail/letter 4 (3%)
- Reaction device 3 (2%)
- Injection/projectile 1 (1%)

Monterey Institute Database, 2000

Chemical Agents Used 2000-2002

Agent	2000	2001	2002
Acid / Alkali	8	4	1
Arsenic	1	0	0
Cyanide	1	1	0
Rodenticides	1	0	0
Pesticide	0	0	1
Poison gas	0	1	0

Monterey Institute Database, 2002

Challenges of Chemical Agent Identification

- Symptoms of exposure to chemical agents may be similar to common disease (gastroenteritis).
- Immediate symptoms might be mild or nonexistent despite risk of long-term effects.

MMWR 10/3/03

Challenges of Chemical Agent Identification

- Reports of contaminated food/water might result in staggered reports over long periods / different locations.
- Mixed clinical presentation may result from exposure to 2 or more agents.
- Health care providers may be less familiar with certain chemical induced presentations.

MMWR 10/3/03

Epidemiological Clues Suggesting Covert Release of Chemical Agent

- Unusual increase in # of patients seeking care for potential chemical release related illness.
- Unexplained deaths among young or healthy people or plants and animals.
- Unexplained odors by patients.

MMWR 10/3/03

Epidemiological Clues Suggesting Covert Release of Chemical Agent

- Cluster of illness in patients with common characteristics such as similar drinking water.
- Rapid onset of symptoms after exposure to potentially contaminated medium.
- Presence of a particular clinical pattern or toxidrome.

MMWR 10/3/03

Selected Clinical Syndromes (Toxidromes) and Potential Chemical Etiologies

Category	Clinical Syndrome	Potential Chemical
Severe gastroenteritis	Abdominal pain, emesis, profuse diarrhea, shock	Botulinum toxin, Ricin, Colchicine
Cholinergic crisis	SLUDGE symptoms, Fasciculations, weakness	OP insecticides, nicotine
Cellular hypoxia	N/V, headache, AMS, shock, seizures, dec pH	CN, SMFA, CO, Azide
Peripheral neuropathy	Muscle weakness, sensory loss	Hg, As, Thallium, Lead,
Mouth pain / ulcerations	Lip / mouth / pharyngeal ulcerations; burning pain	Paraquat / diquat; caustics, Hg

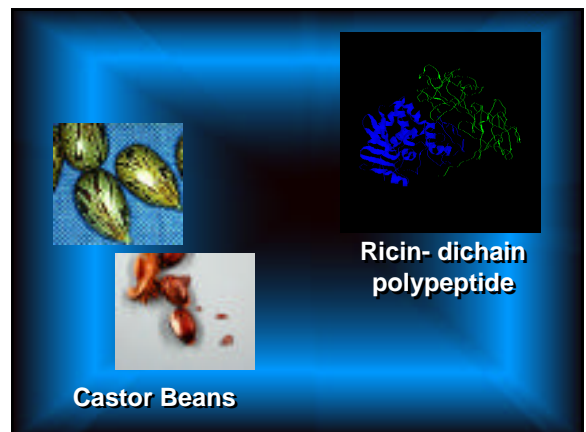
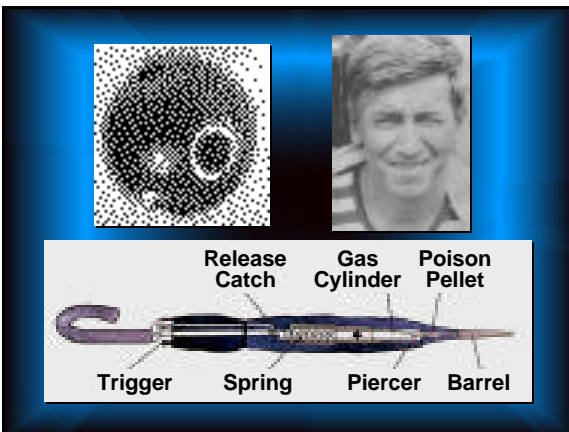
MMWR 10/3/03

A Case

- 49 year old man suddenly develops leg pain while walking
- 15-24 hours – fever, nausea, vomiting
- 36 hours – admitted to hospital with fever, tachycardia, and lymph node swelling

A Case

- 48 hours – hypotension / shock
- 72 hours – anuria, vomited blood, heart block
- 84 hours – death
- Presumed cause of death – Septic Shock



Ricin – Basic Facts

- Cellular toxin – blocks protein synthesis via modification of ribosomal 28s subunit
- Forms – mist, powder, pellet
- Clinical presentation varies with dose and route of exposure
 - Parenteral: local pain, systemic toxicity, multisystem failure
 - lethal dose - 500 µg (head of a pin)

Ricin – Basic Facts

- Inhalation: respiratory distress, necrotizing pneumonitis
- Human reports: allergic syndrome reported in exposed workers
- Oral: GI distress, internal bleeding, visceral necrosis

Toxic Gases in Your Community



Industrial Chemical Event

**Acid Cloud in East Bay
Sends 3,200 to Hospitals**



Chemical Accidents in U.S. Industry RMP for 1994-1999

#1	Anhydrous Ammonia	656
#2	Chlorine	518
#3	Hydrogen Fluoride	101
#4	Flammable Mixture	99
#5	Chlorine Dioxide	55
#6	Propane	54
#7	Sulfur Dioxide	48
#8	Ammonia (>20%)	43
#9	Hydrogen Chloride	32
#19	Phosgene	12

Clinical Manifestations Based on Characteristics of Agent

- High water solubility
- Rapid onset of symptoms
- Good warning properties
- Upper airway irritation and injury
- Poor water solubility

Ammonia > Chlorine > Phosgene

Clinical Manifestations Based on Characteristics of Agent

- Delayed onset of symptoms
- Poor warning properties
- Lower airway and lung injury

Ammonia > Chlorine > Phosgene

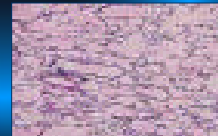
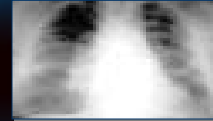
Chlorine Physical Properties

- Intermediate water solubility
- Low odor threshold
- Green-yellow, pungent gas
- Boiling point -31°F
- 2.5 x heavier than air
- Reacts explosively with many compounds

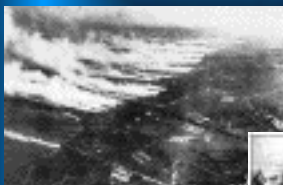
Chlorine Clinical Manifestations

- Intermediate water-solubility
- Low concentration: irritant to eyes, nose, throat, upper respiratory tract
- High concentration or prolonged exposure: severe lower airway and lung damage
 - Chemical pneumonitis
 - Pulmonary edema
 - Pulmonary function abnormalities
 - Chronic airway disease

Chlorine Inhalational Injury



Chlorine World War I



Battle of Loos,
September 1915

Chlorine Gas
Respirators



Chlorine



- Used in
 - Manufacturing of nonagricultural chemicals
 - Pulp and paper industry
 - Commercial and household bleaching agents
 - Water purification and waste treatment systems
- 1998 US production exceeded 14 million tons
 - Shipped as liquefied compressed gas

Chlorine Community Threat Assessment



Fixed Facility

In Transit



Chlorine Gas Alberton, Montana

- 72-car train derailment
- 4 tanker cars contained chlorine gas
- Carrying capacity of 90 tons
- 265,000 pounds toxic chemicals released
- 1 dead, 352 hospitalized

"Toxic trains may be rumbling
through your own town"

Water as an Opportunity for Chemical Terrorism



Chemical Water Terrorism History

- 1986: NYC; plutonium in drinking water
- 1989: Romania; water supply poisoned with an organophosphate
- 1996: China; students poisoned after well serving school was intentionally contaminated
- 1998: Kosovo; wells poisoned

Chemical Water Terrorism History

- 2000: NYC; bottled water contaminated
- 2002: Rome; threat to contaminate water supplies to U.S. Embassy with cyanide

Potential Hostile Actions to Drinking Water

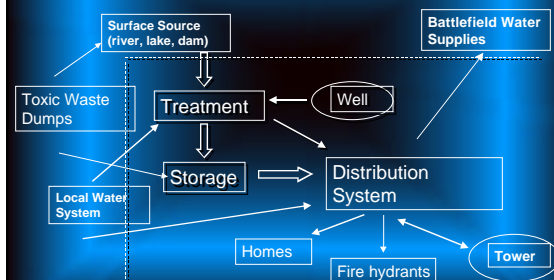
- Biological agents
- Chemical agents
 - Industrial, natural toxins
- Radiological agents
- Damage & destruction of physical infrastructure
- Disruption to computer systems



Chemical Water Terrorism

- Acts that deliberately interrupt:
 - SUPPLY of water
 - Physical destruction
 - Water pressure in a system
 - Computer/data systems
 - QUALITY of water
 - Direct injection of contaminants/poisons

Threats to Water System Infrastructure



Drinking Water – Ideal Contaminant

- Readily available
- Odorless
- Tasteless
- Colorless
- Water soluble
- Stable in water
- Unexpected

Drinking Water – Ideal Contaminant

- Low LD₅₀
- Resists water treatment
- Difficult to detect in water
- Difficult to decontaminate
 - Pipes, reservoirs, etc.
- Illness: delayed onset and difficult to diagnose

Relative Water Toxicity

Compound	R
Botulinum Toxin	10,000
VX	300
Sarin	100
Nicotine	20
Cyanide	9
Amiton	5
Na Fluoroacetate	1
Arsenite, arsenate	1

R =
Solubility/
Lethal Dose
(mg) x 1000

Clark R: J Contingencies Crisis Management 2000

Water System Vulnerabilities

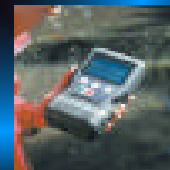
- Essential for Health
- Vulnerable characteristics in the water system
 - Spatially diverse, susceptible to intrusion
 - Numerous components to the system, innumerable attack sites

Water System Vulnerabilities (continued)

- Distribution system closest to consumers (less dilution and reside in system for shorter times)
- Bottled water, Sewage facilities
- Dilutional effects
 - Large quantity to have major effect
- Difficult to identify/track chemical

Rapid Field Testing Kits

- DeltaTOX
- Eclox Rapid Water Test
- IQ-Tox Test
- MicroTOX

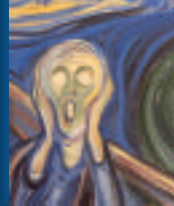


Water Terrorism: Major Consequences

- Widespread fear and panic
- Undermine public confidence in government's ability to protect citizens
- Social and economic disruption
- Loss of drinking water

Observed Behaviors During Mass Chemical Exposures

Are All of These Patients
Poisoned?



Chemical Agents of
Opportunity

Does “hysteria” explain a group’s
nonspecific symptoms with no
apparent exposure?

What Is It Called?

- Mass Hysteria
- Epidemic Hysteria
- Mass Psychogenic Illness
- Epidemic Psychogenic Illness
- Psychological Sequelae
- Psychic Possession
- Crowd Poison
- Psychosocial Casualties

What Is It Called?

- Epidemic Transient Situational Disturbance
- Mass Sociogenic Illness (by proxy)
- Environmental Somatization Syndrome
- Traumatic Stress Response

76 terms found in
literature to identify
“mass hysteria”
Bartholomew 1990

Features Suggestive of “Mass Psychogenic Illness”

- Sudden onset of symptoms after leaving alleged source of exposure
- Significant symptoms not c/w expected toxic effects
- Diversity of symptoms w/o physical signs or abnormal labs
- Symptoms develop after learning of the suspected exposure
- Recurrences in those congregated
- Benign morbidity with no sequelae

Boxer JOM 1985

Most Common Symptoms of “Mass Psychogenic Illness”

- Headache
- Dizziness/lightheadedness
- Nausea
- Dry mouth
- Eye/nose/throat irritation
- Drowsiness
- Numbness and tingling
- Chest tightness
- Weakness

Boxer JOM 1985

Beware of toxicity mimicking
“psychogenic illness”

Is It Psychologic Or Poisoning?

Nerve Agent Poisoning:

- Chest tightness
- Dyspnea
- Tachycardia
- Nausea/Vomiting
- Abdominal cramps
- Involuntary urination
- Fasciculations
- Headache
- Coma
- Diaphoresis

Is It Psychologic Or Poisoning?

Psychological:

- Chest tightness
- Dyspnea
- Tachycardia
- Nausea/Vomiting
- Abdominal cramps
- Involuntary urination
- Tremor
- Headache
- Syncope
- Diaphoresis

Is It Contagious?

- Crowd Poison
- “Groups without nerve agent exposure complained of symptoms experienced by those who had been exposed.”
Fullerton Mil Med 1990
- Symptoms spread
 - proximity of affected/unaffected persons
 - Reassembly of the group
 - “line of sight transmission”
Jones NEJM 2000

Proposed Solutions

- Expect the problem – Plan for it
- Don't ignore these patients
 - In planning
 - In taking them seriously
- Teach emergency responders some basic toxicology principles
 - e.g., Dose-Response

Proposed Solutions

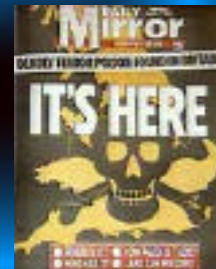
- Look for objective signs of toxicity
- Create a “holding environment”
 - Location away from high-tempo triage activities
 - Symptoms monitored and re-evaluation

Conclusions

- Toxic warfare- necessary to look beyond conventional chemical weapons.
- “Chemical Agents of Opportunity” are readily available and present likely threats of chemical terrorism in our communities and nation.
- Understanding behaviors during mass chemical exposures/disasters is important for appropriate evaluation and management of victims and health care workers.

Acknowledgements

- Paul Wax, MD, FACMT
- Lewis Nelson, MD, FACMT
- Mark Kirk, MD, FACMT
- Thomas Martin, MD, FACMT
- Curtis Snook, MD, FACMT
- Mary Wittler, MD



Upcoming Programs

The Behavioral Health Response
to Disasters

Tuesday, August 24, 2004
2:00-4:00 p.m. (Central Time)

Emerging Trends: STD Treatment and
Body Piercing

Tuesday, September 14, 2004
2:00-4:00 p.m. (Central Time)