SECTION 4

Detection and Diagnosis of Waterborne Terrorism

Environmental Detection and Monitoring of Potential Waterborne CBR Agents:
Deliberate contamination of the wells, reservoirs and other water sources of both military and civilian populations has been employed as a method of attack by opposing forces throughout the history of war (1). Many armies have resorted to this method of warfare including the Romans who contaminated the drinking water of their enemies with diseased cadavers and animal carcasses (1, 2). With enhanced technology and modern advances, the mechanisms of dispersal of warfare agents have expanded significantly. Whether advanced technology or ancient warfare methods are used by terrorists, covert contamination of water sources remains a potential threat to public health. In addition, covert terrorist attacks on our population with deliberate release of chemical, biological and radiologic (CBR) warfare agents may be difficult to identify quickly and reliably in the environment (2). The difficulty of detecting covert terrorist attacks extends to all four potential sources of environmental contamination including air, soil, food and water (3).

In the event of intentional contamination of water with a CBR agent that is colorless, odorless, tasteless and not detectable by other human senses, environmental detection of the agent may present a challenge (4, 5). Both food and water supplies may be contaminated with CBR agents that do not cause any obvious change in the appearance or physical characteristics of water to patients or water consumers (6, 7, 8). A major effort has been undertaken to improve and enhance the ability to detect and characterize deliberate contamination of water systems in the U.S. as part of a collaborative effort by both water utilities and several federal public health agencies (9, 10-13). For example, the National Homeland Security Research Center and the U.S. Environmental Protection Agency have developed the following Water Protection Program:
The Water Protection Program

Primary emphasis of the Water Security Research Program is on water supply, treatment, and distribution infrastructures in U.S. communities. Key research areas are detection and characterization of contaminants, response and mitigation, and prevention and protection.

**Detection and characterization** research is creating rapid screening technologies for the identification of unknown contaminants, while verifying the performance of sensors and biomonitors.

**Response and mitigation** research includes water decontamination techniques and emergency treatment capacity; validation of field portable monitors, point-of-entry and point-of-use devices; and responses to cyber (computerized) or service (electrical/gas) interruptions.

**Prevention and protection** research studies water treatment efficacy, safe transport in distribution systems, and treatment byproducts. This research area also evaluates pilot-plant distribution systems.

A secondary emphasis of the Water Security Research Program is on wastewater treatment and collection infrastructures which include collection (sanitary and storm sewers, or combined sanitary-sewer systems) and impacts on receiving waters such as rivers, estuaries, or lakes.


Early detection and rapid response to biological, chemical or radiologic terrorist assaults on U.S. water supplies will be critical elements to any effective terrorism response strategy. In the event of any act of water terrorism, **early detection will be critical in order to decrease the public health impact of the contamination event** as well as the secondary disruption to water distribution and the psychological impact of the public's lack of confidence in water safety and quality (14). Even short-term disruptions of water service can significantly impact a community in myriad ways since the provision of potable water represents an essential component of the nation's infrastructure. Intentional contamination of a municipal water system as part of a covert terrorist attack could lead to potentially serious medical, public health and economic consequences for a community. Early recognition, accurate diagnosis, and conscientious reporting by community healthcare providers of suspected waterborne disease cases will also be essential to maintaining water security and safety in the future.

**Use of Diagnostic Indicators and Epidemiologic Patterns to Detect CBR Agent Disease and Waterborne Exposure:**

If real-time environmental detection and identification capacity are not present for an intentional release of a CBR agent, **the first indication of a terrorist attack may be an increased number of patients presenting to their healthcare provider or emergency department with unusual or unexplained illness or injury** (5, 15, 16). Humans continue to remain frequently the most sensitive - if not only detector in many cases - of an intentional CBR agent release (4, 7, 15). Therefore, healthcare providers may be the first to discover that a deliberate dissemination of CBR agent has occurred in a community including intentional contamination of water reserves.
Practicing healthcare providers are likely to be the first to observe unusual illness patterns and must understand their critical role as "front-line responders" in detecting water-related disease resulting from biological, chemical or radiological terrorism. Although detection methods for recognizing intentional contamination of a water supply are improving (9), the most likely initial indication that a water contamination event has occurred in a community will be a change in disease trends and illness patterns. This probable scenario would potentially involve a community-wide waterborne disease outbreak or a cluster of water-related cases of chemical or radiologic toxicity in the general population. Therefore, practicing healthcare providers are likely to be the first to observe unusual illness patterns and resultant injury from water-related disease resulting from biological, chemical or radiological terrorism (3).

Clinical detection of a suspicious case of terrorism-related disease is critically important in order for epidemiologic investigations to be initiated and appropriate remediation and prevention efforts to be instituted (5, 15). Unfortunately, the early presenting symptoms of many biological, chemical, and radiologic warfare agents are nonspecific and mimic more common endemic diseases and medical disorders. However, certain clinical manifestations and disease syndromes may be characteristic of potential terrorist attack using biological, chemical or radiologic warfare agents. A heightened level of alertness and awareness by healthcare practitioners of these patterns of illness and clusters of disease may enhance the early discovery of a terrorist attack (17).

In order to respond appropriately to the current threat of terrorism and the possibility of intentional exposure of their patients to weaponized CBR agents, healthcare practitioners will need to 'think like an epidemiologist' when evaluating any suspect case or unusual pattern of disease in their clinical practice (17). This epidemiological approach will require the healthcare provider evaluating an individual patient with an unusual clinical presentation to consider this patient as a potential member of a larger as yet unrecognized cohort of exposed people. This "sentinel event" may require notification of and further study by public health officials.

A clinician's diagnostic acumen can be augmented by embracing this approach and recognizing that terrorism-related illness may fall into several distinct epidemiologic patterns (17, 18). Several epidemiologic patterns or indicators that may assist healthcare providers diagnose terrorism-related disease have been published and may prove valuable to healthcare providers facing the challenges of diagnosing terrorism-related illness and injury (5, 7, 17, 19-23). These epidemiologic indicators or sentinel clues may result from multiple exposure pathways including water and have universal application in a clinical setting. Several of these epidemiologic clues are posted below but are not limited to the following:

<table>
<thead>
<tr>
<th>Epidemiologic Indicators and Sentinel Clues Indicating Possible CBR Agent Exposure and Disease*</th>
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*These epidemiologic indicators or sentinel clues may result from multiple exposure pathways including water and have universal application in a clinical setting. Several of these epidemiologic clues are posted below but are not limited to the following:
• Point source illness and injury patterns with record numbers of severely ill or dying patients presenting within a short period of time

• Very high attack rates with 60-90 percent of potentially exposed patients displaying symptoms or disease from possible CBR agent exposure

• Severe and frequent disease manifestations in previously healthy patients

• Increased and early presentation of immunocompromised patients and vulnerable population patients with debilitating disease since the dose of inoculum or toxic exposure required to cause disease may be less than for the general healthy population

• "Impossible epidemiology" with naturally occurring diseases diagnosed in geographic regions where the disease has not been encountered previously

• Higher than normal numbers of patients presenting with gastrointestinal, respiratory, neurologic and fever diagnoses

• Record number of fatal cases with few recognizable signs and symptoms indicating lethal doses near a point of dissemination or dispersal source of CBR agents

• Localized areas of disease epidemics that may occur in a specific neighborhood or sector possibly indicating contamination of a selected point in a post-treatment water distribution system

• Multiple infections at a single location (school, hospital, nursing home) with an unusual or rare pathogen

• Lack of response or clinical improvement of presenting patients to traditional treatment modalities

• Near simultaneous outbreaks of similar or different epidemics at the same or different locations indicating an organized pattern of intentional CBR agent release

• Endemic disease presenting in a community during an unusual time of the year or found in a community where the normal vector of transmission is absent

• Unusual temporal or geographic clustering of cases with patients attending a common public event, gathering, or recreational venue

• Increased patient presentation with acute neurologic illness or cranial nerve impairment with progressive generalized weakness

• Unusual or uncommon route of exposure of a disease such as illness resulting from an waterborne agent not normally found in the water environment

*Note -- Several epidemiologic patterns are presented above that have been identified as possible clues of a terrorist attack from several public health and military sources (5, 7, 17, 19-23). None of these indicators alone are pathognomonic for terrorism-related disease but are expected or un
pathognomonic for terrorism-related disease but are presented as an educational tool for healthcare providers to be aware of possible disease trends that may warrant further investigation.

Several on-line resources provide valuable reviews of **diagnostic indicators of biological, chemical, and radiologic warfare activity** that may also prove useful as a tool for enhanced recognition and prompt diagnosis of CBR agent exposure by healthcare providers:

<table>
<thead>
<tr>
<th>Biological, Chemical, and Radiologic Warfare Diagnostic Indicators*</th>
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<tbody>
<tr>
<td><strong>RECOGNITION AND DIAGNOSIS OF A BIOLOGICAL WARFARE EXPOSURE</strong></td>
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<tr>
<td><a href="http://www.fas.org/nuke/guide/usa/doctrine/dod/fm8-9/2ch2.htm">http://www.fas.org/nuke/guide/usa/doctrine/dod/fm8-9/2ch2.htm</a></td>
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<tr>
<td><strong>RECOGNITION AND DIAGNOSIS OF A CHEMICAL WARFARE EXPOSURE</strong></td>
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<td><strong>RECOGNITION AND DIAGNOSIS OF NUCLEAR WARFARE AGENT EXPOSURE</strong></td>
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**Completion of an Effective Exposure History to Accurately Diagnose Intentional Waterborne Disease:**

In order to effectively utilize the diagnostic indicators and epidemiologic clues presented above, clinicians must "know what to look for" and "know the right questions to ask" during a case evaluation for potential CBR agent exposure in their patients. The vast majority of physicians are unfamiliar with the appropriate questions to ask their patients in order to obtain an **accurate exposure history** that will clarify the potential role of waterborne exposure in a suspicious case of terrorism-related disease. For a review of the potential mechanisms of exposure and points of contamination for acts of water terrorism, refer to **Section 2- Understanding the Threat of Water Terrorism** and **Section 3- CBR Agent Dispersal and Multiple Exposure Pathways** in this Physician On-Line Readiness Guide.

A complete discussion of the potential points of contamination of the U.S. water supply to acts of overt or covert terrorism is presented in **Section 2- Understanding the Threat of Water Terrorism** which provides a valuable "starting point" for completing an accurate exposure history. The following list of potential sources of water contamination is presented again as an educational tool for healthcare providers to keep in mind when evaluating an unusual symptoms complex or an unusual illness pattern in their practice that may be due to waterborne terrorism (4, 5, 7, 14, 24-26).
Possible Points of Contamination of U.S. Water From Acts of Terrorism*

- **Upstream of a community water supply system or collection point** - water supply systems are comprised of small streams and bodies of water, rivers, service reservoirs, aquifers, wells, and dams that may act as points of deliberate contamination of water.

- **Community water supply intake access point or at the water treatment plant** - many water supply systems are designed to receive water from source water reserves at a central intake point with this source water being subsequently filtered and sanitized at the community water treatment facility for eventual distribution as potable water. Both water intake points and community water treatment plants may be targeted for terrorist activity and deliberate water contamination.

- **Selected points in the post-treatment water distribution system** - treated water is distributed to the water consumer or end-user through transmission pipelines to homes and businesses. Selected portions of a water distribution system or water main are another potential point of water contamination that may affect a subdivision, specific neighborhood, school or hospital if targeted by terrorists.

- **Private home or office building connections, building water supplies or water tanks, cisterns, individual storage tanks** - treated water that is stored very close to the end-user as well as individual house connections may serve as points of contamination of water by terrorists.

- **Water used in food processing, bottled water production, or commercial water** - water used for food processing or preparation as well as bottled water production also represent points of potential water contamination by terrorists.

- **Deliberate contamination of recreational waters and receiving waters** - both treated and untreated recreational waters may serve as a point of potential contamination of water including swimming pools, water parks, and natural bodies of water (small lakes and ponds). Receiving waters such as rivers, estuaries, and lakes may be secondarily contaminated with wastewater from sanitary and storm sewer systems that may have been environmentally contaminated by a biological, chemical or radiologic warfare agents.

*Note: A number of the potential points of contamination of water outlined above are more probable terrorist targets than others (24, 27). However, all healthcare providers should keep these sources of potential water contamination and unusual modes of delivery of CBR warfare agents in mind when evaluating a suspected case of terrorism-related disease.

Completing an accurate and thorough environmental exposure history is perhaps one of the most important components of a practicing clinician's evaluation of a suspected CBR agent exposure that includes the waterborne route of exposure. Several on-line resources are available to assist healthcare practitioners complete an accurate exposure history with
specific reference to possible waterborne contaminant exposure:

<table>
<thead>
<tr>
<th>On-line Exposure History Resources for Waterborne Exposure</th>
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<tr>
<td><strong>Taking an Effective Exposure History for Potential Waterborne Pathogen Exposure</strong></td>
</tr>
<tr>
<td><strong>Taking an Effective Exposure History for Chemical Contaminant Exposure</strong></td>
</tr>
<tr>
<td><strong>Health Professionals Drinking Water Outbreak Response Tools</strong></td>
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<tr>
<td><a href="http://www.cdc.gov/ncidod/dpd/healthywater/professional.htm">http://www.cdc.gov/ncidod/dpd/healthywater/professional.htm</a></td>
</tr>
<tr>
<td><strong>Waterborne Diseases Outbreak Report Form</strong></td>
</tr>
<tr>
<td><strong>Recreational Waters Exposure Report Information</strong></td>
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<tr>
<td>Due to the size of this PDF file, the pages may take some time to come into view.</td>
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<tr>
<td>The screen will remain blank while downloading. Please be patient.</td>
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<tr>
<td>Environmental Health Outbreak Investigation Report: Swimming Pool Venue</td>
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</tbody>
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**Use of Syndromic Surveillance and Disease Trends to Assist in the Diagnosis of Waterborne Terrorism:**

As was apparent from the deliberate release of weaponized *Bacillus anthracis* through the U.S. postal system in 2001, **discovery of a biological, chemical or radiologic terrorist event may occur in a physician's office, emergency room or out-patient clinic**. Healthcare providers will continue to play a vital role in the discovery phase of recognizing an intentional release of CBR warfare agents as well as managing subsequent disease. Current diagnostic laboratory testing, public health surveillance systems, and notifiable disease reporting have improved significantly but may not be able to detect or prevent an evolving terrorist event or outbreak (17). Therefore, the initial indication and recognition of an intentional release of CBR warfare agent may result from recognition of characteristic signs and symptoms of presenting patients through a process known as **syndromic surveillance** (17, 20, 28, 29).

Syndromic surveillance monitors disease trends through **grouping cases into syndromes rather than by specific diagnoses**. State and local health departments are developing and implementing syndromic surveillance systems with the intent of detecting terrorist activity earlier than would be apparent from traditional diagnosis-based surveillance systems (30). Syndromic surveillance systems may augment emergency room and hospital diagnosis-based surveillance by adding the ability to quickly identify clusters of acute illness resulting from potential terrorism exposure (31). **Certain syndromes may be characteristic of terrorist activity and enhanced awareness and thoughtful monitoring of these syndromes by healthcare providers may promote early recognition of CBR terrorist events that may include water as one exposure pathway** (17, 20, 23, 28). Clinicians should maintain a high level of suspicion for the following types of syndromes or clusters of disease in their patient population (17, 28, 29):
Types of Syndromic Clustering of Disease Potentially Indicating CBR Agent Exposure*

- Gastroenteritis of an apparent infectious etiology, acute toxic chemical exposure or possible acute radiation exposure
- Upper and lower respiratory disease with fever and sudden death of previously healthy patients
- Rash of synchronous vesicular or pustular lesions and fever; presence of erythema, epilation and radiation burns.
- Suspected meningitis, encephalitis, and encephalopathy
- Sepsis or non-traumatic shock
- Unexplained death with a history of fever
- Advancing cranial nerve impairment with progressive generalized weakness

*Note: The types of syndromic clustering of disease presented above have been identified as possible indicators of a terrorist attack (8, 17, 28, 29). None of these indicators alone are pathognomonic for terrorism-related disease but are presented as an educational tool for healthcare providers to be aware of possible disease trends that may warrant further investigation.

Through conscientious and close attention to disease patterns and illness trends, healthcare practitioners can play a significant role in initiating rapid action and prevention measures that can decrease the impact of biological, chemical and radiologic terrorism. Surveillance systems are powerful tools for monitoring possible terrorism-related disease and protecting public health with active clinician involvement and participation. A valuable on-line resource that details the use of syndromic surveillance and the application to monitoring disease clusters as a complement to emergency department and hospital-based surveillance is presented below:

Use of Automated Ambulatory-Care Encounter Records for Detection of Acute Illness Clusters, Including Potential Bioterrorism Events
http://www.cdc.gov/ncidod/EID/vol8no8/02-0239.htm

Useful information addressing U.S. surveillance systems and the important role of healthcare provider participation are available at the link below:

Public Health Emergency Preparedness and Response Surveillance

References:


