COURSE #91752 — 1 CONTACT HOUR/CREDIT RELEASE DATE: 06/01/21 EXPIRATION DATE: 05/31/24

Chemical and Radiologic Injuries in Terrorist Attacks

HOW TO RECEIVE CREDIT

- Read the enclosed course.
- Complete the questions at the end of the course.
- Return your completed Evaluation to NetCE by mail or fax, or complete online at www.NetCE.com. (If you are a physician or Florida nurse, please return the included Answer Sheet/Evaluation.) Your postmark or facsimile date will be used as your completion date.
- Receive your Certificate(s) of Completion by mail, fax, or email.

Faculty

Carol Shenold, RN, ICP, graduated from St. Paul's Nursing School, Dallas, Texas, achieving her diploma in nursing. Over the past thirty years she has worked in hospital nursing in various states in the areas of obstetrics, orthopedics, intensive care, surgery and general medicine.

Mrs. Shenold served as the Continuum of Care Manager for Vencor Oklahoma City, coordinating quality review, utilization review, Case Management, Infection Control, and Quality Management. During that time, the hospital achieved Accreditation with Commendation with the Joint Commission, with a score of 100.

Mrs. Shenold was previously the Infection Control Nurse for Deaconess Hospital, a 300-bed acute care facility in Oklahoma City. She is an active member of the Association for Professionals in Infection Control and Epidemiology (APIC). She worked for the Oklahoma Foundation for Medical Quality for six years.

Faculty Disclosure

Contributing faculty, Carol Shenold, RN, ICP, has disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

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The division planners and director have disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

Audience

This course is designed for physicians, physician assistants, and nurses who may be called upon to identify and treat victims of chemical or radiologic terrorist attacks.

Accreditations & Approvals

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A complete Works Cited list begins on page 10.

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NetCE designates this continuing education activity for 1 ANCC contact hour.

This activity was planned by and for the healthcare team, and learners will receive 1 Interprofessional Continuing Education (IPCE) credit for learning and change.

NetCE designates this continuing education activity for 1.2 hours for Alabama nurses.

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Special Approvals

This activity is designed to comply with the requirements of California Assembly Bill 1195, Cultural and Linguistic Competency.

About the Sponsor

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Disclosure Statement

It is the policy of NetCE not to accept commercial support. Furthermore, commercial interests are prohibited from distributing or providing access to this activity to learners.

Course Objective

The purpose of this course is to provide healthcare professionals with the information necessary to appropriately diagnose and treat victims of chemical or radiologic weapons.

Learning Objectives

Upon completion of this course, you should be able to:

1. Recognize the physiologic effects and clinical signs of nerve agent exposure, and devise an acute management strategy for decontamination, supportive care, and pharmacologic treatment based on knowledge of agents most commonly used in chemical warfare.
2. Anticipate the likelihood of radiation exposure based on the type of terrorist attack, and use laboratory findings to assess the degree of exposure and appropriate level of clinical intervention.

INTRODUCTION

The United States government expects healthcare professionals to be on the front line of defense and treatment in the event of a terrorist attack in our country. This includes most medical personnel, but especially physicians, nurses, physician assistants, mental health professionals, and dentists. Increasing awareness and knowledge of possible terrorism agents and attacks will increase healthcare professionals' ability to respond properly.

Hospitals and clinics will have the first opportunity to recognize and initiate a response to terrorism-related events resulting in injuries. Therefore, overall disaster plans should address the issue. Individual facilities should determine the extent of their terrorism readiness. This course will attempt to briefly summarize the characteristics, treatment, and containment of potential chemical and ionizing radiation agents.

CHEMICAL AGENTS

Chemical warfare agents have the potential of being effective weapons for a terrorist attack. They are generally available or easy to manufacture, can be transported and delivered by many means, and their effects can be immediate or delayed. They are also well known, as they were first widely used in warfare during World War I [1].

The categories of chemical agents include nerve agents, such as sarin and tabun, and irritants and vesicants, including mustard gas, lewisite, and industrial chemicals. Also included are cyanide and less harmful agents, such as mace and pepper spray. This section will focus on the diagnosis and treatment of patients exposed to nerve agents.

NERVE AGENTS

Background

Nerve agents are the most toxic weapons in the military chemical warfare arsenal. The most common are sarin (GB), tabun (GA), soman (GD), and VX liquid. The G-type agents are colorless, clear, tasteless liquids [2]. GB evaporates at roughly the same rate as water and has no odor. GA has a fruity odor, and GD smells slightly of camphor; both are less volatile than GB [2]. VX is the least volatile agent and is transparent, amber-colored, odorless, and slightly oily. Any of these compounds can cause seizures, apnea, loss of consciousness, and death [1]. They are all in the class of organophosphates and have physiologic effects similar to those seen when household insecticides are sprayed on an insect [1].

The mechanism of action for all nerve agents is the binding and inhibiting of the enzyme cholinesterase, causing a major increase in the amount of acetylcholine at synaptic clefts and receptor sites. This produces an overstimulation of the muscarinic, central nervous system, and nicotinic postsynaptic receptors, resulting in physiologic responses ranging from increased salivation to paralysis [3]. There may also be an antagonism of the neurotransmitter gamma-aminobutyric acid (GABA), adding to the central nervous system effects. This entire spectrum of signs and symptoms was found in the victims of the sarin attacks by the Aum Shinrikyo cult in Japan in 1994 and 1995 [1].

Diagnosis

Victims of a nerve agent attack may present with [1]:

- Miosis (pinpoint pupils)
- Hyperactivity of the genitourinary and gastrointestinal tracts, with involuntary urination, defecation, vomiting, and diarrhea
- Bronchoconstriction
- Increased glandular secretions, such as thick bronchial mucus
- Rhinorrhea
- Lacrimation
- Salivation
- Increased sweating

The nicotinic effects present as muscle fasciculations and cramping, twitching, weakness, and finally paralysis. The combination of miosis, fasciculations, and respiratory distress is a signal that organophosphate poisoning is present [1].

Other signs and symptoms may include cardiac dysfunction, which can be a tachyarrhythmia, ventricular fibrillation, or bradyarrhythmia and hypotension. The central nervous system effects from small doses of nerve agents include nervousness, irritability, minor memory disturbances, and psychologic manifestations that may persist for weeks. Larger doses result in seizures, loss of consciousness, apnea, paralysis, and death [1].

The type of exposure, whether from a liquid or aerosol, can result in a different pattern of signs and symptoms. For example, VX, which is usually a liquid, can cause fasciculations at the contact site from a small droplet of the agent [1]. Larger doses, however, produce the more generalized somatic effects witnessed with the inhaled nerve gases. After contact with a liquid agent, the onset of symptoms may be delayed from 10 minutes to 18 hours, depending on the dose [1].

Although the primary diagnosis of a nerve agent attack is made on clinical grounds, the Centers for Disease Control and Prevention (CDC) has established a laboratory network to analyze blood and urine samples to detect the presence of chemical warfare agents [1]. It should be noted that the CDC's designation of laboratories was revised in 2005, a change that affected the Laboratory Response Network for chemical terrorism. The current designation is opposite to that used previously, with Level 1 labs now being the most secure and having the most specific analytical equipment (apart from CDC labs). Level 3 labs are the most numerous and are able to perform basic tests [4].

Treatment

The initial care of a victim of either a vapor or liquid nerve agent attack includes rapid decontamination. At a minimum, this includes removal of all clothing, jewelry, and any other possibly contaminated items. Soap and water should be used to wash the skin and hair of patients with suspected exposure to a liquid nerve agent; showers should be used if available [1; 2]. If water is unavailable or limited, absorbent powders can be used (e.g., talcum powder, flour, Fuller's earth). Alternatively, a 0.5% sodium hypochlorite solution can be used [2]. Liquid agents should be immediately removed from the eyes by flushing with water for 5 to 10 minutes. Eye flushing is not necessary when exposed to vapor only; however, skin decontamination with soap and water or hypochlorite solution should be implemented. Special care should also be given to self-protection.

Supportive treatment should include the establishment of a patent airway with the probable need for assisted ventilation. Most patients will die if no antidote is administered and aggressive airway maintenance is not initiated [1].

Atropine, pralidoxime chloride, and diazepam (or other benzodiazepines) are the favored drugs for treatment of nerve agent victims [1]. Atropine blocks the effects of acetylcholine at the muscarinic sites. The drug pralidoxime chloride breaks the bond between the nerve agent and acetyl cholinesterase, allowing the enzyme to become available to break down acetylcholine; however, to be effective it must be administered within minutes to a few hours of exposure, depending on the agent [1; 2]. Diazepam has been suggested as the best medication to use for seizures associated with nerve agent attacks. It has also been suggested that diazepam be used in all victims whether they are convulsing or not. These drugs are available in kits, many of which include "autoinject" syringes. The military has used a kit called the Mark 1, which includes atropine and pralidoxime chloride in autoinjectors; up to three Mark 1 kits may be administered as needed [1; 10]. The injections must be given in a large muscle, preferably the outer thigh muscle or, alternately, the upper buttock in thinly built individuals [10].

The military also has a unit that administers both atropine and pralidoxime chloride through a single needle, referred to as the antidote treatment nerve agent autoinjector (ATNAA) [8]. A similar preparation, the DuoDote Auto-Injector, was FDA-approved for civilian use in cases of organophosphate poisoning due to nerve agents and insecticides [9]. Diazepam autoinjectors and Convulsant Antidote for Nerve Agent (CANA) are also available and are recommended for use if a patient requires three concurrent Mark 1, ATNAA, or DuoDote kits [10].

Containment

Because the nerve agents are not biologic organisms, there is no vaccine or infection control processes. However, there are important steps that should be taken to prevent injury to medical personnel who will be taking care of the victims of an attack and to limit cross-contamination. Obviously, the first consideration is to avoid contact with the noxious materials by using proper technique when handling the patient [1]. This includes wearing rubber gloves and other protective clothing if dealing with a possible liquid agent. The removal of all possibly contaminated items prior to attempting to provide care will help in protecting the medical personnel at the scene, in the transport vehicle, and at the hospital.

RADIOACTIVE MATERIALS

The threat of the use of radioactive materials as possible weapons of terror makes a discussion of ionizing radiation beneficial for all healthcare professionals.

TYPES OF POSSIBLE TERRORIST ATTACKS

There are thought to be five primary ways in which nuclear materials might be used by terrorists. They include [1; 5; 6]:

- **Simple radiologic device (SRD):** Radioactive material is spread around a public place without the use of explosives. This could be with sealed sources or loose material. The effects would be more psychologic than physiologic unless extremely high radiation doses could be produced.

- **Radiologic dispersal device (RDD)**: Explosives are utilized to spread contamination over a greater area. The bomb portion could injure, or possibly kill, those in the immediate vicinity, while the radioactive material affects those in the surrounding area. The high explosives rip the weapon apart and spread radioactive plutonium, an alpha emitter, around the accident site. This type of incident would occur if a nuclear weapon was intentionally destroyed. It is almost impossible for the weapon to "go nuclear" when dropped from a plane by mistake.
- **Nuclear reactor sabotage (NRS)**: This is an unlikely scenario in the United States and most parts of the world. Many fail-safe protections would need to be bypassed and high security areas breached by terrorists. The nuclear accident in Chernobyl, for example, required several safety systems to be bypassed and occurred in a building that did not have appropriate containment. All reactors in the United States, as in essentially all the world at this time, are in containment shells that are designed to prevent the escape of any significant amount of radioactivity from the facility. After 2001, researchers determined that a plane attack would be unlikely to penetrate the most common types of reactors in the country. Following the March 2011 tsunami in Japan (and associated radionuclide leakage from several breached containment shells), additional safety and security studies were undertaken in hopes of preventing a similar disaster.
- **Improvised nuclear device (IND)**: An IND is an operational nuclear device created with the intent of harm, built either from scratch or assembled from stolen or smuggled components. While obtaining fissile material is challenging, the level of sophistication required to produce such a device is relatively low. The IND would likely be a gun-type device, similar in construction to the Little Boy (Hiroshima bomb) design. The fuel (plutonium or weapons-grade uranium) would probably be purchased, gifted, or stolen. Confirmed cases of stolen fissile material are numerous in the former Soviet Union, and it is conceivable that some material has been successfully smuggled out.
- **Nuclear weapon**: This scenario incites the most fear, especially if terrorists could obtain one or more of the ready-made devices. It is felt that the existing supplies of larger weapons, in the countries which possess them, are secure from theft. However, there have been many smaller, tactical nuclear weapons produced in the past that are not accounted for. This type of weapon could produce mass casualties, including killing those closest to the explosion, burning others, and causing radiation sickness in those within the immediate proximity who were not fatally injured by the blast.

DIAGNOSIS

In most cases, diagnosing injuries from ionizing radiation requires the history of radiation exposure. There can be instances when a victim is unaware of the cause and presents with a suggestive constellation of signs and symptoms of the prodromal stage of mild acute radiation syndrome (e.g., nausea, vomiting, anorexia) or a more severe syndrome (e.g., diarrhea, cramps, nervousness, confusion) [7]. In addition, there may be some signs that point to radiation injury, such as skin erythema or lesions without history of thermal burns. Unexplained epilation or a sudden drop in leukocytes or platelets could suggest radiation exposure as the etiology [1]. An examination of the blood, urine, or feces can be performed to determine the presence of any radionuclides that may have entered the body.

TREATMENT

The immediate treatment for victims of radiologic events includes prompt decontamination. This must be performed prior to the patient entering a care facility to prevent the facility from becoming contaminated. The procedure is similar to decontamination techniques used for chemical weapons, including the removal of clothing, copious washing of the body and wounds, and placing all contaminated items into a closed container.

During the first 8 to 12 hours postexposure, blood samples should be taken for complete blood count (CBC), with attention to lymphocyte count, every two to three hours [7]. In the following two days, repeat CBC every four to six hours. The Andrews Lymphocyte Nomogram is used to ascertain level of injury, with absolute lymphocytes in the 1,000–1,500 range indicating moderate injury, 500–1,000 indicating severe injury, 100–500 indicating very severe injury, and less than 100 indicating lethal injury.

Radiation injuries, traumatic injuries, and burns can occur simultaneously in a nuclear terrorist attack that includes the use of explosives. Because high doses of ionizing radiation can impair healing, a victim who receives high levels of whole body radiation will usually have a greater degree of total injury, delayed recovery, and probability of death. A patient who has received more than 200 rems should have all major traumatic injuries treated within 48 hours. (Of note, a rem is equal to a rad for gamma rays.) This includes reducing fractures, suturing wounds, treating burns, and performing any required stabilizing surgery. If these interventions cannot be performed within the first two days, any major surgical procedures should be delayed an additional two to three months [1]. Use of burn units is recommended when indicated [7].

Patients who received less than 100 rems will usually not need treatment. Supportive treatment for those with doses suspected to be more than 100 rems includes fluid and electrolyte replacement, with antiemetics as needed. For those with doses in the range of 200–800 rems, there will probably be a significant drop in leukocyte count requiring protection against infection with antibiotics, antifungals, hyperalimentation, and possible stem cell or platelet transfusions [1; 7]. Patients with doses greater than 1,200 rems are unlikely to survive. The LD50 (the acute penetrating dose to kill half of those exposed) is approximately 400–500 rems [1]. A chromosome aberration cytogenetic bioassay should be used to confirm estimated dose, when available [7].

Radioactive materials are considered "incorporated" when they enter the body and become lodged in the cells [1]. There are procedures available to diminish the radiation dose of those who have internal contamination or incorporated radionuclides. The mechanisms of action of the materials used to "decorporate" include binding, displacing, or in some way enhancing the elimination of the radioactive material from the body. Increasing fluid intake, or in some cases forcing fluids, may be sufficient treatment for a selected group of patients.

PERSONAL PROTECTION

The same procedures of decontamination used for patients apply to healthcare professionals. To review, remove all potentially contaminated clothing and equipment and shower thoroughly with soap and water.

There are no vaccines to prevent the harmful effects of large doses of ionizing radiation. Therefore, reducing exposure to the source of the radiation is the best preventive measure. This can be accomplished by reducing the amount of time in the vicinity of the source, increasing the distance from the source, and using shielding [1].

The radiation dose from a localized radiation source decreases by the square of the distance from it. For example, doubling the distance from the source will result in a dose rate one-fourth of the original dose. Going three times the distance will result in a dose rate of one-ninth the original dose rate.

Reducing the amount of time spent in the radiation field will reduce the dose received. Appropriate shielding will also reduce the absorbed radiation dose. Heavy metals, such as lead, have typically been used to shield from x-rays, gamma rays, and other penetrating radiation. However, neutrons are best shielded by materials with high hydrogen content, such as waxes, concrete, or even water.

CONSIDERATIONS FOR NON-ENGLISH-PROFICIENT VICTIMS

In the increasingly multicultural landscape of the United States, interpreters are a valuable resource to help bridge the communication and cultural gap between patients or caregivers and practitioners. Interpreters are more than passive agents who translate and transmit information from party to party. When they are enlisted and treated as part of the interdisciplinary clinical team, they serve as cultural brokers, who ultimately enhance the clinical encounter. When interacting with patients for whom English is a second language, the consideration of the use of an interpreter and/or patient education materials in their native language may improve understanding and outcomes.

RESOURCES

Access to consultation and clinical guidance on the management of chemical terrorism and radiation exposure is available from the following resources.

Centers for Disease Control and Prevention
The CDC addresses preparedness and medical care with respect to chemical terrorism and radiation contamination.
https://emergency.cdc.gov/hazards-specific.asp

Regional Poison Control Centers
The U.S. Regional Poison Control Network provides emergency consultation and can direct providers to local toxicologists and radiation safety officers.
(800) 222-1222
https://www.poison.org

Chemical Hazards Emergency Medical Management (CHEMM)
A detailed online clinical guide for first responders and hospital providers, maintained by the U.S. Department of Health and Human Services.
https://chemm.hhs.gov

CONCLUSION

Chemical and radiologic weapons have been used in war for decades, but their use in terrorist attacks and civilian situations is an increasing threat. As scientific knowledge has progressed, so has the sophistication of weaponry utilizing chemical or radiologic agents. As discussed, chemical and nuclear agents can be delivered by many means to both combatants and innocent civilians. Bombs, aerosols, and direct application of toxic materials are only some of the methods that have been used to cause injury. The ease with which these many harmful agents can be obtained, produced, and delivered is alarming. All medical personnel should be prepared with the knowledge and ability to perform their role as front-line respondents in the event that chemical or radiologic weapons are used.

Implicit Bias in Health Care

The role of implicit biases on healthcare outcomes has become a concern, as there is some evidence that implicit biases contribute to health disparities, professionals' attitudes toward and interactions with patients, quality of care, diagnoses, and treatment decisions. This may produce differences in help-seeking, diagnoses, and ultimately treatments and interventions. Implicit biases may also unwittingly produce professional behaviors, attitudes, and interactions that reduce patients' trust and comfort with their provider, leading to earlier termination of visits and/or reduced adherence and follow-up. Disadvantaged groups are marginalized in the healthcare system and vulnerable on multiple levels; health professionals' implicit biases can further exacerbate these existing disadvantages.

Interventions or strategies designed to reduce implicit bias may be categorized as change-based or control-based. Change-based interventions focus on reducing or changing cognitive associations underlying implicit biases. These interventions might include challenging stereotypes. Conversely, control-based interventions involve reducing the effects of the implicit bias on the individual's behaviors. These strategies include increasing awareness of biased thoughts and responses. The two types of interventions are not mutually exclusive and may be used synergistically.

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