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Joseph C Stull Date

All-Scenario Medical and Public Health Response for Chemical, Biological, Radiological, Nuclear, and Explosive Incidents

By

Joseph C Stull
Master of Public Health

Global Health

Dr. Deborah McFarland PhD, MSc, MPH
Committee Chair

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Joseph C Stull

Bachelor of Science
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An abstract of
A thesis submitted to the Faculty of the
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Abstract

By: Joseph C Stull

Chemical, biological, radiological, nuclear, and explosive (CBRNE) incidents can occur as a result of deliberate use or through accidental means. Response guidelines and handbooks focus primarily on acts of CBRNE violence. However, as CBRNE incidents can occur through accidents this SSP places emphasis on an all-scenario approach to these incidents. Through an all-scenario approach, CBRNE first responders can aid in a wider range of incidents. For example, the contrast between cyanotic pesticides that were released into the atmosphere in an industrial accident in Bhopal, India, and the deliberate use of sarin gas in a subway in Tokyo, Japan, for political goals demonstrates the need to have an all-scenario approach to response.

In addition to focusing primarily on acts of violence, most of the emphasis in current guidance has been placed on medical treatment of CBRNE victims following an incident. These incidents can cause devastating and long-term impacts on victims and community members and little emphasis has been made to integrate public health practice into initial CBRNE incident response to mitigate these long-term effects. This project begins the integration process of public health practice into initial incident response.

In order to fulfill this integration goal, a medical and public health response manual was created. This is accomplished by providing medical countermeasures relating to clinical features, diagnosis, and treatment options along with public health practice including infection control, decontamination, post-incident mental well-being, surveillance, working with law enforcement, and after-action reviews. Through the integration of these measures, response to CBRNE incidents will become more comprehensive.

Integrating these changes to the response systems should continue to provide competent on-site medical care, while improving the overall well-being of the community as it works to rebuild. These changes are designed around improving long-term outcomes during the recovery phase after the incident.

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Chapter 1: Introduction

Scope of the Project

This project began in Panama while I was working for the Contingency Department of the Ministry of Health from May to August of 2017. The department was charged with developing response frameworks around accidents affecting or attacks on the Panama Canal as well as creating first response systems for accidents, outbreaks, or attacks that potentially could occur during World Youth Day (WYD, 2017). My assignment was to compile information on what is currently available as response frameworks in such settings.

There has been extensive research conducted on chemical, biological, radiological, nuclear, and explosive (CBRNE) agents in the past beginning during World War I and the first widespread use of chemical weapons. There are many manuals that center on chemical and biological agents but leave out radiological agents (Alibek, 2005). Others focus solely on one type of agent providing great detail on biological agents or chemical agents but contain no information on the others (Balali-Mood et.al., 2016; Banks, 2014; Zygmunt, 2011). No resource was found that provided information on all CBRNE agents in one place. With concurrence from the MOH, I decided to create a manual to provide an all-scenario reference guide or field manual for people who are first on the scene following a CBRNE incident whether in an accident, natural outbreak, or a deliberate attack. Following completion of the manual for the Panamanian MOH, I decided to expand the audience of the manual to the global community to aid all in CBRNE response. From there came the development of this special studies project as a way to integrate medical and public health practice.

The manual contains guidelines not only on initial medical treatment, but it also provides recommendations on public health measures to help mitigate the effects of the agent at a population level. Therefore, the manual assumes some previous training in CBRNE response. It can be used by military personnel as well as civilian responders. This manual then serves as a reference guide to be used on site during a response.

Chemical Agents

Chemical agents are compounds without a biological background. Human chemical exposure occurs in solid, liquid, or gaseous states with liquid form (vapors and aerosols) as the most common. Chemical agents have varying effects on humans that can include irritation, incapacitation, injuries, and death. The most common means of ingress into the human body is through dermal contact or through inhalation. Depending on the volatility, persistence, and dose of the chemical exposure, the onset of symptoms can occur within seconds to hours later. The severity of the symptoms also depends on the volatility, persistence, and dose of the chemical exposure. Chemicals have varying symptoms depending on the mechanisms of toxicity in the body. They are categorized based upon these symptoms into nerve agents, cyanide-based agents, pulmonary intoxicants, vesicants (blistering agents), irritants (riot control agents), and incapacitating agents. (Alibek, 2005; Balali-Mood et. al., 2016; Banks, 2014)

Biological Agents

A biological agent is "a microorganism (or a toxin derived from it) which causes disease in man, plants or animals or which causes the deterioration of material" (Alibek, 2005). These agents are infectious and can spread quickly among a population.

Biological agents are categorized according to lethality, transmissibility, and organism. The common organisms for biological agents are bacteria and viruses. Other biological agents include the toxins from a bacterial or virus. Signs and symptoms of a biological agent depend upon the type of organism infecting the people. (Alibek, 2005; Zygmunt, 2011)

Radiological Agents

A radiological agent is any radioactive material coming into contact with humans, animals, or plants which causes illness or injury. These materials are elements that lack the binding energy to keep the nucleus of the atoms intact. Radiation can cause external and internal sickness with varying degrees of severity and lethality. Sources of this material can include a nuclear power plant accident, radioactive medical waste, a radiation exposure device (RED) or a radiological dispersal device (RDD) i.e. a dirty bomb. (Goans, 2013; Holt et. al., 2012; IOP, 2012; Pae, 2017; REMM, 2018)

Nuclear Agents

A nuclear agent specifically entails thermonuclear detonations. These can be fission bombs or fusion bombs. A fission bomb uses a heavy element core such as Uranium or Plutonium and splits the atoms into several parts. A fusion bomb is Hydrogen based and compresses hydrogen atoms together to create Helium atoms. These bombs can include formal nuclear weapons, or an Improvised Nuclear Device (IND) A thermonuclear blast generates a large explosion, light, heat, and a radioactive fallout. The radioactive fallout is the material that rains back to earth from the plume of the

explosion. This fallout will contaminate a larger area than the initial blast and can contaminate food, water, soil, people, animals, and plants. (Goans, 2013; REMM, 2018)

Explosive Agents

Explosive agents involve the detonation of "any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion" (OSHA). With the detonation of an explosive agent, there will be an accompanying release of heat, light, and/or fire. There can also be an expulsion of gas along with the blast itself. Explosive agents can include but are not limited to "dynamite, nitroglycerin, picric acid, lead azide, fulminate of mercury, black powder, blasting caps, and detonating primers" (OSHA). Effects from explosions can include burns, injuries (especially to the eyes), and death as well as causing panic and disruption in the normal flow of society. (OSHA; Ritenour & Baskin, 2008)

Chapter 2: Literature Review

This literature review will include an analysis of each of the five handbooks that serve as key reference sources, followed a review of other resources culled from a formal literature review and review of non-peer reviewed sources. The five handbooks include the United States Army Medical Research Institute of Infectious Disease (USAMRIID) handbook *Medical Management of Biological Casualties Handbook* or "Blue Book," the Organization for the Prohibition of Chemical Weapons handbook *Practical Guide for Medical Management of Chemical Warfare Casualties*, the Office of the Surgeon General handbook *Medical Management of Chemical Casualties Handbook*, The United States Army Medical Department and School textbook *Emergency War Surgery*, and finally *Jane's Chem-Bio Handbook*. Following the analysis of these five handbooks, the other supplementary resources that teach about the history, radiological events, and specific agent needs will be addressed.

USAMRIID Blue Book

The starting point for much of the biological component to this project comes from the United States Army Medical Research Institute of Infectious Disease (USAMRIID) resource *Medical Management of Biological Casualties Handbook* or "Blue Book." The Blue Book was one of the three original resources given to me by Dr. Rolando Luque, the subject matter expert. It serves as the gold standard for the US Army in providing treatment for biological casualties.

The handbook begins by outlining the history and current threat of biological warfare and casualties, from the Hittites in the 12^{th} – 15^{th} centuries BC who used animals to cause epidemics among their enemies. The history also cites the use of plague and

smallpox as biological weapons in Europe and Native American populations respectively. The Blue Book also cites the disarmament of biological weapons agreements between the USA and the USSR during the Cold War, while showing evidence of the continued development of bioweapons through the 90's to the Anthrax attack in 2001 in the United States. Finally, the Blue Book finishes the background information with a warning about the current threat: "the threat of the use of biological weapons against U.S. military forces and civilians may be more acute than at any time in U.S. history, due to the widespread availability of the agents, along with knowledge of production methodologies and potential dissemination devices."

Following the background history and assessment of the current threat, the Blue Book provides guidelines on distinguishing between a natural outbreak and the deliberate use of a bioagent. This list of guidelines is supplemented by an outline of syndromic surveillance. The Blue Book demonstrates that there is a paramount need to detect deliberate infections quickly and efficiently. To fulfill this need there has been an expansion of surveillance systems which gives rise to the need for better response systems. To elucidate this point, the Blue Book provides ten steps to manage biological casualties.

Maintain an index of suspicion

Protect yourself

Assess the patient

Decontaminate as appropriate

Establish a diagnosis

Render prompt treatment

Practice good infection control

Alert the proper authorities

Assist in the epidemiologic investigation and manage the psychological consequences

Maintain proficiency and spread the word

The Blue Book provides these ten steps to understand "the unknown, especially under the austere conditions and chaos expected on the modern battlefield."

The Blue Book then outlines different biological agents by active organism. The Blue Book begins with an examination of bacterial agents followed by viral agents and concludes with biological toxins. Each agent is described in detail through an overview of the agent, the history and significance, the clinical features, proper diagnosis, the medical management, and prophylaxis options. The bacterial agents discussed in the Blue Book are anthrax, brucellosis, glanders and melioidosis, plague, q-fever, and tularemia. The viral agents discussed are smallpox, Venezuelan equine encephalitis, and viral hemorrhagic fevers. The biological toxins discussed are botulinum toxin, ricin, staphylococcal enterotoxin b, and T-2 mycotoxins (Zygmunt, 2011).

The agents discussed in the Blue Book are examined in detail and are written for medical professionals. This means that the explanations and instructions can be difficult to understand and implement for those who are not trained medical professionals. Additionally, with the focus on a limited number of agents, there is no discussion of organisms like cholera, influenza, chikungunya, dengue, and yellow fever. Furthermore, the Blue Book only discusses the agents from the standpoint of a deliberate attack rather than from an all-scenario approach. Additionally, there is very little in the way of public

health response efforts discussed in the Blue Book which leads to the need to integrate medical and public health response efforts. Finally, the Blue Book only discusses the biological component of CBRNE agents.

Chemical Warfare Handbook & Chemical Casualties Handbook

Another important starting point for this project was the resource *Practical Guide for Medical Management of Chemical Warfare Casualties* written by the Organization for the Prohibition of Chemical Weapons and the *Medical Management of Chemical Casualties Handbook* written by the U.S. Office of the Surgeon General. These handbooks were presented to me by Dr. Luque to review and analyze. These two resources discuss chemical agents in a similar manner and will therefore be discussed together.

The *Practical Guide* discusses how chemical warfare has been used "since ancient times, ranging from poisoned arrows and spears, to poisoning wells and food supplies, to the dispersion of toxic vapours and smokes." The *Practical Guide* also discusses that because of the great potential to cause death the use of these chemical weapons has been banned in most cultures in the laws of warfare stating, "the earliest surviving pertinent references include the Manu laws of India (dating from prior to 500 BC), which prohibited the use of poisoned weapons, as well as ancient Chinese, Greek, and Roman law, and law derived from the Koran." Despite these ancient restrictions, chemical warfare made a surge during World War I where choking agents were used by both sides of the conflict. By World War II, the potency of many of the chemical agents had reached a critical level. Many agents like Lewisite caused symptoms on contact with skin and were much more powerful than many of the agents seen before that time. While

many countries had stockpiles of chemical weapons, they were not used in the European theater of the war. However, in the Pacific theater of the war, chemical weapons were used extensively by Japan.

Following the war, most testing of chemical weapons was banned, but this did not prevent the USA and the USSR from continuing to produce and test different chemical weapons until the early 1980s. Much of the impetus to reduce the stockpiles of chemical weapons came from the use of nerve agents against Iran by Iraq in 1984. The widespread use of chemical weapons by Iraq during the Iran-Iraq war was a major player in the development of the Chemical Weapons Convention. Following the ratification of the Convention, nearly 90% of chemical weapons stockpiles worldwide had been destroyed by the year 2015 under the direction of the Organization for the Prohibition of Chemical Weapons (OPCW).

The *Chemical Casualties Handbook* begins with a discussion of the background of chemical agents and relevant terminology. It provides the definition of toxic chemicals as "any chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans or animals." This handbook also discusses how chemical weapons are weapons of mass destruction in that they can cause catastrophic damage to people and infrastructure.

The *Chemical Casualties Handbook* provides information on the physical forms of the different agents. For example, nerve gas and mustard gas are not actually gases at all, but rather are aerosolized solids that are sprayed into the air. This section in the handbook also makes the distinction between volatility and persistence stating that the two concepts are inversely related. The more volatile a chemical, the less it persists in

the environment and the more persistent a chemical, the less volatile it is. The timeline of persistent chemicals is 24 hours. If a chemical persists in an area for more than 24 hours, it is considered to be persistent. The tactical use of a chemical depends on the desired outcome.

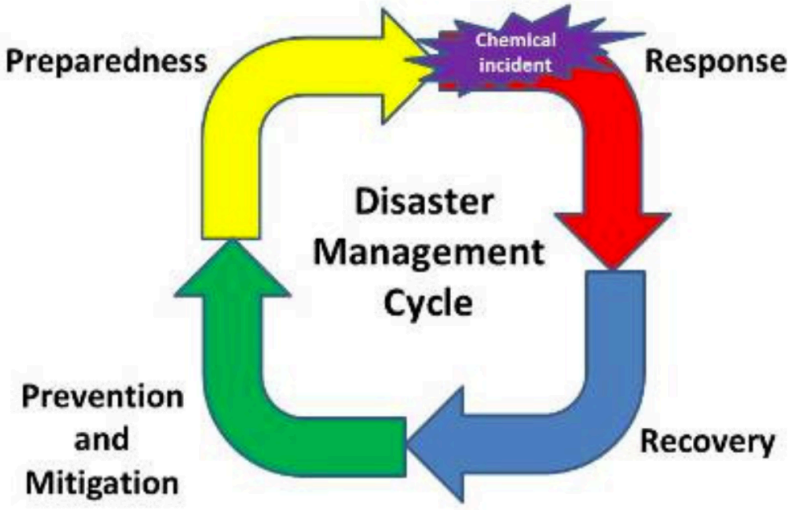
The handbook discusses the tactics of when to use a more volatile and less persistent compound versus using a less volatile but more persistent compound depending on the reason for using a chemical agent. For example, a persistent compound such as mustard gas, will persist for a long time and is deployed to drive an enemy from an area or to contaminate supplies. A non-persistent compound, such as cyanide, is used in direct assaults on victims as it brings death within a short period of time but does not persist after a few hours. These examples are also subject to factors such as "temperature, environmental factors such as wind, and surface characteristics."

After discussing the physical forms of the agents, the handbook presents information on exposure and absorption of each respective chemical by the body. Exposure is an external contamination (skin, eyes, respiratory tract, and GI tracts) where absorption is the passage of that chemical from the outer epithelial tissue into deeper tissue. With the definitions of exposure and absorption, comes the foundation of medical management of chemical casualties. The processes of recognition and triage are discussed in this resource and in the *Practical Guide*, but both make reference to the *Emergency War Surgery* standard of triage to be seen later in this literature review.

The *Practical Guide* also provides information on a few other background considerations to the management of chemical casualties. It outlines the disaster management cycle beginning with prevention and mitigation which are the steps taken to

minimize the consequences of the disaster. Next comes preparedness which details the response implementation plans with simplicity and directness. The response phase puts the preparedness plan into effect. Following the response phase is the recovery phase which entails working to return to the pre-event situation and then back to mitigation and prevention strategies.

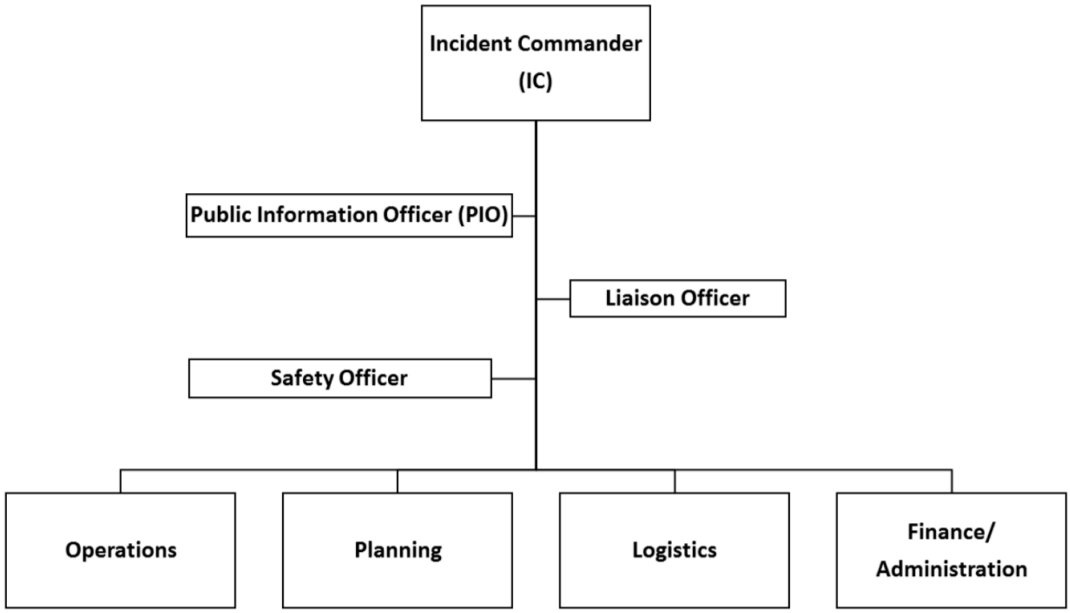
Figure 1: Disaster Management Cycle



Before discussing the various agents, the *Practical Guide* outlines the different levels of Personal Protective Equipment (PPE) needed for different scenarios, Incident Command Structure, on-site decontamination setup (hot, warm, and cold zones), minimum evacuation distances, and patient decontamination. The highest level of PPE contains the fully encapsulated suits that are resistant to chemicals with self-contained breathing apparatuses. This highest level of PPE is to be used in unknown or high-risk agent scenarios. The lowest level of PPE is simply the common work uniform of the responder. This lowest level of PPE can be worn when there is no known hazard. The complete PPE levels are outlined fully later in this work. For any chemical incident, the

Practical Guide recommends the standard Incident Command Structure as seen in Figure 2 below.

Figure 2: Incident Command Structure



At the conclusion of the background information sections of each book, there is discussion of the individual types of chemical agents. Both resources discuss nerve agents, vesicants, pulmonary intoxicants (lung damaging or choking agents), cyanide compounds, and riot control agents. The *Chemical Casualties Handbook* provides additional information on incapacitating agents as well as the other five.

The *Practical Guide* gives an introduction to each agent, the physical properties of the agent, detection, protection, decontamination, mechanism of action, toxicity, signs and symptoms, treatment options, triage, course and prognosis, and the long-term effects of each agent. The *Chemical Casualties Handbook* provides an overview of each agent, it's history and military relevance, the nomenclature associated with the agent, sources other than the military, physical characteristics of the agent, detection, protection, the

mechanism of toxicity, lethal dose calculations, mechanism of action, clinical effects, time course of effects, differential diagnosis options, laboratory findings, medical management, triage, and returning to duty guidelines for each agent. (Balali-Mood et. al., 2016; Banks, 2014)

These two resources are thorough examinations of chemical agents. They provide in depth medical response information as well as valuable public health response knowledge. This however can be difficult to read and is impractical for use as a reference guide in the field during a response. There is an impressive outline of public health response frameworks from the perspective of a disaster as a whole, but there is very little discussion on public health response for a specific agent. Finally, like the USAMRIID Blue Book, the *Practical Guide* and *Chemical Casualties Handbook* only provide instruction on one type of agent among the CBRNE cadre.

Radiological Casualties Handbook

The US Army medical textbook *Emergency War Surgery* (reviewed next) contained a reference for The Armed Forces Radiobiology Research Institute handbook *Medical Management of Radiological Casualties*. This handbook became a key resource on the response to nuclear and radiological agents.

The *Radiological Casualties* handbook begins with a discussion on emergency response efforts surrounding a nuclear or radioactive material by encouraging planners to think about the scale of a disaster. The introduction also teaches proper triage protocol for radiological casualties. The categories are the same as the US Army standards, but in this case, the triage combines physical injury with the level of exposure to radiation. Exposures above 6Gy (Grays are the International System of Units for the dose of

radiation absorbed) are generally triaged as expectant regardless of the level of physical damage (for information on triage levels, see *EWS*).

From the considerations on planning and triage, the *Radiological Casualties* handbook discusses major medical issues following exposure to radiation. One of the major tactics for determining the triage level is the time it takes a patient to vomit. It also provides guidelines on specific laboratory tests needed for complete understanding of the total medical issue. The *Radiological Casualties* handbook then describes different threat scenarios by defining Radiation Exposure Devices (RED), Radiological Dispersal Devices (RDD), and Improvised Nuclear Devices (IND). In addition to these devices, sources of radiation can occur from a nuclear plant, improper disposal of radioactive waste, or a nuclear weapon. Following a nuclear scenario, it is imperative that responders use Level A Personal Protective Equipment to assure they do not become contaminated themselves. A further important topic covered in this section is the information on the types of radiation: alpha, beta, gamma rays, and neutrons. The *Système international* (SI) unit of absorbed radiation is the Gray (Gy)

After the background information, the *Radiological Casualties* handbook describes acute radiation syndrome (ARS) or internal contamination. ARS affects the hematopoietic system, the gastrointestinal system, and the neurovascular system. After discussing the effects radiation has on each system, the handbook describes the medical treatment for ARS. In conjunction with ARS are skin injuries from external contamination. The extent of the damage to the skin is determined through the amount of radiation exposure the patient received. The handbook then provides several options for skin care to prevent and treat necrosis following external radiation exposure.

After discussing ARS and skin contamination, the *Radiological Casualties* handbook discusses various response approaches for different radionucleotides. The handbook discusses important radionucleotides of concern in accidents or attacks: Tritium (^{3}H), Carbon-14, Phosphorous-32, Cobalt-60, Iodine-125, Iodine-131, Californium-252, Iridium-192, Cesium-137, Uranium-235, Plutonium-239, and Americium-241 as well as fission products. After describing these radionucleotides, the handbook then describes specific treatment options that assuage the effects of a specific radionucleotide

Following the discussion on the radionucleotides, the *Radiological Casualties* handbook then describes further injuries victims might sustain in conjunction with a nuclear event. These injuries include blast injuries, irradiated wounds, burns/thermal injuries, eye injuries, and combined injuries. Alongside physical injuries comes a review of psychological support to offer to victims and communities. The psychological support includes immediate and long-term treatment protocols. Another complication with radiation injuries is the possibility of carcinogenic effects and other long-term physical effects. Some of the more severe effects include birth defects.

After discussing the lasting injuries and effects of the nuclear event, the *Radiological Casualties* handbook then describes decontamination techniques. Unless a person has been exposed to severe levels of radiation, much of the decontamination process can be done by the patient. "Removal of outer clothing and shoes and rapid washing of exposed skin and hair removes ~ 90% of contamination." Washing with plain soap and clean water is sufficient for most decontamination procedures in radiation incidents. First responders must assure that the majority of decontamination has occurred

prior to patient arrival at the hospital. There are also guidelines on wound and burn protocols. (Goans, 2013)

The *Medical Management of Radiological Casualties* is an extremely technical text and is difficult to read by anyone who is not extensively trained in radiation. It is therefore impractical for use in the field by first responders. It does however, contain valuable public health information following a nuclear disaster. While there is mention of accidental exposures, this text was written from a military perspective and the perspective of an attack using a radioactive source. Lastly like the other Medical Management texts, this one only provides information on one type of CBRNE agent.

Emergency War Surgery – Triage, Radiological Injuries, Biological Agents, Chemical Injuries

Another important document is the textbook *Emergency War Surgery* (*EWS*) from the United States Army Medical Department Center and School. Among many subjects, this textbook outlines the army guidelines for triage cited by the *Practical Guide for Medical Management of Chemical Warfare Casualties* and *Medical Management of Chemical Casualties Handbook*. In addition to the guidelines on triage, *EWS* provides chapters on radiological injuries, biological warfare agents, and chemical injuries. These chapters however come with strong advisories to supplement the information in them with the *Medical Management of Radiological Casualties*, *Medical Management of Biological Casualties*, and *Medical Management of Chemical Casualties* resources.

The EWS chapter on mass casualties and triage establishes the guidelines for dealing with many casualties that arise in a short amount of time. In the theater of war, the casualties can quickly overwhelm the available medical resources. Therefore,

"effective mass casualty response is founded on the principle of triage, the system of sorting and prioritizing casualties based on the tactical situation, mission, and available resources." This triage system is designed around a utilitarian principle of doing the most good for the most amount of people. To fulfill this need, the triage categories of immediate, delayed, minimal, and expectant were established.

These categories serve to help responders sort through casualties for the optimal allocation of resources. The immediate category includes those patients who have a good chance of survival provided that they receive treatment within a few minutes to 2 hours. This can include injuries like airway collapse, uncontrolled hemorrhaging, severe head injuries, or needing to amputate one or more extremity.

The delayed category includes those casualties who need medical intervention, but they can be stabilized to wait until that intervention can occur. The stabilization can include fluid administration, stabilizing broken bones, catheterization, administering antibiotics, and pain management. This category includes blunt or penetrating trauma without shock, fractures, and some burns.

The minimal category is for relatively minor injuries, lacerations, abrasions, burns, or breaks. These patients can reasonably care for themselves or survive with minimal care. They can assist in performing minor functions within the medical center on an as needed basis. These casualties should not be allowed to overwhelm the medical center as they are often the first to arrive. They should be encouraged to wait until the more severe injuries have been stabilized and treated.

The expectant category includes those injuries that overwhelm the current capacity of the medical center to respond to the event. These patients should be placed in

an area away from other patients and reassessed intermittently. The patients in this category arrive with no vital signs, transcranial wounds, uncontrollable bleeding from a pelvis injury, high spinal cord injuries, and/or severe burns. The majority of these patients are unlikely to survive the sustained injuries.

This chapter makes it clear that triage is a fluid process that allows for the allocation of available resources when and where they are most needed and can do the most good. The chapter also considers additional topics of triage such as resource constraints and how the constraints affect the process of triage as well as providing resources on which wounds are most common and where they occur on the body. Lastly the chapter provides a diagram of how to establish a triage and stabilization area.

The other three chapters used in this project contain information on radiological injuries, biological warfare agents, and chemical injuries. Each of these chapters provides a superficial examination of the different agents, injuries and casualties. This information is presented and reviewed in other resources, so a formal review of this material will not be presented here.

(Cubano, 2014, pp. 29-46, 427-450)

The information presented in *Emergency War Surgery* forms the basis of all the triage models used in all CBRNE resources. The specific CBRNE information itself was superficial and was more thoroughly presented in other works.

Jane's Chem-Bio Handbook

Jane's Chem-Bio Handbook was a resource provided by Dr. Mark Keim who teaches a course at the Rollins School of Public Health at Emory University on the public health consequences of disaster. *Jane's* is a handbook that provides thorough

information on chemical and biological agents as well as important public health information in other sections of the handbook.

Jane's begins by talking about pre-incident planning. This section provides information on assessing the threat by gaining as much knowledge about the agents as possible. The acquisition of knowledge then lends itself to understanding the vulnerability of different locations to help prepare potential targets for the possibility of an attack. *Jane's* lists the Department of Homeland Security's criteria for vulnerability to aid in this analysis. Once the vulnerability has been assessed, *Jane's* moves into medical response considerations stating that "the capability of the medical and public health response, essential to minimize the impact of incidents where casualties are involved, should not be overlooked in the incident response planning." In addition to the medical considerations, *Jane's* encourages the development of a response plan that includes specific goals, scenarios of suspected incidents, tactics, PPE, and decontamination. With the development of a plan, it is imperative to test and exercise the plan to identify gaps and shortcomings which will allow for improvement. With the planning and preparation completed, *Jane's* moves to on-scene procedures.

Following an incident, the first procedure that must occur is gathering information from a situation report and then approach the scene from a safe direction. When approaching victims, first responders should identify needs and provide reassurance. After gathering information about the incident and approaching the victims, *Jane's* then gives general information on chemical incidents as a whole. For example, *Jane's* recommends level A PPE for all workers, provides information on an exclusion zones, ICS, and chemical indicators. The chemical indicators include victim symptoms to check

to aid in determining which type of agent was used. Following information on chemical incidents is information on biological incidents. Again, the first step is to collect as much information about the agent used as possible. After collecting pertinent information, then personnel can approach the site and contaminant. Upon arrival on-site, make sure the site management is established. Proper site management includes continuing to gather more information on the type of delivery, wind direction, terrain, population centers, and waterways. With this information management can establish site boundaries with hot, warm, and cold zones. The information about zones is presented later in this document. *Jane's* also provides information on triage that is similar to the *EWS* standard of triage. The on-site procedures section finishes by discussing decontamination techniques for victims and workers wearing PPE.

The next chapter in *Jane's Chem-Bio Handbook* discusses chemical agents. it begins with a discussion of general agent properties and chemical delivery. Similar to the *Chemical Casualties Handbook*, *Jane's* discusses the physical forms of the agents and how the can be dispersed as solids, liquids or gases. *Jane's* also discusses agent persistence and volatility which determines how quickly the effects of the agent are seen in a human population. This discussion of general properties is followed by a look at delivery systems that include weaponization of the agents. In addition to the weaponization of a chemical weapon, the meteorological conditions can affect the success of an attack. After presenting the background information, *Jane's* then presents information on nerve agents, cyanide, blister agents, pulmonary agents, and riot control agents. Each chemical is examined through the effects of the agent, early recognition, physical examination, and specific chemical properties. The properties discuss

mechanisms of action, physical appearance of the chemical, and the major effects of the chemical.

Chapter 4 in *Jane's Chem-Bio Handbook* discusses treatment options for each agent as well as casualty decontamination. For each agent, guidelines for triage, antidote administration, and further care are discussed.

The following chapter in *Jane's* begins the discussion of biological agents. For each biological agent there are four factors that determine effectiveness: the agent itself, the delivery system, the delivery, and the meteorological conditions. Agents can be classified as incapacitating or lethal depending on if the agent makes people ill or has a high case fatality rate. Delivery systems can include almost any aerosol device. Effectiveness of the agent is also contingent upon the meteorological conditions at the time of release. The agents thrive in ideal conditions: not too hot, not too cold, and warm humid air. If an agent is not sprayed, it can be delivered through food and water contamination, dermal contact, or vector transmission. Finally, *Jane's* discusses the clinical effects of bacteria, rickettsia, toxins, and viruses. The agents included are anthrax, brucellosis, cholera, glanders, melioidosis, plague, tularemia, typhoid, typhus, q fever, botulinum toxin, ricin, saxitoxin, staphylococcus enterotoxin b, trichothecene mycotoxins, chikungunya, Congo Crimean hemorrhagic fever, dengue, Ebola, Marburg, Junín, rift valley fever, smallpox, Venezuelan equine encephalitis, and yellow fever. Chapter 6 discusses the treatment options for each of these agents. Treatments are agent specific.

Chapter 7 of *Jane's Chem-Bio Handbook* discusses the post-incident care needed following an event. It discusses the psychological impact on individuals and on

communities. For most communities there are five phases of psychological impact: initial impact, heroic period, honeymoon period, disillusionment, and reconstruction. The psychological impacts on individuals include physical symptoms, behavioral changes, emotional changes, and cognitive changes. Chapter 7 also includes information on interaction with law enforcement officials and the importance of maintaining the crime scene. The last section discusses the importance of the after-action review as well as the implementation of a public relations plan (Alibek, 2005).

Jane's Chem-Bio Handbook has a thorough presentation of information on medical treatment for chemical and biological agents. It is also the most integrated approach to medical treatment with public health strategies of the resources reviewed for this project. There is no discussion on incapacitating agents in the section on chemical agents. Additionally, *Jane's* does not contain information on radioactive disasters or explosions. It also operates under the assumption of an attack rather than an all-scenario approach.

CDC & WHO

The supporting documents found through the CDC and WHO websites usually followed a simple format. The CDC fact sheets or webpages contained relevant information on specific organisms, toxins, agents, or illnesses. These fact sheets and webpages were designed around medical professionals and laboratory technicians. They provided background information on the topic as well as information on diagnosis and testing. There were also CDC recommendations for treatment options and alternatives. These resources provided supplementary information that aided in the creation of the manual.

The WHO webpages were designed in a similar format to the CDC webpages. They provided relevant background information, diagnostic procedures, treatment and control options. The WHO webpages usually presented the information in simpler language than the CDC which made the WHO information much more accessible to a lay audience. Like the CDC information, the WHO webpages provided supplementary information that was included in the manual.

Historical Sources

In order to provide context for the conclusion that CBRNE response should focus on all-scenario responses rather than solely on attack responses, there needed to be accounts of exposure to CBRNE agents that was not an intentional attack. For this purpose, these resources were compiled. For many of the incidents PubMed was searched to find peer-reviewed articles with information on the effect of the incident. For others, news reports by the New York Times or the BBC were consulted. Specific analysis of these articles is presented in the All-Scenario section of the document.

Chapter 3: Methods

The genesis of this project occurred in Panama during my time working in the Contingency Department of their Ministry of Public Health in the summer of 2017. I was assigned to work with Dr. Rolando Luque N. of the local government on a project that fulfilled a Presidential Decree from the president of Panama to develop response plans for chemical, biological, and radiological incidents. As Dr. Luque and I discussed the needs of the country, he asked me to create a first response resource in Spanish to be used following a chemical, biological or radiological incident. In the course of our discussions, we turned to three initial resources. Dr. Luque provided me with the United States Army Medical Research Institute of Infectious Diseases (USAMRIID) Blue Book: *A Medical Management of Biological Casualties Handbook*, the United States Army Medical Department and Center's *Medical Management of Chemical Casualties Handbook*, and the *Practical Guide for Medical Management of Chemical Warfare Casualties*. We discussed what information to include in the resource I was asked to create.

For each chemical agent, I was instructed to review and distill the salient information into a background information section, show the common clinical effects, provide guidelines for triage, and give recommendations for initial medical treatment. For each biological agent, I was instructed to review and distill the salient information into a background information section, show common clinical effects, give proper diagnostic procedures, provide initial medical treatment recommendations, and guidelines for infection control. For radioactive materials, I was instructed to review and distill the salient information on skin injuries and acute radiation syndrome into a background

information section, show common symptoms, provide triage guidelines, and give initial treatment options.

With these instructions, Dr. Luque worked with me on two entries into the manual so that I could learn what information to include in each section. He made several requests for information to be included in different areas. For example, Dr. Luque requested that I include information on the incubation period of the biological agents, as well as information on the lethality and mortality rates. I first presented the information in text format, but he asked to have the information in listed form so as to be easily readable and accessible. After going through the first couple entries together, I created the guidelines for the agents he requested.

Dr. Luque requested entries on many biological agents that were not discussed in the USAMRIID Blue Book. For example, he requested that I include an entry with information on influenza. Because influenza and a few other agents were not included within the information provided in the Blue Book I asked Dr. Luque where I should look for information on those agents. He suggested that I search through Centers for Disease Control and Prevention (CDC) and World Health Organization (WHO) databases for information on those agents. I began then to supplement the information I found in the Blue Book as well as the *Practical Guide* and the *Chemical Casualties* handbooks with information from CDC and WHO. I also began to look at scholarly articles in PubMed searches to find more information about specific agents. None of three original sources provided by Dr. Luque contained any information pertinent to radiological disasters, so I sought out information on radiation from both CDC and WHO as well as emergency medicine sources.

The *Practical Guide* and the *Chemical Casualties Handbook* both referenced the US Army standard of triage, so I sought out the textbook that taught the information and found *Emergency War Surgery* (EWS). I was able to amplify the triage guidelines I included in the manual I was creating. Furthermore, in EWS I also found a reference for the *Radiological Casualties Handbook*. This new handbook provided much needed information regarding exposure to radioactive materials.

Upon returning home from my work in Panama, I presented the manual I had created to Jim Banaski the team lead for the CDC Global Response Preparedness Team. His military career included working as a CBRN training specialist with the US Army. A recommendation he made to me was to include more public health response strategies into the manual.

I went back to the three original sources provided by Dr. Luque and reviewed the information presented on public health response. I found that the public health strategies were not included in the specific response recommendations but were rather annexes or in part of the introduction. I decided to take Mr. Banaski's advice and integrate public health strategies into the whole response operation. This would create a comprehensive approach to the response by combining medical measures with public health efforts.

The idea to integrate public health strategies was aided by the acquisition of another handbook *Jane's Chem-Bio Handbook*. This handbook was given to me by Dr. Mark Keim, a professor at the Rollins School of Public Health who taught a course on the Public Health Consequences of Disaster. The public health strategies in this handbook were more thorough than the sources recommended by Dr. Luque, but the strategies were still not integrated into the response. Through the many lessons learned in the course on

Public Health Consequences of Disaster, I worked to integrate public health strategies into the response pattern for each agent.

After discussion with my Special Studies Project (SSP) advisor, I realized that my approach was too narrow. Up to that point in time I only undertook the project from a counter-terrorism standpoint. At that point, I had not stopped to consider that people can be exposed to CBRNE agents through accidents or natural outbreaks as well as deliberate attacks. I decided to expand my approach to the project to include response patterns for accidents as well as the deliberate attacks.

This new approach necessitated further research to provide background information on different exposure patterns for chemical, biological, radiological, nuclear and explosive agents. For example, there was a large-scale cholera outbreak in Haiti following the earthquake there in 2010 that was not a deliberate attack; however, it still requires prompt and efficient medical and public health response. To provide contrast to the cholera outbreak, I then sought out information on the 1984 Rajneesh Salmonella Attack in Oregon. This deliberate act of bioterrorism is the largest to have occurred on US soil. Finally, I found information about Francisco Pizarro who was able to conquer the Inca Empire with 168 men due to, inadvertently, introducing smallpox into the population. I included similar information about chemical, radiological, and explosive injuries from different accidents or deliberate attacks.

With the encouragement of my SSP advisor, I came to three conclusions from this project. First, an all-scenario approach to CBRNE incidents provides a broader range of opportunities for first responders to come to the aid of victims. Instead of focusing solely on acts of terrorism, first responders should have an all-scenario mindset when

responding to CBRNE incidents. Second, the integration of public health strategies with medical measures creates a comprehensive response framework for CBRNE incidents. Third, integration of public health strategies has both short and long-term positive effects on responders, victims, and communities.

Chapter 4: The Manual

All-Scenario Medical and Public Health Response Manual for Chemical, Biological, Radiological, Nuclear, and Explosive Incidents

Joseph C Stull MPH
Emory University
Rollins School of Public Health

Dr. Deborah A. McFarland
Thesis Advisor
Emory University
Rollins School of Public Health

Jim Banaski
Technical Advisor
Centers for Disease Control and Prevention
Global Response and Preparedness Team

Dr. Rolando Luque N.
Technical Advisor
Ministry of Health – Panama
Contingency Department

Introduction

The genesis of this manual comes from a compilation of chemical, biological, radiological, nuclear and explosive (CBRNE) agent response resources. Though there are many guidebooks and handbooks that discuss the CBRNE agents, none serves as an all-hazard resource for on-site first responders countering the effects of CBRNE agents. Therefore, this manual serves as an on-site, all-hazard, response handbook to all military and civilian first responders who have had prior CBRNE response training. This manual does not take the perspective that CBRNE agents are only used in acts of terrorism, but rather takes a broader perspective that exposure to CBRNE agents can occur in a variety of different ways including accidents and natural outbreaks as well as acts of terrorism. From this perspective, the all-hazard preparation standard is established for this manual.

Chemical Agents

Chemical agents are compounds without a biological background. Human chemical exposure occurs in solid, liquid, or gaseous states with liquid form (vapors and aerosols) as the most common. Chemical agents have varying effects on humans that can include irritation, incapacitation, injuries, and death. The most common means of ingress into the human body is through dermal contact or through inhalation. Depending on the volatility, persistence, and dose of the chemical exposure, the onset of symptoms can occur within seconds to hours later. The severity of the symptoms also depends on the volatility, persistence, and dose of the chemical exposure. Chemicals have varying symptoms depending on the mechanisms of toxicity in the body. They are categorized based upon these symptoms into nerve agents, cyanide-based agents, pulmonary intoxicants, vesicants (blistering agents), irritants (riot control agents), and incapacitating agents (Alibek, 2005; Balali-Mood et. al., 2016; Banks, 2014).

Biological Agents

A biological agent is "a microorganism (or a toxin derived from it) which causes disease in man, plants or animals or which causes the deterioration of material" (Alibek, 2005). These agents are infectious or can spread quickly among a population. Biological agents are categorized according to lethality, transmissibility, and organism. The common organisms for biological agents are bacteria and viruses. Other biological agents include the toxins from a bacterial or virus. Signs and symptoms of a biological agent depend upon the organism infecting the people (Alibek, 2005; Zygmunt, 2011).

Radiological Agents

A radiological agent is any radioactive material coming into contact with humans, animals, or plants which causes illness or injury. These materials are elements that lack the binding energy to keep the nucleus of the atoms intact. Radiation can cause external and internal sickness with varying degrees of severity and lethality. Sources of this material can include a nuclear power plant accident, radioactive medical waste, a radiation exposure device (RED) or a radiological dispersal device (RDD) i.e. a dirty bomb (Goans, 2013; Holt et. al., 2012; IOP, 2012; Pae, 2017; REMM, 2018).

Nuclear Agents

A nuclear agent specifically entails thermonuclear detonations. These can be fission bombs or fusion bombs. A fission bomb uses a heavy element core such as Uranium or Plutonium and splits the atoms into several parts. A fusion bomb is Hydrogen based and compresses hydrogen atoms together to create Helium atoms. These bombs can include formal nuclear weapons, or an Improvised Nuclear Device (IND) A thermonuclear blast generates a large explosion, light, heat, and a radioactive fallout.

The radioactive fallout is the material that rains back to earth from the plume of the explosion. This fallout will contaminate a larger area than the initial blast and can contaminate food, water, soil, people, animals, and plants (Goans, 2013; REMM, 2018).

Explosive Agents

Explosive agents involve the detonation of "any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion" (OSHA). With the detonation of an explosive agent, there will be an accompanying release of heat, light, and/or fire. There can also be an expulsion of gas along with the blast itself. Explosive agents can include but are not limited to "dynamite, nitroglycerin, picric acid, lead azide, fulminate of mercury, black powder, blasting caps, and detonating primers" (OSHA). Effects from explosions can include burns, injuries (especially to the eyes), and death as well as causing panic and disruption in the normal flow of society (OSHA; Ritenour & Baskin, 2008).

All-Scenario Preparation

All-scenario response preparation is necessary because an incident involving a chemical agent, biological organism, radioactive material, or explosive can cause accidental exposure which requires the same level of competence as a response effort following a deliberate attack. This section demonstrates the wide variety of possible exposures to CBRNE agents. Due to this wide variety of exposure possibilities, this manual is intended to be used in all situations related to CBRNE incidents, and not solely following acts of terrorism.

Chemical

Industrialization of the world has seen a pervasive increase in the production of chemicals in use in the world today. With this increase in chemical production, human contact with chemicals is also increasing. For example, according to the CDC there are "more than 13 million workers in the United States [who] have jobs that result in exposure of the skin to chemicals" (NIOSH, 2011). This creates a problem where chemical exposure is commonplace, such as widespread pesticide use in the agriculture industry and urban home use (Langley & Mort, 2012). Because of the widespread use of pesticides, more and more people are experiencing accidental exposures with adverse health outcomes. This is an issue because organophosphate pesticides have similar chemical structures to nerve agents such as sarin gas (Bajgar, 2004).

In one of the worst industrial disasters in history, thousands of people in Bhopal, India were killed within hours of an accidental release of a pesticide from a factory. As the owners were preparing to sell the factory, they directed workers to decrease the operation of safety equipment. Despite the decreased operation of safety equipment, the factory continued to produce pesticide at a normal level. Then on December 3, 1984,

disaster struck when 40 tons of methyl isocyanate (part of the cyanide family), phosgene (a vesicant), and hydrochloric acid were accidentally released into the air as a cloud of noxious gas. Within a few hours, almost 4,000 people had been killed. Those who were not immediately killed experienced symptoms such as swelling and redness in their eyes as well as severe respiratory distress and pulmonary edema. In the ensuing weeks and years, the accidental release caused between 15,000 and 20,000 premature deaths. In addition to the death brought on by the gas release, there were a variety of further symptoms manifesting themselves including ocular lesions, respiratory problems, gastrointestinal issues, reproductive issues, immune system compromise, psychological issues, and neurological side effects. There were carcinogenic effects following exposure as well (Broughton, 2005; Dhara & Dhara, 2002). This case shows an emergency situation that exposed vulnerable populations to chemical agents that was not a deliberate attack. All-scenario preparation is critical for timely and competent aid.

In a deliberate use of a chemical weapon, the Aum Shinrikyo cult released sarin gas in a Tokyo subway on March 20, 1995. This incident was the culmination of several previous attacks either using sarin gas or biological agents. The members of the cult placed five separate bags of chemicals onto different trains and punctured the bags with umbrellas to release the gas. Within a few hours, there were almost 4,000 citizens affected by the attack, several required hospitalizations and 12 people were killed. This attack by a cult organization brings to bear the reality of chemical agents being used purposefully (Olson, 2010). As part of the integrated public health strategy, a first responder must be able to not only provide relief to those who are injured but must also be able to provide a calm and reassuring face to those affected by the attack.

More recently, an attack on Kahn Sheikhoun, a town in Syria, caused victims to present with symptoms consistent with exposure to a nerve agent. While there is some debate about whether chemical weapons were actually used, victims were found with "redness of the eyes, foaming from the mouth, constricted pupils, blue facial skin and lips, severe shortness of breath and asphyxiation" which are all consistent with a chemical attack. Following the attack, estimates put the death toll between 80 and 90 people with another 500 to 600 injured. Following the examination of body tissues from the deceased, remnants of sarin gas were found in the victims (BBC, 2017). With uses like this, it is imperative that first responders work quickly and efficiently to save as many people as possible while still protecting themselves and their well-being.

In public health response to incidents involving chemical agents, first responders should expect to act in all scenarios, not just in acts of terrorism or chemical warfare. First responders should focus their efforts on recognizing the symptoms of chemical exposure to provide efficient and competent aid to victims. As they provide aid to the affected people, the first responders should also begin the implementation of sound public health strategies to promote long-term recovery following an incident.

Biological

Infectious diseases are a part of life on Earth. For example, the CDC has released information about an *E. Coli* outbreak as a result of contaminated romaine lettuce (CDC 2018). Because infectious diseases are a part of life, it is imperative that surveillance systems be in place to warn authorities and mitigate as many of the negative effects as possible (Zygmunt, 2011). With an all-scenario approach to medical and public health response, professionals can quickly and efficiently respond to biological agents.

The cholera epidemic in Haiti serves as a prime example of a biological agent incident affecting many people. After nearly a century of not seeing any cases of cholera in Haiti, there were suddenly many cases being reported in late October of 2010. This was nine months following the earthquake that rocked Haiti earlier that year. Through investigative work, officials were able to determine the origin of the specific strain of cholera. As time passed, the number of cases shot to nearly 10,000 with a rising death toll (Piarroux et. al., 2011). It is imperative that first responders work quickly and efficiently with medical measures and public health strategies to determine what the burden of disease will be, and how best to respond.

In a deliberate use of a biological agent, the 1984 Rajneesh salmonella attack is the largest act of bioterrorism to occur on United States soil. The incident occurred in The Dalles, Oregon, a small, rural, farming community. This community had become home to a religious commune known as the Rajneeshpuram. The commune members wanted to influence an upcoming county election by incapacitating members of The Dalles on election day to prevent them from voting. To accomplish this goal, they began to culture salmonella in a secret lab within the commune. They took the bacteria they had grown and spread it across salad bars in restaurants all over the town. In the end there were 751 people affected by the attack. Investigators did not realize until nearly a year later that this was actually a bioterrorism attack rather than a natural outbreak (Török, 1997). This demonstrates the need for well-trained responders who can adapt to any scenario. At the time, the outbreak was considered natural, but later was shown to be an intentional act. First responders with all-scenario training must effectively respond to outbreaks of biological agents.

During the course of human events, there is a long history of biowarfare. As early as the 15th century BC the Hittites drove diseased animals into enemy camps to cause outbreaks among the soldiers. In the mid-1300s plague bodies were catapulted over European city walls to infect the populations within. From that initial exposure, as many as 25 million people were killed by plague in Europe. When Europeans came to the Americas, biowarfare tactics continued. Francisco Pizarro presented smallpox infested blankets and clothing to the Native American tribes who he then conquered easily. With the modern era, biowarfare agents are becoming a potent threat in warfare or terrorism (Zygmunt, 2011). The long history of biowarfare, coupled with today's ability to produce, manipulate, and disseminate biological agents, makes for a potentially dangerous and destructive situation. A first responder must not only know the medical countermeasures for a biological incident but must also implement public health measures to prevent further damage by the agent.

By focusing preparation efforts on an all-scenario approach to biological agent response, first responders should expect to lend support and aid in all biological incidents. Integrating medical measures with public health strategies will create a comprehensive and long-term response that leads to full recovery following an incident involving a biological agent.

Radiological/Nuclear

Sources of radiation exist naturally in the environment which means that exposure to radiation is part of the human experience in this world. For example, there is radiation from the sun that reaches Earth, as well as radiation emanating from the Earth itself. However, with increased industrialization, the possibility of exposure to radioactive

substances does increase. There are medical treatments that have integral radioactive materials as well as an increase in the number of nuclear power plants. There is even a radioactive core in the common household smoke detector (EPA, 2010). With these few examples, it becomes easy to understand how accidental exposure could happen. A first responder should understand the effects of radiation on the body, and with that information be able to respond in any incident involving a radioactive material.

Nuclear disasters can be an adverse outcome following a large scale natural disaster as was seen in the Fukushima Daiichi nuclear power station. On March 11, 2011, an earthquake and tsunami struck in an area near the power plant. The water from the tsunami wiped out the cooling systems for the reactors "causing several of them to undergo fuel melting, hydrogen explosions, and radioactive releases." The resultant radioactive exposure contaminated areas up to 25 miles away and affected more than 100,000 people. Most people were evacuated which mitigated many of the adverse outcomes with high radiation exposure, but the area and the population affected will be important to monitor for long-term adverse effects such as cancer and birth defects. One important lesson from this disaster is the implementation of an after-action review. The AAR and subsequent studies have led to improved designs, safety processes, and response actions (Holt et. al., 2012). Through swift action many of the casualties that might have occurred in this disaster were averted. This should be an example to first responders of the effect that rapid response can have on the well-being of a community.

In addition to nuclear incidents following natural disasters, there are nuclear incidents that are a result of human error. The Chernobyl crew were running tests on the reactor, but they disabled the automatic shutdown mechanism before running the test.

This led to unstable conditions in the reactor itself which generated more damage in the whole system. The damage and unstable conditions then caused two massive explosions. The explosions killed two workers and expelled radioactive iodine-131 and cesium-137 into the environment. The radiation exposure killed 28 people and then highly contaminated areas up to nearly 30,000km^2. This wide area contained close to 6 million people and many hundreds of thousands had to be relocated to other less-contaminated areas (WNA, 2016). The Chernobyl incident occurred due to human error and had wide-spread effects on many people. This further illustrates the need for all-scenario preparation for radioactive exposure. Nuclear incidents, regardless of accidental or purposeful dispersal, can cause catastrophic effects.

While all nuclear incidents have the potential for catastrophic effects, purposeful exposures to radioactive contaminants are designed to cause significantly more injuries than an accident might cause. A purposeful exposure can include the detonation of an atomic bomb. For example, following the bombings on Hiroshima at the end of World War II, it is estimated that 140,000 people died from the blast and effects of radiation (AHF, 2017). Since 1945 the destructive power of atomic bombs has grown significantly through refining the nuclear fission bomb and the development of the hydrogen fusion bomb. In order to save as many lives as possible following a thermonuclear blast, first responders will need to be equipped with the best available techniques for response. Furthermore, purposeful dispersals of radioactive material do not end with atomic bombs. They can include radiation exposure devices, radiological dispersal devices, or improvised nuclear devices. Each of these devices has potential to contaminate and harm great numbers of people (Goans, 2013).

There are potential sources of radiation all around. These sources include potential exposure from a catastrophic nuclear disaster, and the possibility of a devastating attack with a nuclear device. Efficient response to the incident should assure that the loss of life is mitigated. Integrating public health efforts into the response should aid in the long-term recovery of the affected population or community.

Explosive

Explosive agents involve the detonation of "any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion" (OSHA). Effects from explosions can include burns, injuries (especially to the eyes), and death as well as causing panic and disruption in the normal flow of society (OSHA; Ritenour & Baskin, 2008). For this reason, it is important that first responders include public health strategies into their efforts. The public health efforts will aid the restoration of normalcy into a population. There are a variety of ways an explosion could occur. For example, there are industrial accidents such as the explosion on the Deepwater Horizon rig. The explosion could also be a purposeful detonation of a device such as the bombs that went off during the Boston Marathon.

The Deepwater Horizon was an oil drilling rig off the gulf coast of the United States. On April 20, 2010 the Horizon experienced a blowout; the crew worked to contain the damage, but many of the safety mechanisms failed to deploy. The blowout consisted of oil and gas forcing past the main blowout preventer. Following the failure of the blowout prevention, the gas exploded, and the rig caught fire. In the initial blast, 11 workers were killed and many more were injured. This disaster became one of the worst marine incidents in history (Barstow, Rohde, & Saul, 2010; Zeller, 2010). This industrial

accident shows that despite the available prevention methods, accidents do happen. It is therefore imperative to be ready to respond in any scenario.

In contrast to the accident at the Deepwater Horizon rig, the Boston Marathon bombing is an example of a purposeful explosion. On April 15, 2013, two bombs detonated near the finish line of the Boston Marathon. The blasts killed three people and injured more than 100 other people. The bombs were homemade and placed in trashcans. Many people lost their legs due to the level of the blast and their proximity to it. Following the blast, there was a scene of great panic with further bomb scares occurring as separate bags and packages were investigated for potential bombs (Eligon & Cooper, 2013). From this experience, first responders can see the need to provide a calm, reassuring presence for to the community as they work. Integrating this public health measure alongside the medical efforts makes for a comprehensive response effort.

Explosions can cause widespread panic, confusion, and chaos in a community. By developing effective medical and public health measures, first responders can provide prompt treatment to the victims. They will also be equipped to work alongside law enforcement officials as they conduct investigations into the explosions. Through these measures, the first responders can react in all scenarios for the benefit of the community.

Chemical, biological, radiological, nuclear, or explosive agents can be used in acts of terrorism as has been seen in this section. It is imperative to provide efficient and prompt medical attention to the victims of such attacks. In addition to the medical attention, the integration of public health efforts allows first responders to aid in the long-term recovery of the community. First responders should also expect to work alongside law enforcement officials and aid in the investigations. Although deliberate attacks with

CBRNE agents are often catastrophic in nature, these same agents can be present in accidents, natural outbreaks, or human oversight. In any of these scenarios, first responders must be ready to lend aid wherever they are needed. By doing so, they will provide comprehensive care to all who are affected by a CBRNE agent.

Part One: Chemical Agents

Chemical Agents are compounds without a biological background. Human chemical exposure occurs in solid, liquid, or gaseous states with liquid form (vapors and aerosols) as the most common. Chemical agents have varying effects on humans that can include irritation, incapacitation, injuries, and death. The most common means of ingress into the human body is through dermal contact or through inhalation. Depending on the volatility, persistence, and dose of the chemical exposure, the onset of symptoms can occur within seconds to hours later. The severity of the symptoms also depends on the volatility, persistence, and dose of the chemical exposure. Chemicals have varying symptoms depending on the mechanisms of toxicity in the body. They are categorized based upon these symptoms into nerve agents, cyanide-based agents, pulmonary intoxicants, vesicants (blistering agents), irritants (riot control agents), and incapacitating agents.

Humans can be exposed to these compounds in a variety of different methods, but the most common route of exposure is dispersal of liquids or solids in vapor or aerosol form. Exposure to a chemical refers to an external contamination of epithelial tissue which can include the skin, eyes, respiratory, and GI tracts. Following exposure, the chemical can be absorbed into the body through the exposed epithelial tissue.

Chemical agents can be inexpensive, easy to produce, and transport, which in the case of malicious use would produce devastating consequences among the victims. Chemical agents that have been weaponized have been stabilized to prevent degradation, thickened to increase persistency, and additional carriers to increase the dispersal range. Munitions are designed to create an aerosol or droplets from a bulk product. (Alibek, 2005; Balali-Mood et. al., 2016; Banks, 2014)

This section of the manual describes the categories of chemical agents by providing an overview of the background information, the clinical effects, triage guidelines according to United States Military Triage Categories (Cubano, 2014, pp. 29-31), initial medical treatment and a public health response.

Table 1: Chemical Agents

Chemical Agents					
Nerve Agents	**Cyanide**	**Pulmonary Intoxicants**	**Vesicants**	**Irritants**	**Incapacitating Agents**
Tabin	Hydrogen Cyanide	Phosgene	Mustard Gas	Tear Gas	QNB (BZ)
Sarin	Cyanogen Chloride	Chlorine	Arsenics	Mace/Capsaisin	Benzodiazepines (Valium)
Soman					Opioids (Fentanyl)
VX					
Cyclosarin					

Nerve Agents

Background Information

- These are the most toxic and dangerous chemical agents
- They are dangerous in vapor or liquid form
- They can cause death within minutes of exposure
- They are chemically similar to organophosphate pesticides but are more potent
- They primarily inhibit acetylcholinesterase

Clinical Effects

Table 2:

Clinical Effects			
Vapor, Low Exposure	**Vapor, High Exposure**	**Liquid, Low Exposure**	**Liquid, High Exposure**
Miosis	Loss of Consciousness	Localized Sweating	Loss of Consciousness
Rhinorrhea	Convulsions	Nausea	Convulsions
Difficulty Breathing	Apnea	Vomiting	Apnea
	Flaccid Paralysis	Sensation of Weakness	Flaccid Paralysis
	Copious Secretions		Copious Secretions
	Miosis		

Triage

- Expectant – Loss of consciousness, respiratory failure, unable to take a blood pressure reading, or no treatment options are currently available
- Immediate – Loss of consciousness, miosis, severe difficulty breathing, copious secretions, convulsions, and treatment options are available
- Delayed – Ataxia, difficulty breathing, or recovering from high exposure
- Minimal – The victim can walk and talk despite exposure

Medical Treatment

- Remove the patient from the source or source from the patient, decontaminate (remove clothing and showered with soap and water), manage airways, breathing, and circulation
- Antidote Treatment – Nerve Agent Auto-injector (ATNAA)
    - Contents in separate injections
        - Atropine Sulfate – 2.1 mg in 0.7mL of sterile solution (pH 4.0-5.0)
        - Pralidoxime Chloride – 600mg in 2.0mL sterile solution (pH 2.0-3.0)
        - Diazepam – 10mg at 10 min intervals to convulsing patients
    - Place and administer the injection in the lateral and ventral side of the thigh

Table 3: ATNAA Injections

Medical Treatment				
Person	**Vapor, Low Exposure**	**Vapor, High Exposure**	**Liquid, Low Exposure**	**Liquid, High Exposure**
Self	ATNAA x1	Incapacitated	ATNAA x1-2	Incapacitated
Friend	Wait	ATNAA x 3	Wait	ATNAA x3
		Diazepam		Diazepam

- Provide ventilation therapy to reduce bronchoconstriction (give the patient oxygen)
- Correct Acidosis
- Monitor long-term neuropsychiatric outcomes

Public Health Response

For an incident with a nerve agent, begin the response effort by using Level A Personal Protective Equipment. Following testing to determine the severity, extent, and toxicity of the nerve agent, a first responder can adjust the level of PPE appropriately.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with a nerve agent. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial decontamination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.

(Alibek, 2005; Banks, 2014; Khoshnevis, et. al., 2015)

Cyanide

Background Information

- Fast acting, lethal, and volatile
- Inhibits intracellular oxygen use
- Can cause death within 8 minutes of inhalational exposure
- There are few symptoms that indicate the use of cyanide

Clinical Effects

- 15 seconds – Increase in rhythm and depth of breathing
- 30 seconds – Convulsions
- 2-4 minutes – Cessation of breathing
- 4-8 minutes – Cardiac Arrest

Triage

- Expectant – Cardiac and respiratory failure
- Immediate – Convulsions and difficulty breathing
- Delayed – Mild effects or recuperation from treatment
- Minimal – Very mild effects

Medical Treatment

- Check airways, breathing, and circulation
- Antidote – Intravenous Sodium Nitrite (4mg/kg, 10mL), inhalational Amyl Nitrite beads (1 bead per minute), or Intravenous Sodium Thiosulfate (100mg/kg, 30mL)
- Support – Administer oxygen to assist with breathing normalization
- Correct acidosis

Public Health Response

Begin the response effort with Level A Personal Protective Equipment and adjust the level according to the severity and extent of the contamination with a cyanide agent. Cyanide is a volatile compound that can cause death quickly. Proceed with caution in the first 24 hours following the start of the incident.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with a cyanide agent. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial decontamination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Banks, 2014)

Pulmonary Intoxicants

Background Information

- They have been used in times of war (World War I)
- They are most lethal in gaseous or vapor forms
- They can accidentally form by mixing household chemicals like bleach and ammonia.
- Death comes through asphyxiation

Clinical Effects

- Burning sensation in the eyes
- Constriction of airways – Dyspnea
- Pressure in the chest
- Pulmonary edema

Triage

- Expectant – pulmonary edema, cyanosis, hypotension
- Immediate – pulmonary edema
- Delayed – difficulty breathing
- Minimal – asymptomatic, but with known exposure

Medical Treatment

- Assess airways, breathing, and circulation
- Remove the exposure source from the victim
- Cardiopulmonary Resuscitation
- Allow the victim to rest while providing oxygen
- Supportive treatment if it becomes necessary.

Public Health Response

Begin the response with the Level A Personal Protective Equipment and adjust the level as more information on the severity and extent of the contamination is obtained.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with a pulmonary intoxicant. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial decontamination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Balali-Mood et. al., 2016; Banks, 2014)

Vesicants

Background Information

- There are two forms of Vesicants
  - Mustard Gas – Sulfur and Nitrogen mustards
  - Arsenic based – Lewisite and Phosgene
- They have been used in times of war
- They cause serious blistering on exposed victims
- They can be fatal with high exposure

Clinical Effects

Table 4

Clinical Effects		
System	**Mustard**	**Arsenic**
Eyes	Lacrimation	Pain
	Sensation of Sand	Blepharospasm
	Eyelids become red	Edema
		Necrosis
		Infection
Skin	Erythema	Blisters
	Blisters	Burns
	Complete loss of the Epidermis	Necrosis of tissues
Respiratory	Rhinorrhea	Rhinorrhea
	Pain in the throat	Pain in the throat
	Obstructed breathing	Obstructed breathing
	Bronchopneumonia	Bronchopneumonia
		Pleural edema
		Pleural effusion

Triage

- Expectant* – Severe burns > 50% of the body & severe respiratory effects
- Immediate* – Serious burns and medium respiratory effects
- Delayed – Mild respiratory effects, medium burns and blisters
- Minimal – burns and blisters on less than 5% of the body
- *The majority of the Expectant and Urgent victims will not survive. If they recover, it will require enormous expenditures for the burns and respiratory failure. Be cautious in triaging patients

Medical Treatment

- Remove the victim from the contaminant or the contaminant from the victim
- Mustard Gas
  - There is no specific treatment for these wounds
  - Treat the burns, prevent infection, and assist with pain management

- Arsenics
    - The treatment for Lewisite is dimercaprol ointment
    - Standard burn protocol (do not over-hydrate)
    - Use morphine for the pain
- Use calamine lotion on the skin
- Irrigate denuded skin 3 to 4 times a day followed by topical antibiotic
- Steam inhalation for mild upper airway lesions, intubation for severe exposure
- Irrigate the eyes 3 to 4 times a day followed by topical antibiotic as needed for eye care

Public Health Response

Begin the response with Level A Personal Protective Equipment and adjust the level as the severity and extent of the contamination becomes known.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with a vesicant. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial decontamination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Balali-Mood et. al., 2016; Banks, 2014)

Irritants/Riot Control

Background Information

- These have low toxicity, rapid onset, and short duration
- Their principle use is for riot control
- Pepper spray (a form of irritant) can be easily purchased for self-defense

Clinical Effects

- Burning sensation in mucosal membranes
- Pain in the eyes, skin, and respiratory pathways
- Lacrimation, difficulty breathing

Triage

- Casualties do not need triage

Medical Treatment

- The symptoms generally disperse within an hour
- If symptoms persist past an hour, treat as necessary
    - Wash out the eyes with water
    - Wash the skin with soap and water
    - Ventilate with oxygen as needed
    - Use soothing lotions and prevent infection

Public Health Response

Generally, there is no need for Personal Protective Equipment. If used in the context of a riot, make sure to treat patients as needed according to their injuries.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with an incapacitating agent. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial decontamination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Balali-Mood et. al., 2016; Banks, 2014)

Incapacitating Agents

Background Information

- These are anticholinergic compounds
- They are dispersed as a solid aerosol
- It is a competitive inhibitor in acetylcholine receptors

Clinical Effects

- Mydriasis
- Dry mouth and skin
- Hypothermia
- Increased deep tendon reflexes
- Confusion, disorientation, and hallucinations
- Denial of symptoms/sickness
- Short attention span
- Memory deterioration

Triage

- Expectant – Severe cardiorespiratory compromise
- Immediate – Cardiorespiratory compromise and severe hypothermia
- Delayed – Medium levels of clinical effects
- Minimal – Mild levels of clinical effects

Medical Treatment

- Antidote – Physostigmine
    - 45µg/kg every 60 minutes
    - Assess mental status with each dosage
    - Decrease dosage as mental status improves
- Monitor vital signs
- Prevent the victim from causing self-harm
- Maintain fluid balance, and monitor hypothermia

(Banks, 2014)

Public Health Response

Use appropriate levels of Personal Protective Equipment and adjust as needed.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with an incapacitating agent. As a first responder, provide a calm reassuring face

to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial decontamination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005)

Part Two: Biological Agents

A Biological Agent is "a microorganism (or a toxin derived from it) which causes disease in man, plants or animals or which causes the deterioration of material" (Alibek, 2005). These agents are infectious or can spread quickly among a population. Biological agents are categorized according to lethality, transmissibility, and organism. The common organisms for biological agents are bacteria and viruses. Other biological agents include the toxins from a bacterial or virus. Signs and symptoms of a biological agent depend upon the organism infecting the people. (Alibek, 2005; Zygmunt, 2011)

Humans can be exposed to these agents in a variety of different ways including ingestion of or contact with food or water, inhalation, contact with diseased animals, or from person to person. Depending on the infectivity of the agent, it can affect people over a large area quickly with devastating consequences. The lethality of the agent will determine the number of fatal cases caused by an agent.

A biological agent that has been developed for the specific purpose of malicious intent will most likely be disseminated in a liquid or dried form. As high heat will most likely kill most organisms, the dispersal method will likely not include an explosive device but will rather be disseminated in another method.

This section of the manual describes biological agents by providing an overview of the background information, the clinical characteristics, diagnosis protocol, initial medical treatment and a public health control and response measures.

Table 6: Biological Agents

Biological Agents		
Bacterial	**Viral**	**Toxin**
Anthrax	Smallpox	Botulinum Toxin
Plague	Viral Hemorrhagic Fevers	Ricin Toxin
Tularemia	Arbovirus and Alphavirus	Staphylococcal Enterotoxin B
Meningitis	Rift Valley Fever	T-2 Mycotoxin
Cholera	Hantavirus	
Salmonella	Influenza	
Q-Fever	Venezuelan Equine Encephalitis	
Brucellosis		

Anthrax

Background Information

- Gram positive Spore
- Can survive great lengths of time in soil or water
- Zoonotic in origin (sheep, goats, cattle, and horses)
- Humans can naturally contract Anthrax by touching the contaminated hair, wool, hide, blood, or excrement of infected animals

Clinical Characteristics

- Incubation Period: one to six days
- Common Symptoms
  - Fever
  - Malaise
  - Fatigue
  - Dry cough
- Severe Symptoms
  - Dyspnea
  - Diaphoresis
  - Cyanosis
  - Shock
- Death occurs within 24 to 36 hours after the onset of the severe symptoms

Diagnosis

- Pulmonary CT scan (Mediastinal widening or pleural effusion)
- Gram Stain
- Blood Culture
- Complete Blood Count

Medical Treatment

- Ciproflaxacin
  - 400mg through an IV line over 12 hours
  - OR 500mg orally
- Doxycycline
  - 200mg through an IV line followed by 100mg over 12 hours
  - OR 200mg orally followed by 100mg doses.
- Prophylactic: *Biothrax*® vaccine

Public Health Control and Response

Standard precautions must be observed when treating patients during an anthrax attack. Cadavers should not have autopsies performed nor be embalmed. Cadavers should be cremated to prevent the creation of infectious droplets. Every instrument used in the response must be disinfected and sterilized in an autoclave or incinerated. Rooms that held patients must be cleaned with a sporicidal agent.

During an anthrax outbreak, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding

system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the outbreak will aid in the active case finding.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with Anthrax. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial examination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Zygmunt, 2011)

Plague

Background Information

- Gram-negative bacteria
- Remains viable for several weeks in non-chlorinated water, moist soil, and grain
- Zoonotic (Rodents: rats, mice, and squirrels)
- Humans contract plague from the bites of fleas from infected rodents. The rodents die in large quantities and the fleas migrate to humans as an alternative host.

Clinical Characteristics

- Incubation Period: one to six days
- Common Symptoms
    - High fever with chills
    - Headache
    - Malaise and coughing
    - Inflamed Lymph Nodes (Buboes)
- Severe Symptoms
    - Dyspnea
    - Stridor
    - Cyanosis
    - Shock
    - Thrombosis
- Death
    - Respiratory Failure
    - Circulatory Collapse
    - Bleeding Diathesis

Diagnosis

- Follow clinical signs for preliminary diagnosis, then confirm with lab tests
- Verify the diagnosis of pneumonia
- Gram stain of sputum (coccobacilli)
- Culture the organism from blood, sputum, lumbar puncture, or lymph nodes

Medical Treatment

- Isolation therapy for >48 hours in conjunction with antibiotic therapy
- Administer Streptomycin → 1g Intramuscular, Twice Daily
- OR Gentamycin → 5mg/kg intramuscular or intravenous, every day
- Can use Doxycycline or Ciprofloxacin as alternatives

Public Health Control and Response

Standard precautions must be observed with plague. *Yersinia pestis* is susceptible to heat, disinfectants, and sunlight. Observe hand washing protocol with soap and water. Infected patients should be quarantined for at least 48 hours or until sputum cultures are negative for plague. Also perform vector control or rodents and fleas.

During an outbreak of plague, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the outbreak will aid in the active case finding.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with Plague. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial examination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Zygmunt, 2011)

Tularemia

Background Information

- Aerobic bacteria, gram-negative
- Remains viable for several weeks in water, soil, skin and animal cadavers
- Can remain viable for several years in frozen rabbit meat
- Zoonotic (primarily rabbits, Arthropods: Mosquitos, Ticks, Deer Flies)
- Humans contract tularemia through bites from infected arthropods or through contact with bodily fluids or tissues of infected animals.

Clinical Characteristics

- Incubation Period: three to six days
- Common Symptoms
  - Fever
  - Chills
  - Headache
  - Cough
  - Myalgia
- Severe Symptoms,
  - Pleural pneumonitis
  - Ulceroglandular Sickness

Diagnosis

- Large numbers of temporally clustered patients with clinical characteristics
- Chest X-ray
- White blood cell count (5,000 – 22,000 WBC/mL)
- Cultivate the organism from blood, ulcers, or sputum (small, smooth, opaque colonies)
- Polymerase Chain Reaction (PCR)
- ELISA

Medical Treatment

- Streptomycin
  - 1g Intramuscular, Twice Daily
- Gentamycin
  - 5mg/kg intramuscular or intravenous, every day
- Alternatives: Doxycycline and ciprofloxacin

Public Health Control and Response

Use the pneumonia standard precautions when treating patients with tularemia. Assure strict adherence to the standard precautions especially when draining lesions or disinfecting clothes, sheets, and equipment. Use heat and disinfectant to kill the organisms.

During a tularemia outbreak, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding

system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the outbreak will aid in the active case finding.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with Tularemia. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial examination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Zygmunt, 2011)

Meningitis

Background Information

- Meningitis is an infection in the meninges surrounding the brain
- It can be caused by bacteria or virus
- Meningitis affects all people, but it is most common in babies, children, adolescents, and young adults
- Bacterial Meningitis causes death in 50% of cases that receive no treatment.
- Patients Viral Meningitis usually get better within 7-10 days

Clinical Characteristics

- Incubation period – 2 to 10 days (an average of 4 days)
- Common Symptoms
    - Rigid neck (the patient cannot look down)
    - High fever (38°C)
    - Headache
    - Photophobia
    - Somnolence
    - Vomiting
    - Convulsions
    - Skin Rash
- Severe Symptoms
    - Brain Damage
    - Loss of hearing
    - Develop learning disabilities
    - Septicemia
- Death occurs within 24 to 48 hours after the onset of symptoms if left untreated

Diagnosis

- Examine the patient according to the clinical characteristics
- Lumbar tap – purulent cerebrospinal fluid
- PCR and culture of organisms from the lumbar tap

Medical Treatment

- Identify the strain of bacteria to determine the best course of action for treatment
- Penicillin, ampicillin, or ceftriaxone are antibiotics
- Administer IV fluids and oxygen as needed
- Provide supportive therapy for patients with viral meningitis and wait 7-10 days

Public Health Control and Response

Perform droplet control among patients to prevent spread through sneezing, coughing, kissing, sharing utensils, or toothbrushes. A tetravalent vaccine can be administered to prevent the spread of infection. Create space among people living in crowded living conditions such as dorms.

During a meningitis outbreak, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the outbreak will aid in the active case finding.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with Meningitis. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial examination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Meningitis, 2016; Meningococcal Meningitis, 2015)

Cholera

Background Information

- *Vibrio cholerae* is a bent rod-shaped, non-sporulating, gram-negative bacteria
- Cholera survives in clean and polluted water for up to six weeks
- Cholera is passed through the consumption of food or water contaminated with fecal matter
- Cholera is lethal in 3%-30% of treated cases and 50%-80% of untreated cases

Clinical Characteristics

- Incubation Period – hours to 5 days (average of 2-3 days)
- Sudden Onset of GI Symptoms
    - Nausea
    - Vomiting
    - Copious watery diarrhea (appearance of rice water)
    - Rapid loss of bodily fluids
    - Toxemia,
    - Severe dehydration
- Death can occur within hours after the onset of symptoms if left untreated

Diagnosis

- Compare symptoms to clinical characteristics
- Serological tests are needed to determine the specific strain of cholera
- Cholera can be confirmed through stool culture

Medical Treatment

- Up to 6L of Oral Rehydration Solution (1 packet of WHO ORS to 1L of water)
- Tetracycline – 500mg every 6 hours for 3 days
- Alternatives
    - Ciprofloxacin – 500 mg every 12 hours for 3 days
    - Erythromycin – 500 mg every 6 hours for 3 days
    - Doxycycline – 6mg/kg

Public Health Control and Response

To assist in controlling the spread of cholera, the WHO recommends active surveillance and case finding during a known outbreak as well as water and sanitation interventions. The cholera organism is killed through the use of heat to 250°F (118°C), steam, boiling, regular disinfectants, and water chlorination. Use standard droplet protocol when treating patients with cholera and be vigilant in handwashing protocols.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of

supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

During a cholera outbreak, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the outbreak will aid in the active case finding.

The psychological profile of the community is important following an incident with Cholera. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial examination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Cubano, 2014, p. 440; WHO, 2017)

Salmonella

Background Information

- *Salmonellae* are gram-negative rod-shaped bacteria
- Humans are infected with Salmonella through ingesting contaminated food or water or by handling live animals
- Salmonella generally lives in animal sources, but can be found in plant sources as well
- The largest bioterrorism attack on US soil used salmonella

Clinical Characteristics

- Incubation Period – 6 to 72 hours
- Symptoms
    - Sudden onset of diarrhea (possibly bloody)
    - Fever
    - Abdominal cramps
    - Nausea
    - Vomiting
    - Headache
- Most people make a full recovery though it requires several months to return to normal

Diagnosis

- Compare patient symptoms to clinical characteristics
- Serological testing needed to determine the specific strain of salmonella
- Stool culture confirms the presence of salmonella

Medical Treatment

- Most of the time antibiotic therapies are not needed
- Ensure that the patient is well-hydrated
- Ensure that the patient rests sufficiently until the end of the duration of the disease

Public Health Control and Response

When there is an outbreak of salmonella, assure that people and restaurants are thoroughly cooking all foods. Make sure to observe strict hand washing protocols and encourage all to do so as well. Avoid direct contact with reptiles, birds, or other animal feces. People who are sick should not be preparing food for others. Observe droplet protocol when treating patients, and assure hand washing following contact.

During a salmonella outbreak, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the outbreak will aid in the active case finding.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with Salmonella. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial examination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; CDC, 2018; DHHS, 2009)

Q-Fever

Background Information

- *Coxiella burnetii* is a gram-negative bacterium
- It is an incredibly hardy bacterium and can survive for many years in the environment
- Zoonotic in origin with sheep, cattle, goats, rabbits, cats, dogs, rodents, birds, and ticks as the primary reservoirs
- Q-Fever has a low infectious dose: one bacterium can cause infection in 50% of people
- Humans contract the disease through respiration of aerosolized particles from animals, consuming contaminated milk or cheese, tick bites, or direct contact with fetal membranes or fluids

Clinical Characteristics

- Incubation period – 10 to 14 days
- Symptoms
    - Sudden onset of fever
    - Headache, chills, and weakness
    - Profuse sweating
    - Upper respiratory problems
    - Coughing
    - Chest muscle and joint pain
- Q-Fever is an incapacitating agent and is not generally lethal

Diagnosis

- Compare symptoms to clinical characteristics
- Definitive diagnosis done through sputum stain, culture, or serology tests

Medical Treatment

- Administer Tetracycline – 500mg every 6 hours
- Alternative Doxycycline – 100mg every 12 hours for 5 to 7 days
- Administer supportive treatment as necessary
- Vaccination provides complete coverage, but the vaccine causes severe side effects

Public Health Control and Response

Work with animal health experts to prevent the spread of disease among animals, and aside from that work, minimize contact with animals. Use standard droplet and aerosol procedures when treating infected patients. Q-fever can be killed by heat to 112°F (44°C) for 30 minutes. It can be inactivated when subjected to 0.1% formalin and 0.5% phenol.

During a Q-fever outbreak, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread of

disease. The development of a case definition for the outbreak will aid in the active case finding.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with Q-fever. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

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Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Cubano, 2014, p. 440; Zygmunt, 2011)

Brucellosis

Background Information

- There are several Brucella species: *Brucella suis, Brucella abortus, Brucella canis,* and *Brucella melitensis*
- They are gram-negative, can be round or rod shaped cocco-bacilli
- Zoonotic in origin from cattle, bison, deer, goats, sheep, pigs, dogs, cayotes, and humans
- Humans contract the disease through exposure to raw dairy products as well as close contact with an animal reservoir.

Clinical Characteristics

- Incubation Period – 5 to 21 days
- Common Symptoms
    - Prolonged intermittent fever
    - Headaches
    - Profuse sweating
    - Chills
    - Muscle and joint pain
    - Malaise
    - Anorexia
- Brucellosis is generally not lethal, but rather is an incapacitating illness

Diagnosis

- Diagnosis is difficult and requires a high degree of surety before testing begins
- Record patient history of contact with animals
- Compare symptoms to clinical characteristics
- Laboratory confirmation requires serum agglutination tests, ELISA, and/or culture (culture needs 30 days to incubate before testing)

Medical Treatment

- Administer antibiotic treatment for six weeks
    - Doxycycline – 100mg 2 times per day AND
    - Rifampin – 600mg per day
- Treatment completion is critical to prevent relapse

Public Health Control and Response

Use standard precautions when working with patients infected with brucellosis and assure that no aerosols are formed. Perform appropriate decontaminations with common disinfectants. Assure that all dairy products are properly pasteurized before consumption. Minimize contact with infected animals.

During a brucellosis outbreak, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread

of disease. The development of a case definition for the outbreak will aid in the active case finding.

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The psychological profile of the community is important following an incident with brucellosis. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

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Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Cubano, 2014, p. 440; Zygmunt, 2011)

Smallpox

Background Information

- Extremely infectious virus (R_0 = 5 to 7)
- Smallpox was declared eradicated by the WHO in 1980
- Smallpox still exists as a military threat
- It is easy to produce in large scale and arm as a biological weapon

Clinical Characteristics

- Incubation Period: average of 12 days (range of 7-19 days)
- Immediate Symptoms
  - Malaise
  - Fever – above 38°C
  - Rigors
  - Headache and back pain
- Symptoms after 2-3 Days
  - Skin lesions
  - Macules → Papules → Pustular Vesicles
  - Vesicles are most abundant on the face and extremities
- Death occurs during the second week of the sickness

Diagnosis

- Distinguish between the clinical characteristics of smallpox and other vesicular exanthemas (other poxes)
- Collect specimens from skin lesions, fluid from the lesions, blood, scabs, or pharyngeal swab
- Real-time PCR must be done in the USA in BSL-4 conditions at the CDC or USAMRIID

Medical Treatment

- Immediate quarantine (At least 17 asymptomatic days)
- Vaccinate the patient within four days of being infected
  - Acam2000
  - OR Dryvax (can be diluted up to five times)
- Report all cases to the Public Health Authorities
- Vaccinate all contacts

Public Health Control and Response

Endemic smallpox was declared eradicated in 1980 by the World Health Organization (WHO). There are two WHO approved repositories of the smallpox virus in the world today: The Centers for Disease Control and Prevention in the USA, and in The Russian State Centre for Research on Virology and Biotechnology. Unfortunately, there could be other unknown stockpiles of the virus elsewhere in the world that could be used in an attack. In the case of an attack, quarantine the victims immediately to prevent the spread of disease and begin a mass vaccination campaign

During a smallpox outbreak, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the outbreak will aid in the active case finding.

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The psychological profile of the community is important following an incident with smallpox. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

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Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Cubano, 2014, p. 441; NIH, 2014; Zygmunt, 2011)

Viral Hemorrhagic Fevers: Ebola, Marburg, Junín, & Lassa

Background Information

- Single-stranded RNA virus
- There are four families of virus: *Arenaviridae* (Lassa & Junín), *Bunyaviridae*, *Filoviridae* (Ebola & Marburg), and *Flaviviridae*
    - *Bunyaviridae* – see Rift Valley Fever and Hantavirus
    - *Flaviviridae* – see Arbovirus and Alphavirus
- Infection comes from exposure to infected blood or bodily fluids. It can also be transmitted through the respiratory system
- Zoonotic Potential – vectors and rodents

Clinical Characteristics

- Incubation period – there is some variation within 2 to 25 days
- Initial and Common Symptoms
    - Fever, malaise, and myalgia
    - Headache
    - Vascular instability
        - Easy bleeding
        - Flushed face and chest
        - Non-dependent Edema
- Severe Symptoms
    - Capillary leak
    - Bleeding diathesis
    - Hemodynamic compromise
    - Shock
- There is great variety in symptoms due to different mechanisms of infection.
- Death can occur at the beginning of the second week of illness with up to 80% mortality

Diagnosis

- Compare symptoms to the known clinical characteristics
- Take a detailed travel history (make special note of proximity to rodents, infected cadavers, and mosquitoes)
- Perform diagnostic virology
- Order a PCR test in the USA from the CDC or USAMRIID

Medical Treatment

- Perform supportive therapies for hemodynamic, hematologic, pulmonary, and neurological symptoms
- Isolation chambers with negative pressure are necessary for patients
- For VFHs administer Ribavirin through an IV line in the first four days of illness along with follow-up doses.
    - Load dose – 30mg/kg once
    - Maintenance dose – 16mg/kg every six hours for four days

Public Health Control and Response

Use strict patient contact protocols with infected patients. Each worker must have on double gloves, impermeable gowns, leg and shoe covers, and a face shield. Strict precautions for airborne droplets must be implemented at all times to prevent infection of medical personnel. Assure that all personnel are using a filtered respirator. Perform all decontaminations with hypochlorite or with phenolic disinfectants. All laboratory specimens must be incinerated. Cadavers should be placed into a leak proof bag and cremated as soon as possible. An autopsy should not be performed. Any survivors of a VHF should avoid sexual contact for at least three months.

During a VHF outbreak, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the outbreak will aid in the active case finding.

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The psychological profile of the community is important following an incident with a VHF. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

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Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Cubano, 2014, p. 441; Zygmunt, 2011)

Arbovirus and Alphavirus: Dengue, Zika, Yellow Fever, & Chikungunya

Background Information

- These are part of the VHF family of *flaviviridae*
- Zoonotic illnesses, but the principle hosts are human beings
- Humans are infected by a mosquito bite (generally the vectors are *Aedes aegypti* and *A. albopictus*

Clinical Characteristics

Table 7

Arbovirus and Alphavirus				
Clinical Characteristics	**Dengue**	**Zika**	**Yellow Fever**	**Chikungunya**
Incubation Period	3 to 14 Days	<14 Days	3 to 6 days	3 to 7 Days
Common Symptoms	Fever	Fever	Fever	Fever
	Myalgia	Arthralgia	Chills	Arthralgia
	Arthralgia	Conjunctivitis	Headache	Conjunctivitis
	Headache	Rash	Back Pain	Rash
	Rash	Headache	Pain in the Body	Headache
	Nausea	Vomiting	Nausea	Vomiting
	Vomiting		Vomiting	
	Petechiae		Fatigue	
			Weakness	
Critical Symptoms	Thrombocytopenia	Birth Defects	High Fever	Rare
	Hemorrhage		Jaundice	
	Shock		Bleeding	
	Severe organ failure		Shock	
	Severe pulmonary edema		Severe organ failure	

Diagnosis

- Compare patient's symptoms to the clinical characteristics
- Exclude a diagnosis of malaria
- Complete Blood Count (CBC)
- Liver Function Tests
- Chem 7/Basic Metabolic Panel

Medical Treatment

- Treatment must only be supportive
- NEVER administer nonsteroidal anti-inflammatory
- NEVER administer steroids
- Assure the patient rests, drinks plenty of fluids, and administer analgesics

Public Health Control and Response

To control these infections, perform vector control with insecticides because following a biological attack, the sickness can easily spread by mosquitoes biting infected people. Additional precautions include insect repellant and mosquito nets.

During a dengue, zika, yellow fever, or chikungunya outbreak, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the outbreak will aid in the active case finding.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with dengue, zika, yellow fever, or chikungunya. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial examination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Patterson, et.al., 2016; Yellow Fever, 2015)

Rift Valley Fever

Background Information

- RVF is part of the *bunyaviridae* family of VHFs.
- It is a mosquito borne disease in nature
- Usually associated with the rainy season during arthropod vector proliferation times

Clinical Characteristics

- Incubation Period – 2 to 6 days
- Initial symptoms
  - Fever (2 to 6 days)
  - Conjunctival injection (red eyes)
  - Abdominal tenderness
  - Petechiae (spotted hemorrhagic areas)
  - Epistaxis (nosebleeds)
- Severe Symptoms
  - Widespread petechiae
  - Mucosal bleeding
  - Jaundice
  - Anuria (no urine production)
  - Shock
- RVF has a mortality rate of ~50%

Diagnosis

- Compare patient symptoms to clinical characteristics
- Take patient travel history and note contact with mosquitoes
- Perform diagnostic virology tests in a laboratory
- PCR tests will also provide a definitive diagnosis

Medical Treatment

- Antiviral treatment with Ribavirin
  - Load dose: 30mg/kg in an IV line
  - Follow-up dose one: 15mg/kg in an IV line, every 6 hours for 4 days
  - Follow-up dose two: 7.5mg/kg in an IV line, every 8 hours for 6 days
- There is a limited quantity of vaccine available
  - Three doses on days 1, 7, and 28
  - Administer the booster each year

Public Health Control and Response

Exercise extreme caution when treating patients with RVF to avoid contamination and perpetuation of the disease. The patient should be quarantined in a negative-pressure room. Patients should have on Level A Personal Protective Equipment to avoid infection. Follow strict droplet and aerosol protocols. Perform all decontaminations with hypochlorite or with phenolic disinfectants. All laboratory specimens must be incinerated. Cadavers should be placed into a leak proof bag and cremated as soon as possible. An autopsy should not be performed.

During a Rift Valley fever outbreak, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the outbreak will aid in the active case finding.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with Rift Valley fever. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

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(Alibek, 2005; Zygmunt, 2011)

Hantavirus

Background Information

- Hantavirus is part of the VHF family *bunyaviridae*
- Single-stranded RNA virus
- Zoonotic in origin – humans become infected after contact with the urine, feces or saliva of rodents

Clinical Characteristics

- Incubation period – Unknown but believed to be between 1 and 8 weeks.
- Initial Symptoms
  - Fever
  - Fatigue
  - Muscle pains – thighs, hips, back, and shoulders
  - Headache
  - Dizziness
  - Chills
  - Abdominal problems – Nausea, vomiting, diarrhea
- Subsequent Symptoms
  - Difficulty breathing
  - Coughing
  - Lungs filling with liquid
- Death occurs in around 38% of cases without treatment

Diagnosis

- Exclude a diagnosis of influenza
- Determine a contact history with rodents
- Compare the symptoms of the patient with the clinical characteristics and history of rodent contact

Medical Treatment

- There is no specific treatment
- Intubate the patient to provide oxygen if it becomes necessary
- Provide mechanical breathing if necessary

Public Health Control and Response

Standard precautions are necessary when responding to hantavirus. Perform rodent control to prevent the continued spread of disease. Clean well, set traps, fill in rodent holes, and pick up loose food. Maintain cleanliness at all times.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

During a hantavirus outbreak, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the outbreak will aid in the active case finding.

The psychological profile of the community is important following an incident with hantavirus. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

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(Alibek, 2005; Hantavirus, 2013; Zygmunt, 2011;)

Influenza

Background Information

- This is a common virus worldwide
- Influenza virus causes an acute respiratory illness
- There are three subgroups (A, B, and C), but only type A has caused pandemics
- Humans contract influenza by breathing in droplets from the sneezes or coughs of infected people. Humans can also come into contract influenza from touching surfaces that have been made contagious by infected patients

Clinical Characteristics

- Incubation Period – 1 to 4 days (average of 2 days)
- Common Symptoms
    - Sudden onset of fever
    - Dry cough
    - Headache
    - Joint and muscle pain
    - Malaise
    - Runny nose
- Death can occur within any population but is most common among high risk groups
    - Pregnant women, the elderly, or children less than 5 years old
    - People with compromised immune systems

Diagnosis

- Compare the patient's symptoms to the clinical characteristics
- If it becomes necessary, perform a viral culture or PCR to definitively diagnose influenza

Medical Treatment

- The best treatment for influenza is preventative: administer the flu vaccine each year
- If a patient is infected, they should remain at home, drink plenty of fluids, and maintain warmth
- Paracetamol and ibuprofen can reduce the fever
- If the patient is in a high-risk group, seek immediate medical attention

Public Health Control and Response

Use standard precautions for droplets when treating an infected patient. The best way to prevent an outbreak or attack is through administering a competent vaccine each year to as many people as possible. The vaccine will provide protection against the most common strains in addition to the less common strains. Additionally, quarantining patients with flu-like symptoms until the symptoms are gone is an effective control measure.

During an influenza outbreak, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case

finding system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the outbreak will aid in the active case finding.

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The psychological profile of the community is important following an incident with influenza. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

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(Alibek, 2005; Flu, 2015; Influenza, 2016; Influenza Signs and Symptoms, 2016)

Venezuelan Equine Encephalitis

Background Information

- Viral group with 6 serotypes and 13 subgroups
- Zoonotic – Equine (Horses, mules, and donkeys)
- Humans can become infected with VEE through mosquito bites when in proximity to any equine animal.
- There is a small transfer dose of 10 to 100 organisms

Clinical Characteristics

- Incubation period: 2 to 6 days
- Presents as an acute systemic febrile illness
- Initial Symptoms (24-72 hours
    - Malaise
    - Fever
    - Rigors
    - Severe headache
    - Photophobia
    - Myalgia
- Subsequent Symptoms
    - Nausea
    - Vomiting
    - Coughing
    - Throat pain
    - Diarrhea
    - Encephalitis and other CNS symptoms
- Mortality is low but there is high susceptibility with high incapacitation of those infected

Diagnosis

- Compare the patient's symptoms to the clinical characteristics
- Perform PCR
- Run serological tests to determine serotype and subgroup

Medical Treatment

- Treatment consists of supportive therapies due to a lack of an antiviral therapy
- Administer IV fluids to prevent or correct dehydration
- Administer anticonvulsive drugs when necessary (i.e. patient is having convulsions)

Public Health Control and Response

There is no evidence of human to human or equine to human transmission of the disease which means that quarantine is not necessary. PH Control consists of performing vector control through insecticides and administering insect repellant and mosquito nets. Heat and disinfectants easily kill the VEE virus. Assure the use of standard precautions when treating patients with VEE.

During a VEE outbreak, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the outbreak occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the outbreak will aid in the active case finding.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with Venezuelan equine encephalitis. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial examination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Cubano, 2014, p.441; Zygmunt, 2011)

Botulinum Toxin

Background Information

- Neurotoxin produced by *Clostridium botulinum*
- Humans contract botulism through the consumption of contaminated foods
- *Clostridium botulinum* needs anaerobic incubation (living environments without oxygen)
- *C. botulinum* can be produced in a large scale through the process of fermentation

Clinical Characteristics

- Onset of symptoms – 12 to 36 hours following exposure
- Initial Symptoms
    - Paralysis of optical cranial nerves – blurry vision, mydriasis, diplopia, ptosis, and photophobia
    - Paralysis of other cranial nerves – Dysarthria, Dysphonia, Dysphagia
- Subsequent Symptoms
    - Flaccid Paralysis of skeletal muscles – symmetrical, descending, progressive
    - Respiratory failure – this causes death within 24 hours
    - Dry mouth, constipation, urinary retention

Diagnosis

- Compare the patient's symptoms to the clinical characteristics
- Perform a serum bioassay
- Perform a reverse transcriptase PCR to detect the toxin

Medical Treatment

- Heptavalent antitoxin
- Intubation and ventilation assistance
- Perform a tracheotomy if it becomes necessary

Public Health Control and Response

Standard precautions are sufficient for responders when treating patients with botulism. Perform decontaminations with soap and water. The toxin is inactivated within one to three hours of direct sunlight. Heat (80°C for 30 minutes) and bleach will destroy the neurotoxin.

During an incident with botulinum toxin, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the incident occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the incident will aid in the active case finding.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First

Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with a botulinum toxin agent. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial examination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Cubano, 2014, p. 439; Zygmunt, 2011)

Ricin Toxin

Background information

- Ricin is a toxin produced from the byproducts of processing Castor beans for oil
- It is easy to produce and is extremely stable
- The most probable route of exposure to Ricin is through either inhalation or ingestion
- Ricin is also considered a chemical agent
- The lethal dose of inhalational Ricin is around 22μg/kg of body weight
- The lethal dose from ingesting Ricin is around 1mg/kg of body weight

Clinical Characteristics

- Onset of Symptoms – 2 to 3 hours following exposure
- Inhalational Exposure
    - Initial Symptoms
        - Coughing
        - Tightness of the chest
        - Difficulty breathing
        - Nausea
        - Muscle aches
    - Subsequent Symptoms
        - Inflammation of the lungs and airways
        - Cyanosis (blue skin)
    - Death from Inhalational Exposure occurs in 36 to 48 hours
- Ingestion Exposure
    - Critical Symptoms
        - Nausea and Vomiting
        - Internal bleeding in the stomach and intestines
        - Liver, spleen, and kidney failure
    - Death is caused by circulatory collapse and major organ failure soon after exposure

Diagnosis

- Human exposure to Ricin is rare so a clinical diagnosis procedure has not been developed
- Compare the symptoms of the patient to the clinical characteristics

Medical Treatment

- There is no vaccine nor is there an anti-toxin
- Perform supportive treatments for lung injuries and pulmonary edema
- Perform a gastrointestinal lavage if the victim was found within one hour of exposure

Public Health Control and Response

Standard precautions must be observed when treating victims exposed to Ricin. Decontaminate victims, responders, equipment, and supplies with soap and water. Ricin is also inactivated at temperatures over 80°C.

During an incident with ricin, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the incident occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the incident will aid in the active case finding.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with ricin. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial examination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Cubano, 2014, p. 439; ESFA, 2008, Zygmunt, 2011)

Staphylococcal Enterotoxin B (SEB)

Background Information

- Toxin produced by *Staphylococcus aureus*
- This is a common cause of food poisoning after improper food preparation
- Different clinical features based upon route of exposure between ingestion and inhalation
- SEB is a stable toxin and requires a small dose to affect humans, and it is an incapacitating agent that places a heavy burden on the medical system

Clinical Characteristics

- Onset to Symptoms – 1 to 12 hours for inhalational, 4 to 10 hours for ingestion
- Initial symptoms: Fever (up to 5 days), Headache, Chills, Myalgias
- Ingestion symptoms
    - Nausea
    - Vomiting
    - Diarrhea
- Inhalational symptoms
    - Non-productive cough – up to 4 weeks
    - Retrosternal chest pain
    - Dyspnea
    - Can have GI symptoms if mucous is swallowed
- SEB has a low mortality rate (>2%) but incapacitates its victims for days

Diagnosis

- Compare patient symptoms with clinical characteristics
- Account for many cases in a short amount of time.
- Laboratory diagnosis is done through ELISA and PCR

Medical Treatment

- Provide supportive therapy for symptoms
- Administer oxygen when necessary and assure proper hydration
- Assure that the patient properly rests for at least 2 weeks before returning to normal life

Public Health Control and Response

Use standard precautions when treating patients with SEB. Work to isolate where the exposure originated to decontaminate the source of the infection.

During an incident with SEB, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case finding system will aid first responders and public health officials to track where the incident occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the incident will aid in the active case finding.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with SEB. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

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Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Cubano, 2014, p. 439, Zygmunt, 2011)

T-2 Mycotoxin

Background Information

- There are a variety of filamentous fungi (molds) that produce mycotoxins: *Fusarium, Myrotecium, Trichoderma,* and *Stachybotrys*
- T-2 mycotoxin has high environmental stability and can be easily disseminated in aerosol form
- T-2 mycotoxin penetrates the body through epithelial tissue of the mouth, throat, lungs, and gastrointestinal tract by way of ingestion, inhalation, and/or dermal absorption
- T-2 mycotoxin inhibits the production of proteins and nucleic acids in bone marrow, skin, mucosal epithelia, and germ cells

Clinical Characteristics

- Onset of Symptoms – within minutes of exposure
- Initial symptoms: burning skin, redness, tenderness, blistering, and skin necrosis (the skin can slough off in fatal cases)
- Upper respiratory symptoms: nasal itching and pain, sneezing, nosebleeds, rhinorrhea (runny nose)
- Pulmonary symptoms: dyspnea (difficulty breathing), wheezing, coughing
- Throat symptoms: pain, bloody saliva and sputum
- Gastrointestinal symptoms: anorexia, nausea, vomiting, diarrhea, abdominal cramps
- Ocular symptoms: pain, redness, blurred vision
- Systemic symptoms: weakness, prostration, dizziness, ataxia, loss of coordination, tachycardia (rapid heartbeat), hypothermia, and hypotension
- Death can occur within hours or days

Diagnosis

- Rapid onset of patient symptoms that compare to clinical characteristics
- Laboratory test should be done on urine or serum

Medical Treatment

- There is no specific antidote or treatment
- Provide supportive therapy according to symptoms

Public Health Control and Response

Follow standard poison and toxin control for T-2 mycotoxin by administering super-activated charcoal to absorb the toxin. Remove clothing and wash the skin as quickly as possible with soap and water to decontaminate the victim. Decontaminate clothing and tools in a 5% bleach solution. Assure that proper PPE is used during the response to avoid accidental exposure. Begin with Level A PPE and adjust as necessary.

During an incident with mycotoxins, it is imperative that a syndromic surveillance system be put into effect to monitor the area for more cases. This active case

finding system will aid first responders and public health officials to track where the incident occurred, track its progress, and develop plans to prevent the spread of disease. The development of a case definition for the incident will aid in the active case finding.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with T-2 mycotoxin. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial examination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Cubano, 2014, p. 2014; Zygmunt, 2011)

Part Three: Radiological/Nuclear Agents

Sources of radiation exist naturally in the environment which means that exposure to radiation is part of the human experience in this world. For example, there is radiation from the sun that reaches Earth, as well as radiation emanating from the Earth itself. However, with increased industrialization, the possibility of exposure to radioactive substances does increase. There are medical treatments that have integral radioactive materials as well as an increase in nuclear power plants. There is even a radioactive core in the common household smoke detector (EPA, 2010). With these few examples, it becomes easy to understand how accidental exposure could happen.

According to the United States Armed Forces Radiobiology Research Institute, there are several important radionucleotides of concern in accidents or attacks which include Tritium (^{3}H), Carbon-14, Phosphorous-32, Cobalt-60, Iodine-125, Iodine-131, Californium-252, Iridium-192, Cesium-137, Uranium-235, Plutonium-239, and Americium-241 as well as fission products.

Even with proper protection and preparation, radioactive substance release can incite panic, sickness, and even death among a population, however, radiation effects such as irradiation and contamination can be mitigated through proper preparation and protection. Part of the necessary preparation is learning to properly recognize and diagnose the Acute Radiation Syndrome (ARS) and External Skin Injury. From there the medical and public health response efforts begin.

A nuclear agent specifically entails thermonuclear detonations. These can be fission bombs or fusion bombs. A fission bomb uses a heavy element core such as Uranium or Plutonium and splits the atoms into several parts. A fusion bomb is Hydrogen based and compresses hydrogen atoms together to create Helium atoms. These

bombs can include formal nuclear weapons, or an Improvised Nuclear Device (IND) A thermonuclear blast generates a large explosion, light, heat, and a radioactive fallout. The radioactive fallout is the material that rains back to earth from the plume of the explosion. This fallout will contaminate a larger area than the initial blast and can contaminate food, water, soil, people, animals, and plants.

A radiological agent is any radioactive material coming into contact with humans, animals, or plants which causes illness or injury. These materials are elements that lack the binding energy to keep the nucleus of the atoms intact. Radiation can cause external and internal sickness with varying degrees of severity and lethality. Sources of this material can include a nuclear power plant accident, radioactive medical waste, a radiation exposure device (RED) or a radiological dispersal device (RDD) i.e. a dirty bomb. (Goans, 2013; Holt et. al., 2012; IOP, 2012; Pae, 2017; REMM, 2018)

In this section of the manual, there are explanations of radiation, irradiation, and contamination. The next portion of this section will assist first responders in the diagnosis and treatment options for Acute Radiation Syndrome and Skin Injuries. The last portion of this section will be public health responses to a nuclear incident.

Radiation

- High-Energy, Ionizing
    - Waves
        - X-rays, Gamma rays, and Cosmic rays
        - These can travel long distances
        - They penetrate the body
        - They cause irradiation
            - The whole body becomes radioactive
            - But, they do not remain radioactive
    - Particles
        - Alpha Particles
            - Travel a few centimeters
            - Cannot penetrate the skin
        - Beta Particles
            - Travel a few meters
            - Can only penetrate the top layers of skin
        - They cause contamination
            - Only the exposed parts of the body become contaminated
            - The contaminated areas remain radioactive
            - Must be ingested to cause acute radiation syndrome
- Low-Energy, Non-Ionizing
    - These are only waves
    - Radio waves, visible light, radar, electrical energy, and microwaves
- Radiation is odorless, tasteless, and invisible
- Exposure is measured in Gray Units
    - One Joule of radiation energy absorbed per kilogram of material
    - Gy = 1J/kg

(Goans, 2013; Pae, 2017)

Skin Injuries

Background Information

- Contamination by alpha and beta particles, exposed skin remains radioactive
- The severity of the symptoms depends on the duration, quantity, and extent of contamination and exposure
- The particles affect the DNA in the skin and hair follicles
- Skin Injuries require various levels of exposure for different symptoms.

Symptoms

- Immediate Symptoms (1-2 hours following exposure)
    - Erythema (reddening of the skin)
    - Prickling, pins and needles, itching, tingling
    - Sensation of heat or burning & blisters
    - Hair falls out/depilation
- Symptoms of Sickness (1 day to 5 weeks following exposure)
    - Burns
    - Edema
    - Increased pigmentation
    - Severe effects: Skin peeling/desquamation, Ulceration, Skin Necrosis
- Delayed Onset Symptoms (10-16 weeks following exposure)
    - Severe erythema (reddening of the skin)
    - Damage to blood vessels
    - Severe edema
    - Increased sensation of Pain
    - Severe effects: Skin can turn blue, ulcers, necrosis and/or dermal atrophy
- Late Onset Symptoms (months to years following exposure, also needs a high exposure)
    - Necrosis and Dermal Atrophy
    - Ulcers
    - Deformities
    - Interruption of the lymphatic system and blood supply to the skin
    - Skin cancer

Treatment

- Decontaminate the patient
    - Remove contaminated clothing and shoes
        - Cut and roll the clothing away from the face
        - Put clothing in bags tagged & designated for radioactive materials
    - Clean wounds with water or 0.9% saline solution
    - Clean the skin with soap and water (from outside the contaminated area working into the center of the exposed area.)
    - Repeat until radiation levels are at most 2 times more than normal
- Administer antihistamines and anti-inflammatories
- Maintain sanitary conditions to prevent infection
- Perform pain management

(Goans, 2013; Cutaneous, 2015;)

Acute Radiation Syndrome (ARS)

Background Information

- Contamination ingested and incorporated throughout the body
- Contamination occurs within a few minutes following exposure
- Radiation affects the whole body, but the systems most damaged through ARS are the Hematopoietic system, the Gastrointestinal system, and the Neurovascular system.

Symptoms

- Immediate Symptoms
  - Nausea, Diarrhea, and Vomiting
- System Specific Symptoms
  - Hematopoietic System (>0.7Gy)
    - Fever
    - Malaise
    - Decreased blood cell count
    - Damage to bone marrow
  - Gastrointestinal System (10Gy)
    - Anorexia
    - Muscle obstruction
    - Malaise
    - Dehydration
    - Electrolyte Imbalance
  - Neurovascular system (>50Gy)
    - Nervousness
    - Confusion
    - Edema
    - Vasculitis
    - Meningitis
    - Convulsions
    - Coma
- Death
  - Hematopoietic – Infection, hemorrhage
  - Gastrointestinal – Infection, dehydration, and electrolyte imbalance
  - Neurovascular – Circulatory system collapse, too much pressure cranial pressure

Triage

- Expectant – expectant physical injury + >6Gy and vomiting <1 hour after exposure
- Immediate – immediate physical injury + 1-6Gy and vomiting within 1-4 hours
- Delayed – delayed physical injury + <2Gy and vomiting more than four hours OR minimal injury + 2-6Gy and vomiting within 1-4 hours
- Minimal – minimal injury + <2Gy and vomiting after more than four hours

Treatment

- Specific treatments depend on determining the radioactive element used
  - Tritium (^3H) → Water Diuresis
  - Carbon-14 → No treatment available
  - Phosphorous-32 → Phosphorous Therapy
  - Cobalt-60 → Diethylenetriamine Pentaacetic Acid (DTPA)
  - Iodine-125 → Potassium Iodide
  - Iodine-131 → Potassium Iodide
  - Cesium-137 → Prussian Blue
  - Iridium-192→ DTPA
  - Uranium-235 → Bicarbonate
  - Plutonium-239 → DTPA
  - Americium-241 → DTPA
  - Curium-247 → DTPA
  - Californium-252 → DTPA
- Therapies
  - Water Diuresis → >4L H_2O/day
  - Phosphorous Therapy → Potassium Phosphate, 250mg P/tablet, 4X/day w/water
  - Potassium Iodide → 75mg/day
  - Prussian Blue → 3g, 3X/day
  - Bicarbonate → provide orally or in an IV line
  - DTPA → IV line, 1g in 5mL, push over 3-4 minutes
- Treat the nausea, vomiting, and diarrhea
- Prevent infection and provide fluids for the patient
- If the patient presents with neurological symptoms or has a known exposure greater than 10Gy, then the patient has received a lethal dose. Death comes within 2 days to 2 weeks. Assure humane end-of-life treatment
  - Provide pain management
  - Provide psychological care
  - Provide religious support as requested by the patient
- Treat any blast, thermal, or eye injuries as needed

(Acute, 2015; Goans, 2013; Mayo Clinic, 2015; Pae, 2017)

Public Health Response

Following an incident with a nuclear agent, establish a surveillance system to monitor the cancerous outcomes of the incident. Additionally, monitor for cataracts, hyperparathyroidism, and T-cell and B-cell response reduction. Finally, monitor for severe birth defects such as microcephaly, mental retardation, developmental delays, and lower IQ scores.

After an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with a nuclear or radiological agent. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial decontamination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

Following any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Goans, 2013)

Part Four: Explosive Agents

Explosive agents involve the detonation of "any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion" (OSHA). With the detonation of an explosive agent, there will be an accompanying release of heat, light, and/or fire. There can also be an expulsion of gas along with the blast itself. Explosive agents can include but are not limited to "dynamite, nitroglycerin, picric acid, lead azide, fulminate of mercury, black powder, blasting caps, and detonating primers" (OSHA). Effects from explosions can include burns, injuries (especially to the eyes), and death as well as causing panic and disruption in the normal flow of society. (OSHA; Ritenour & Baskin, 2008)

In this section of the manual the injuries surrounding blast injuries will be examined through the background information, symptoms, triage, treatment, and public health response

Blast Injuries

Background Information

- Blast injuries are categorized into four different levels of trauma
  - Primary – injuries from the blast wave
  - Secondary – injuries from the fragmentation of the explosive device
  - Tertiary – injuries from blunt trauma
  - Quaternary – burns, toxins, and/or radiation
- A blast wave can travel at 3000 to 8000m/sec
- A blast wave causes injuries in the eyes, ears, lungs, intestines, cardiovascular system, and brain
- People close to the blast epicenter die instantaneously and injuries radiate and dissipate outward from the blast area.

Symptoms

- Ocular effects – lacerations of eyelids and cornea, bursting the globe, orbital fractures
- Aural effects – rupture of the tympanic membrane, hearing loss, tinnitus, dizziness
- Lung effects – parenchymal hemorrhage, pulmonary edema, air embolism, respiratory distress, hypoxia,
- Intestinal effects – (these are rare) contusions, intramural hemorrhages, perforations, mesenteric vessel tears, possible rupture of the spleen, liver and kidney
- Cardiovascular effects – contusions, bradycardia, hypotension, apnea, hemorrhage
- Neurological effects – cracks in the skull, air embolism, PTSD, attentional disfunction, "excitability, irrationality, retrograde amnesia, apathy, lethargy, poor concentration, insomnia, psychomotor agitation, depression, anxiety, fatigue, headache, back and diffuse pains, vertigo, transient paralysis, and "heavy" feeling extremities

Triage

- Expectant – transcranial laceration, uncontrolled bleeding from pelvic injury, severe burns, high spinal cord injuries
- Immediate – severe hemorrhage, possible loss of limb, torso, neck, or pelvis injuries
- Delayed – tertiary effects, fractures, any injuries without profuse bleeding
- Minimal – lacerations, abrasions, small fractures, minimal burns

Treatment

- Treat patients according to current trauma protocols
- Use fluid resuscitation strategies to revive a patient
- Perform resuscitative measures to increase cardiovascular activity
- Protect the eyes and provide rapid transport to medical care
- Do not put any pressure on the eye
- Avoid positive pressure ventilation for respiratory effects

- Bowel rest and surgical measures where necessary
- Treat brain injuries according to standard protocol, provide psychological counselling for any needs
- Treat any other secondary, tertiary, or quaternary injuries experienced by the victim

Public Health Response

In combat situations assure that each soldier has proper eye and ear protection as well as body armor with a helmet. Assure proper protocols for site containment following an explosion to reduce the number of secondary injuries. Provide resources for people to contact families or friends.

Following an incident, many individual members of the community may need psychological support. Community members can experience physical effects, behavioral changes, emotional changes, and cognitive changes. A First Responder should encourage positive coping mechanisms such as constructive health practices, regular exercise, rest, healthy food, and the company of supportive family and friends. Encourage community members to avoid substance abuse as a coping mechanism.

The psychological profile of the community is important following an incident with an explosion. As a first responder, provide a calm reassuring face to the community members through the initial phases of the disaster. Focus on effective solutions with public outreach to help mitigate the effects of the incident and show the community how to recover and rebuild.

Each first responder should monitor their stress levels and that of their co-workers. Arrange time to speak with a psychological counselor immediately following an incident. Schedule a medical examination to assure physical well-being following an incident.

Following the initial examination of patients, it is imperative that law enforcement officials are allowed to investigate the scene. In assisting in the investigation, assure that access to the site is controlled through proper checkpoints and identification logging. Assist the law enforcement personnel in securing the evidence which should be bagged, sealed, and labeled appropriately. Create a system to record the evidence, the custody, movement, and storage of the evidence.

After any incident, assure that the After-Action Report (AAR) is completed. The AAR should include feedback on what was done right, what was done wrong, and what should be improved in the future.
(Alibek, 2005; Morely et. al., 2010; Ritenour & Baskin, 2008)

Personal Protection Equipment (PPE)

Table 8

Personal Protective Equipment			
Level	**Respiratory**	**Skin**	**Scenario**
A	Pressure-demand, full face shield	Fully Encapsulated Chemical-Resistant Suit	Unknown Agent
	Self-Contained Breathing Apparatus	Gloves and boots that are resistant to Chemical Agents	Significant Hazard
B	Pressure-demand, full face shield	Clothing resistant to Chemical Agents with a hood	Known Agent that necessitates respiratory protection
	Self-Contained Breathing Apparatus	Gloves and boots that are resistant to Chemical Agents	Atmosphere contains less than 19.5% Oxygen
C	Air purfying respirator	Clothing resistant to Chemical Agents with a hood	The agent can be removed from the environment by the respirator
	Full or medium faceplate	Gloves and boots that are resistant to Chemical Agents	Non-threatening agent and no absorbtion occurs
			Atmosphere contains more than 19.5% oxygen
D	None	Regular Uniform	No known hazard

(Alibek, 2005; Balali-Mood, et.al., 2014)

Assure that each responder has a Geiger Counter during radiation emergencies

Donning and Doffing PPE

Steps to **put on** personal protective equipment (PPE) including **gown**

1 Remove all personal items (jewelry, watches, cell phones, pens, etc.)

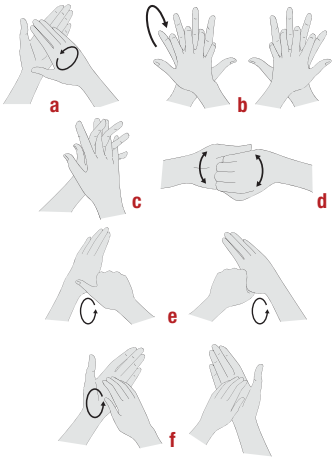
2 Put on scrub suit and rubber boots[1] in the changing room.

3 Move to the clean area at the entrance of the isolation unit.

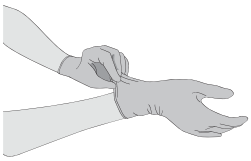
4 By visual inspection, ensure that all sizes of the PPE set are correct and the quality is appropriate.

5 Undertake the procedure of putting on PPE under the guidance and supervision of a trained observer (colleague).

6 Perform hand hygiene.



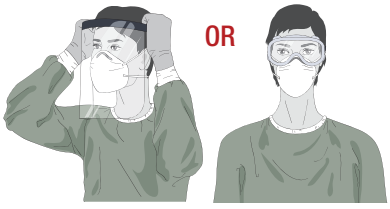
7 Put on gloves (examination, nitrile gloves).



8 Put on disposable gown made of fabric that is tested for resistance to penetration by blood or body fluids OR to blood-borne pathogens.

9 Put on face mask.

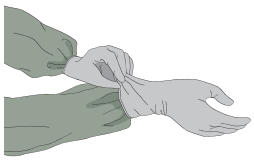
10 Put on face shield OR goggles.



11 Put on head and neck covering surgical bonnet covering neck and sides of the head (preferable with face shield) OR hood.

12 Put on disposable waterproof apron (if not available, use heavy duty, reusable waterproof apron).

13 Put on second pair of (preferably long cuff) gloves over the cuff.



1 If boots are not available, use closed shoes (slip-ons without shoelaces and fully covering the dorsum of the foot and ankles) and shoe covers (nonslip and preferably impermeable)

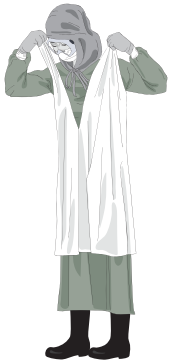
World Health Organization

Steps to **take off** personal protective equipment (PPE) including **gown**

1 Always remove PPE under the guidance and supervision of a trained observer (colleague). Ensure that infectious waste containers are available in the doffing area for safe disposal of PPE. Separate containers should be available for reusable items.

2 Perform hand hygiene on gloved hands.[1]

3 Remove apron leaning forward and taking care to avoid contaminating your hands. When removing disposable apron, tear it off at the neck and roll it down without touching the front area. Then untie the back and roll the apron forward.



4 Perform hand hygiene on gloved hands.

5 Remove outer pair of gloves and dispose of them safely.
Use the technique shown in Step 17

6 Perform hand hygiene on gloved hands.

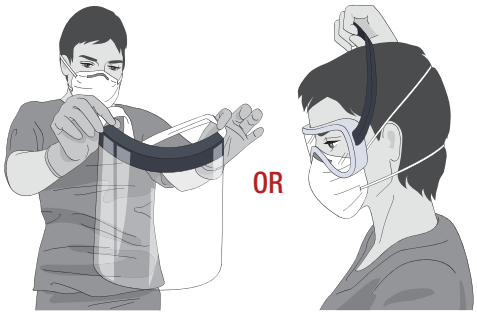
7 Remove head and neck covering taking care to avoid contaminating your face by starting from the bottom of the hood in the back and rolling from back to front and from inside to outside, and dispose of it safely.

8 Perform hand hygiene on gloved hands.

9 Remove the gown by untying the knot first, then pulling from back to front rolling it from inside to outside and dispose of it safely.

10 Perform hand hygiene on gloved hands.

11 Remove eye protection by pulling the string from behind the head and dispose of it safely.



12 Perform hand hygiene on gloved hands.

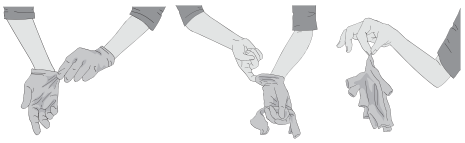
13 Remove the mask from behind the head by first untying the bottom string above the head and leaving it hanging in front; and then the top string next from behind head and dispose of it safely.

14 Perform hand hygiene on gloved hands.

15 Remove rubber boots without touching them (or overshoes if wearing shoes). If the same boots are to be used outside of the high-risk zone, keep them on but clean and decontaminate appropriately before leaving the doffing area.[2]

16 Perform hand hygiene on gloved hands.

17 Remove gloves carefully with appropriate technique and dispose of them safely.



18 Perform hand hygiene.

1 While working in the patient care area, outer gloves should be changed between patients and prior to exiting (change after seeing the last patient)

2 Appropriate decontamination of boots includes stepping into a footbath with 0.5% chlorine solution (and removing dirt with toilet brush if heavily soiled with mud and/or organic materials) and then wiping all sides with 0.5% chlorine solution. At least once a day boots should be disinfected by soaking in a 0.5% chlorine solution for 30 min, then rinsed and dried.

World Health Organization

WHO/HIS/SDS/2015.3

Steps to **put on** personal protective equipment (PPE) including **coverall**

1 Remove all personal items (jewelry, watches, cell phones, pens, etc.)

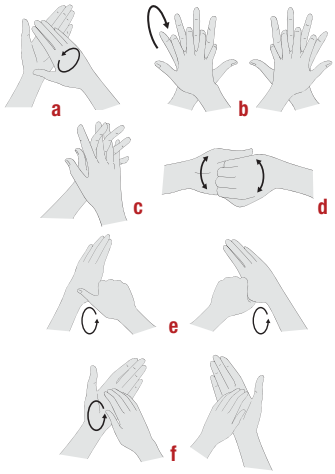
2 Put on scrub suit and rubber boots[1] in the changing room.

3 Move to the clean area at the entrance of the isolation unit.

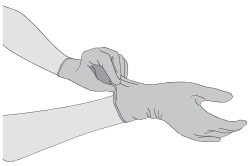
4 By visual inspection, ensure that all sizes of the PPE set are correct and the quality is appropriate.

5 Undertake the procedure of putting on PPE under the guidance and supervision of a trained observer (colleague).

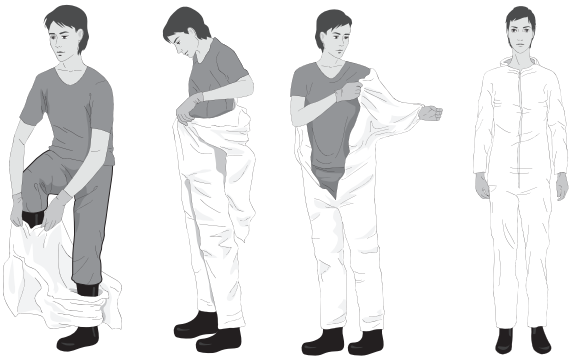
6 Perform hand hygiene.



7 Put on gloves (examination, nitrile gloves).

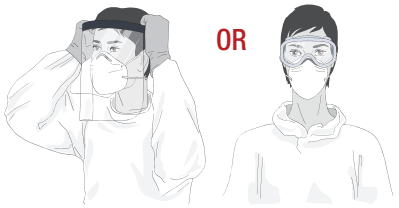


8 Put on coverall.[2]



9 Put on face mask.

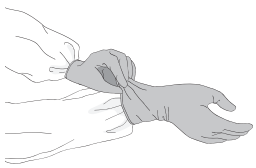
10 Put on face shield OR goggles.



11 Put on head and neck covering surgical bonnet covering neck and sides of the head (preferable with face shield) OR hood.

12 Put on disposable waterproof apron (if not available, use heavy duty, reusable waterproof apron).

13 Put on second pair of (preferably long cuff)[2] gloves over the cuff.



1 If boots are not available, use closed shoes (slip-ons without shoelaces and fully covering the dorsum of the foot and ankles) and shoe covers (nonslip and preferably impermeable)

2 Do not use adhesive tape to attach the gloves. If the gloves or the coverall sleeves are not long enough, make a thumb (or middle finger) hole in the coverall sleeve to ensure that your forearm is not exposed when making wide movements. Some coverall models have finger loops attached to sleeves.

World Health Organization

Steps to **take off** personal protective equipment (PPE) including **coverall**

1 Always remove PPE under the guidance and supervision of a trained observer (colleague). Ensure that infectious waste containers are available in the doffing area for safe disposal of PPE. Separate containers should be available for reusable items.

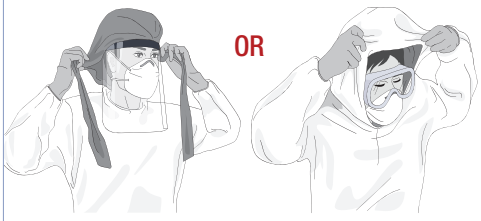
2 Perform hand hygiene on gloved hands.[1]

3 Remove apron leaning forward and taking care to avoid contaminating your hands.

When removing disposable apron, tear it off at the neck and roll it down without touching the front area. Then untie the back and roll the apron forward.

4 Perform hand hygiene on gloved hands.

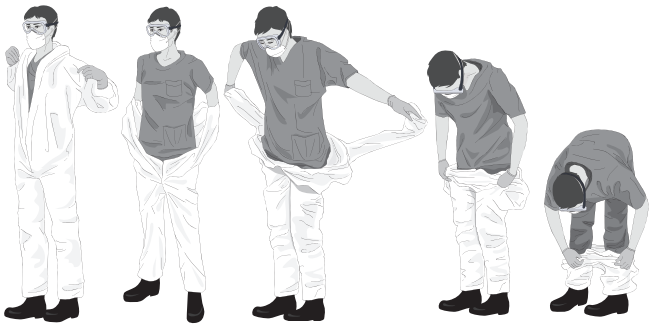
5 Remove head and neck covering taking care to avoid contaminating your face by starting from the bottom of the hood in the back and rolling from back to front and from inside to outside, and dispose of it safely.



6 Perform hand hygiene on gloved hands.

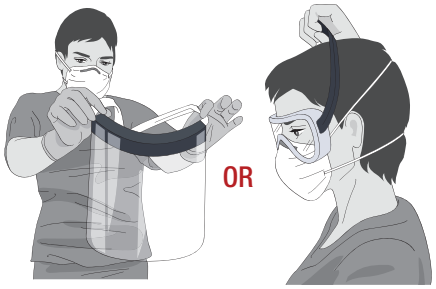
7 Remove coverall and outer pair of gloves:

Ideally, in front of a mirror, tilt head back to reach zipper, unzip completely without touching any skin or scrubs, and start removing coverall from top to bottom. After freeing shoulders, remove the outer gloves[2] while pulling the arms out of the sleeves. With inner gloves roll the coverall, from the waist down and from the inside of the coverall, down to the top of the boots. Use one boot to pull off coverall from other boot and vice versa, then step away from the coverall and dispose of it safely.



8 Perform hand hygiene on gloved hands.

9 Remove eye protection by pulling the string from behind the head and dispose of it safely.



10 Perform hand hygiene on gloved hands.

11 Remove the mask from behind the head by first untying the bottom string above the head and leaving it hanging in front; and then the top string next from behind head and dispose of it safely.

12 Perform hand hygiene on gloved hands.

13 Remove rubber boots without touching them (or overshoes if wearing shoes). If the same boots are to be used outside of the high-risk zone, keep them on but clean and decontaminate appropriately before leaving the doffing area.[3]

14 Perform hand hygiene on gloved hands.

15 Remove gloves carefully with appropriate technique and dispose of them safely.

16 Perform hand hygiene.

1 While working in the patient care area, outer gloves should be changed between patients and prior to exiting (change after seeing the last patient)

2 This technique requires properly fitted gloves. When outer gloves are too tight or inner gloves are too loose and/or hands are sweaty, the outer gloves may need to be removed separately, after removing the apron.

3 Appropriate decontamination of boots includes stepping into a footbath with 0.5% chlorine solution (and removing dirt with toilet brush if heavily soiled with mud and/or organic materials) and then wiping all sides with 0.5% chlorine solution. At least once a day boots should be disinfected by soaking in a 0.5% chlorine solution for 30 min, then rinsed and dried.

World Health Organization

(WHO, 2015)

Decontamination

Chemical Agents

- Personal Decontamination
  - Doff PPE and/or clothing
  - Use soap and water to wash the body
    - High volume of water with low pressure
    - Fat-based soap
  - Put flour on the skin and remove it with wipes or moist tissues
  - Rinse the eyes with 0.9% saline solution
  - Vigorously wash the hair
- Wound Decontamination
  - Remove the bandages
  - Wash the wound with sterilized water or 0.9% saline

(Alibek, 2005; Balali-Mood et.al., 2016; Banks, 2014)

Biological Agents

- Personal Decontamination
  - Soap and Water for general decontamination
  - 0.5% hypochlorite solution (1:9 bleach to water)
- Equipment Decontamination
  - 5% hypochlorite solution
    - This is an extremely corrosive solution; use caution at all times
    - Rinse each piece of equipment with water after sterilization with hypochlorite
  - Heat
    - 2 hours at 160°C
    - Sunlight and solar radiation kill most biological agents

(Alibek, 2005; Zygmunt, 2011)

Radiological Agents

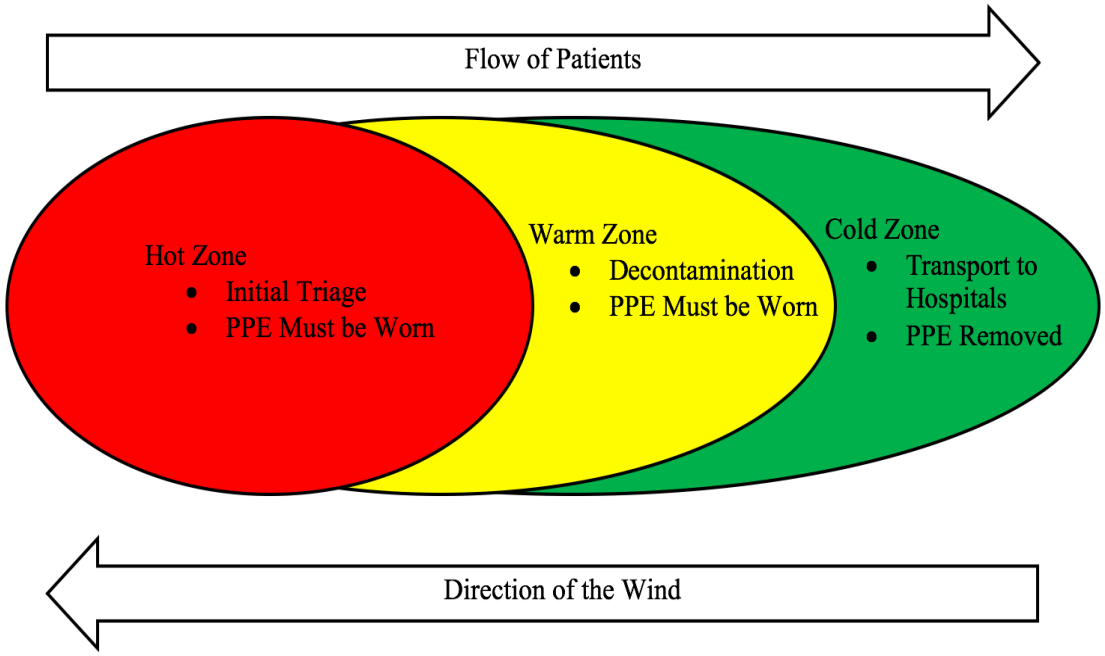
- Examine the patient with a Geiger Counter to find the contamination
- Remove radioactive objects with forceps and place them in lead-lined boxes
- Remove contaminated clothing and shoes
  - Cut and roll the clothing away from the face
  - Place clothing in bags tagged and designated for radioactive materials
- Wash wounds with water or 0.9% saline solution
- Wash the face, eyes, nose, ears, and mouth with water or 0.9% saline solution
- Wash the skin with soap and water (starting at the outside of the contaminated area and working towards the center)
- Repeat until radiation levels are at most 2 times more than normal

(Goans, 2013; Cutaneous, 2015)

On-site Decontamination

- Hot Zone – site directly affected by a chemical, biological, or radiological agent
  - Perform initial triage here
  - Response teams must have PPE on at all times
  - This includes the all directions minimum evacuation zone (Annex Four)
- Warm Zone – site that is contaminated by the egress of workers from the hot zone
  - Personal and victim decontamination takes place here
  - Response teams must have PPE on at all times until moving out of the warm to the cold zone
- Cold Zone – site completely free from any contamination
  - Begin transportation to hospitals
  - PPE is not needed in this area

Figure 3: On-site Flow



(Alibek, 2005; Balali-Mood et.al., 2016; Banks, 2014)

Annexes

Annex One: How to Distinguish between a Natural Outbreak and a Biological Attack
Annex Two: Public Health Measures for Protection and Control
Annex Three: Evacuation Distances
Annex Four: CBRNE Images

Annex One: How to Distinguish between a Natural Outbreak and a Biological Attack

- Strange increase in the number of cases in humans and animals simultaneously OR a zoonotic disease that occurs in humans but not in animals
- Abnormally high rates of infection (60% to 90%)
- An outbreak of a rarely seen disease in a novel population
- Symptoms that are more severe than normally occur for a specific illness
- A sickness that affects a group or age that is normally not affected
    - A sickness that normally affects babies and the elderly is now killing young adults
- A vector borne disease is being spread without evidence of the vector
- Unusual strains of bacteria
- The sickness is highly localized, OR the sickness begins in multiple areas
- There is "direct evidence of an attack, such as contaminated or unexploded munitions"

(Cubano, 2014, p. 345; Zygmunt, 2011)

Annex Two: Public Health Measures for Protection and Control

Chemical Agents

- Protection – use appropriate PPE
- Distance – evacuate unaffected people to the minimum safe distance (Annex Four)
- Time – minimize the time anyone (including responders) is exposed to the chemical
- Decontamination – thorough and exhaustive decontamination of the site and victims
- Rapid Treatment – be prepared beforehand for an attack

(Alibek, 2005; Balali-Mood et.al., 2016; Banks, 2014)

Biological Agents

- Maintain a Level of Suspicion
- Use appropriate PPE during a situation
    - Generally Level C or above (Surgical Mask)
    - Perform appropriate prophylaxis
    - Administer vaccines to responders
- Decontaminate the site and the victims
    - Soap and Water are usually sufficient for patient decontamination
    - 0.1% bleach solution is sufficient to eliminate all pathogens
    - Do not destroy evidence of criminal activity for law enforcement authorities
- Develop the ability to rapidly diagnose, respond to, and treat victims
- Perform proper infection control
- Protect the community through transparent sharing of information

(Alibek, 2005; Zygmunt, 2011)

Radiological Agents

- Protection – Use lead barriers and PPE
- Distance – increase the distance between people and the radioactive material
- Time – minimize the exposure time to the radioactive material

(Goans, 2013; Pae, 2017)

Annex Three: Evacuation Distances

Table 9: Minimum Evacuation Distances

Minimum Evacuation Distances				
	Agent and Exposure	All Directions	Down Wind - Day	Down Wind - Night
Chemical Agents	Nerve Agent - Low	65m	0.5km	1.15km
	Nerve Agent - High	400m	2.1km	4.9km
	Cyanide - Low	65m	0.35km	1.0km
	Cyanide - High	950m	3.7km	8.6km
	Pulmonary Intoxicants - Low	155m	0.8km	3.3km
	Pulmonary Intoxicants - High	950m	10km	12+km
	Vesicants - Low	65m	0.5km	0.8km
	Vesicants - High	305m	1.8km	2.8km
	Irritants - Low	30m	0.2km	0.5km
	Irritants - High	120m	1.2km	3.3km
	Incapacitating Agents - Low	30m	0.1km	0.5km
	Incapacitating Agents - High	60m	0.5km	2.0km
	Biological Agents	100m	300m	300m
	Radiological Agents	300m	100m	100m

(Emergency, 2012; WISER, 2013)

Annex Four: CBRNE Images

Figure 4: Chemical Symbols

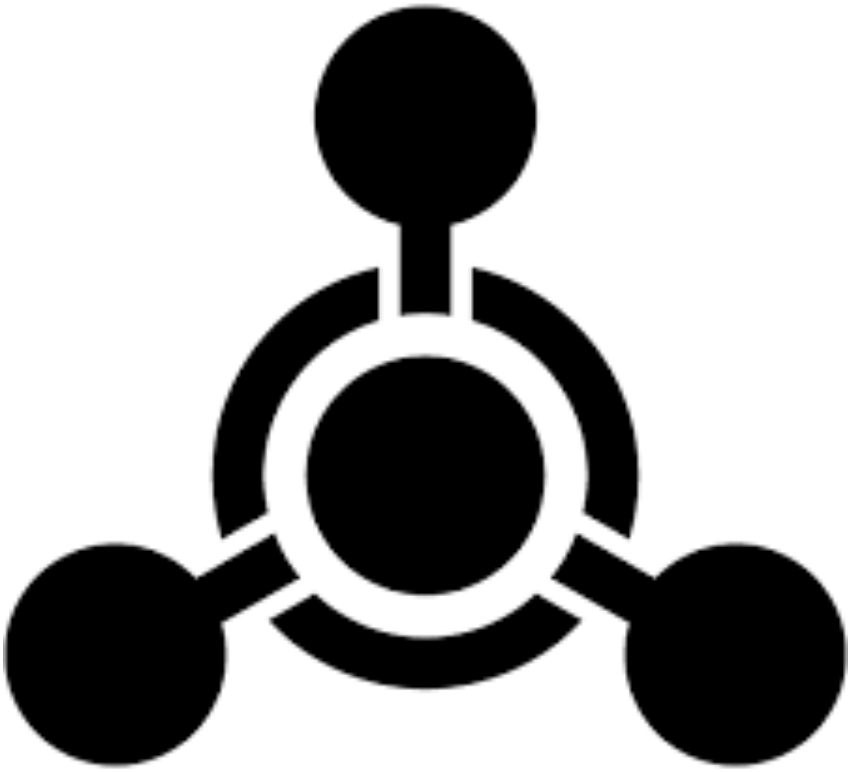


Figure 5: Biological Hazard Symbol

Figure 6: Radiation Symbol

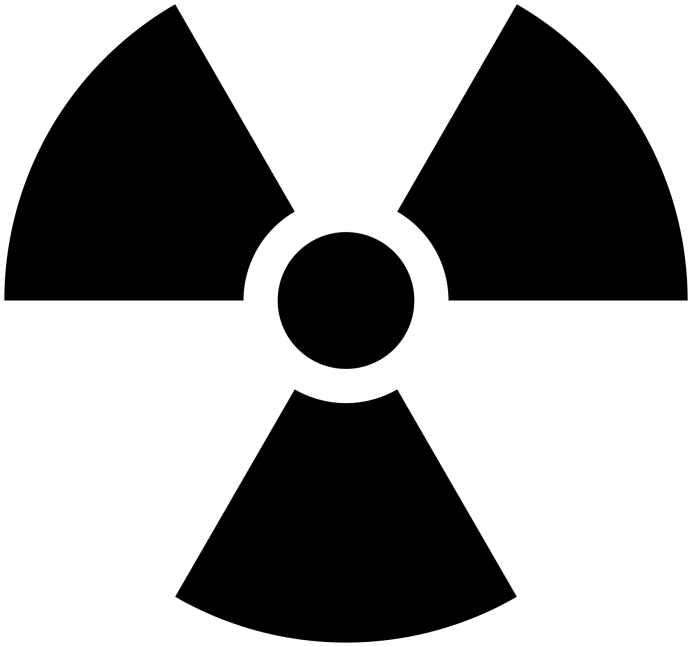


Figure 7: Explosive Symbol

Chapter Five: Discussion, Conclusion, & Next Steps

Discussion

There are three important lessons from this project that constitute the value added. First, it is important to have an all-scenario approach to CBRNE incidents. Second, combining medical aid with public health efforts provides a comprehensive response framework following a CBRNE incident. Third, performing public health efforts immediately following a CBRNE incident provides many short-term as well as long-term benefits for overall recovery. These lessons should help to integrate public health efforts into response systems in the future.

As was discussed earlier in this work, CBRNE agents can be disseminated in a variety of different scenarios. These CBRNE incidents require specific response patterns regardless of how or why a population was exposed to an agent. Therefore, it is imperative that military or civilian first responders have an all-scenario mindset. This will allow for a broader perspective of response, rather than solely for acts of terrorism. This can include scenarios such as the Bhopal, India pesticide release which killed and/or affected thousands of people, the accidental exposure of cholera in Haiti, the Fukushima Daiichi reactor malfunction after the earthquake, or the Deepwater Horizon explosion. Each of these scenarios involves a CBRNE agent, but none of them had malicious intent behind the exposure. By creating an all-scenario preparation plan, CBRNE specialists will be able to lend aid in a much broader range of disasters.

Combining medical aid with public health efforts establishes a more comprehensive response framework following CBRNE incidents. Most handbooks and manuals only present information on medical response to a CBRNE incident and public health efforts are either not included or are contained in an annex. This manual integrates

public health efforts into the medical response. By doing so, this manual creates a comprehensive approach to an all-scenario system following exposure to CBRNE agents. Therefore, as CBRNE specialists come to the aid of victims, their automatic efforts will include both medical and public health efforts. These efforts will have far reaching consequences in a broad range of incidents involving a CBRNE agent.

Integrating public health efforts into the initial response yields short-term and long-term benefits to the exposed and affected population. In the short-term, the public health efforts provide for the protection of the responders through appropriate PPE as well as protection from over-exposure to the scene following a CBRNE incident. Moving into the long-term benefits, the effective public health communication and interaction with the community aids the population to purposeful recovery. This includes aiding law enforcement in their investigation of the situation as well as aiding those affected to make healthy recovery choices. The public health response also invites first responders to participate in the after-action report. The ARR helps responders know what was done well and informs leaders on areas of improvement. Additionally, CBRNE specialists will have the tools to be a public face of the response to provide competent reassurance to affected community. They can show the community how to rebuild and recover in addition to providing medical care.

These lessons are integral in creating a comprehensive framework for CBRNE response. By recognizing the need for all-scenario preparation and adding in public health efforts, CBRNE first responders should be able to assist in a broader range of incidents and provide great depth of care within each scenario. These lessons will add value and depth to the overall competency first responders working in CBRNE incidents.

Conclusion

While this project began in Panama, it has grown from there to assist a broader global community in CBRNE response. By building upon work that has been done in the past and combining many elements of other work, this project will help responders going forward with an all-scenario response by including both medical and public health efforts. By including both elements into the response pattern for each agent in the manual, first responders will automatically include the public health efforts into each incident.

Incidents involving chemicals, biological agents, radioactive materials, or explosions are often catastrophic and require efficient response in order to completely recover. First responders need to be trained in the aspects of response including medical aid as well as public health efforts. By doing so, responders can mitigate the clinical effects of exposure to an agent as well as aid in the overall recovery of the community.

The manual itself serves as a field guide for responders who have had CBRNE response training in the past. It is to be used during incidents to guide the response pattern through treating victims as well as providing for the well-being of all those affected by the incident. When used appropriately, the manual will supplement the information already learned through previous training courses. Responders will be able to diagnose signs and symptoms of an agent, perform appropriate triage, and provide competent care to the victims all while being leaders in the path to recovery through public health efforts.

Next Steps

There are three next steps that would further increase the value of this project. The first step I would take would be to continue to refine the project itself. As with any project, this one needs continued reviewing and revising to be even better. The process of revision takes me to the next step I would take. I want to review all of this material with a CBRNE subject matter expert. I want to make sure that the changes I suggest in this document are feasible for use in the field. And finally, with the idea of working in the field I arrive at the third step I would take. I would work to condense the medical and public health information presented in this manual into a pocket guide for use during an incident. With these three changes, this project would take on even greater value.

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