Biological Threats:

A Practical Assessment for the Occupational Health Department

by

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ABSTRACT

Bioterrorism is a term that every person has had to come to grips with since the events of September 11, 2001. Industry has also had to take a hard look at how to be prepared for this new threat. The occupational and environmental health nurse (OEHN) has a unique opportunity to bridge the gap between the concerns of industry and the community. The OEHN must have an in-depth knowledge of the top five biological agents that may be used in a terrorist attack and an explicit understanding of the occupational and environmental health nurse's roles and responsibilities. Beginning in January 2003, an assessment tool was developed to assess a large semiconductor company's occupational health department's preparedness in three major geographical regions. This tool, using the System's Theory (Rogers, 1994), thoroughly assessed the factors influencing the occupational health department. The results are the first step in understanding where improvements are needed so industry can be better prepared in the event of a bioterrorist attack.

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CHAPTER 1

INTRODUCTION

The goal of terrorism is to intimidate a population. Unfortunately, there are groups of people around the world that feel that terrorism is an appropriate tool to get their "messages" heard, and industry must be prepared for this eventuality. Since September 11, 2001 and the subsequent anthrax attacks in the fall of 2001, all federal, state, and local governments have enhanced their emergency preparedness plans. During the same time many industries have examined their emergency plans and developed terrorist threat preparedness. Bioterrorism threat preparedness is a subset of these plans because it has a very unique feature: bioterrorism can be unleashed without anyone's knowledge. This is different from a plane being flown into a building or a release of chemical agents because when these events happen they are recognized immediately as a public health disaster. Many of the biological threats have incubation periods of two to six days so a release can occur and not be recognized until a sufficient number of cases have developed.

The Centers for Disease Control and Prevention (CDC) have categorized the biological threats into three categories (2003a).

> Category A: The United States (U.S.) public health system and primary healthcare providers must be prepared to address various biological agents, including pathogens that are rarely seen in the

U.S. High-priority agents include organisms that pose a risk to national security because they

- can be easily disseminated or transmitted from person to person;
- result in high mortality rates and have the potential for major public health impact;
- might cause public panic and social disruption; and
- require special action for public health preparedness.

Examples: Anthrax, Botulism and Tularemia

Category B: Second highest priority agents include those that

- are moderately easy to disseminate;
- result in moderate morbidity rates and low mortality rates; and
- require specific enhancements of CDC's diagnostic capacity and enhanced disease surveillance.

Examples: Brucellosis, Glanders, and Ricin Toxin

Category C: Third highest priority agents include emerging pathogens that could be engineered for mass dissemination in the future because of

- availability;
- ease of production and dissemination;

- and potential for high morbidity and mortality rates and major health impact.

Examples: Nipah Virus and Hantavirus.

Using these prioritized categories of bacterial agents, the occupational and environmental health nurse (OEHN) must increase his/her knowledge of these known potentially dangerous agents of terrorism.

The role of the OEHN is varied and complex. Many factors influence response to a threat such as bioterrorism. The fundamental roles of planner, educator, and emergency responder must be explored to create an effective preparedness plan for the occupational health department.

Many corporations have extremely robust and comprehensive emergency preparedness plans. The occupational health department of a large semiconductor company began exploring biological threat preparedness as part of the corporation's business plan in the summer/fall of 2002. A preparedness evaluation was conducted in the spring of 2003. An administrative tool was developed so that it could be used by each of the 25 occupational health clinics within this corporation. The goal was to provide the clinics with an understanding of their individual clinic biological threat preparedness.

CHAPTER 2

BIOLOGICAL THREAT PROFILES

Each bacterial biological agent has a unique disease profile. These profiles must be understood to ensure preparedness for a biological event. The top five bacterial agents are Smallpox, Anthrax, Tularemia, Plague, and Botulism. Each agent will be reviewed including its history, transmission/communicability, signs and symptoms, infection and exposure control, prevention or prophylaxis, and treatment.

Smallpox

History

Smallpox is an infectious disease caused by the variola virus. The term smallpox comes from the Latin word for "spotted" because the lesions cover the patient's face and body. Although the first classification of the disease, later to be called smallpox, appeared in a fourth century Chinese text, it was not until the 15th century that Europeans, in an effort to distinguish variola from the great pox (syphilis), began using the term smallpox. For both cultures, this disease spread quickly and wiped out thousands during the years before it was contained. By the eighth century, China and India had attempted vaccinations for smallpox, but it was not until 1796 that the first modern attempt to vaccinate against smallpox was performed by Edward Jenner. He proved that smallpox could be prevented by inoculation of a person with material from a cowpox lesion (CDC, 2002c). This breakthrough turned the tide of the epidemic

and in 1980, following a 24 year intensive global eradication program, smallpox was declared "globally eradicated" by the World Health Organization (WHO). Through the use of vaccination, detection, and isolation, the last United States case of smallpox was reported in Texas in 1949 and the last natural smallpox case was in Somalia in October of 1977.

Currently the only known sources of the variola virus can be found either at the Centers for Disease Control and Prevention (CDC) in Atlanta, or at the State Research Center of Virology and Biotechnology in Koltsovo, Russia (CDC, 2002c). It is feared, however, that other countries or terrorists groups have obtained a supply of the variola virus. Smallpox is a bioterrorism threat for two reasons: 1) it has the potential to cause severe morbidity in a non-immune population, and 2) it can be spread via an airborne route (English, 1999).

The variola virus is a member of the genus Orthopoxvirus, family Poxviradae (CDC, 2002c). There are two clinical forms of smallpox: variola minor and variola major. Variola minor is a less severe disease with a fatality rate of <1%. Variola major is divided into four clinical presentations based on the Rao classification of 1972. The four different types are identified by skin lesions: ordinary, modified, flat/malignant, and hemorrhagic. *Ordinary* is the most common, occurring in 90% of all cases. *Modified,* also common, is usually seen in previously vaccinated

patients. The two rarest and severest types of smallpox *Flat/Malignant* and *Hemorrhagic* are usually fatal (CDC, 2002c).

Mode of Transmission/Communicability

Smallpox's mode of transmission is by both large and small respiratory droplets, either aerosolized artificially or from a human host. There are no known natural hosts of the virus. The droplets can originate from oral, nasal, or pharyngeal mucosa of a person who is in the communicable stages of smallpox. Although very rare, the chance of skin lesion transmission of smallpox is possible. Face-to-face contact, either within a household or at a health care facility, can result in disease transmission. "Household secondary attack rates are generally 50% to 60%" (CDC, 2002c, p. 235), meaning that those within the same household get infected approximately 50% to 60% of the time by just being in the proximity of a smallpox patient.

The incubation period for smallpox is from 7 to 17 days but is usually about 12 to 14 days. During this time the patients, while not contagious, may not have symptoms and may actually feel well.

The patients become infectious when the lesions start to develop in the mouth and pharynx. They remain contagious throughout the course of the illness, until the last lesion has separated and fallen from the skin. Because it is sometimes difficult to observe the rash inside the mouth and on the pharynx, disease transmission can occur before overt signs of smallpox develop. These eruptions can begin to occur late in the initial or

prodromal stage of smallpox. It must be assumed that smallpox patients are contagious within 24 to 48 hours of symptom onset.

Signs & Symptoms

All four types of variola major have the same initial symptoms which include: acute onset of fever ≥ 101°F, malaise, headache, muscle pain, nausea, vomiting, and backache. These non-specific symptoms can be confused with any number of other conditions. The patients are usually quite ill and are not able to perform normal activities. This initial phase usually lasts between two to four days but communicability is unclear unless lesions begin developing in the oral or pharyngeal membranes. During this initial phase, the four different types of smallpox diverge.

Ordinary

The macules, small localized changes in the color of the skin that is neither raised nor depressed, occur two to four days after the onset of fever. The first spots known as "herald spots" usually occur on the face. Within 24 hours all parts of the body become covered from the proximal extremities working outward to the distal extremities. The rash is pervasive and can even cover the palms of the hands and soles of the feet. It develops all at once, with each area of the body being at the same phase at the same time. The rash also is more densely populated distally, having more lesions on the extremities than on the trunk. These two unique characteristics help separate this rash from that of the common Varicella or Chickenpox.

By day three of the rash, the macules convert to papules which are solid rounded bumps. By day five, the papules change into vesicles which are small blisters that become "opaque and turbid" (CDC, 2002c) within 48 hours. At this stage "umbilication" occurs. The middle of the vesicle (and eventually the pustule) becomes depressed giving the lesion the appearance of having an umbilicus. This umbilication is uncommon in other vesicular or pustular rashes. By day seven of the rash, all of the vesicles become pustules. These pustules are typically raised and very firm to the touch. They are described as being "shotty" as if upon palpation they are filled with small pellets or "gun shot" (CDC, 2002a). Around day 14 of the rash, all of the pustules should have a scab, with some even separating and falling from the skin. *Confluent* smallpox, a subcategory of the ordinary group, occurs when the pustular lesions are so extensive and numerous that they cover large portions of the face and extremities. The smaller lesions actually merge to become one large lesion.

The presence of a fever and symptom severity depends on the clinical eruption of the rash. The more lesions are present, the more grave the prognosis. The overall fatality rate of *ordinary* smallpox is 30% with the *ordinary confluent* type of smallpox having a fatality rate of 62% (CDC, 2002c).

Modified

Modified smallpox occurs most often in those patients who have been previously vaccinated. The prodromal phase is less severe but has all the same signs and symptoms of *ordinary* smallpox. The lesions tend to develop quicker, with less uniformity and are fewer in number. This variola form usually progresses quickly and is rarely fatal.

Flat/Malignant

The prodromal phase is more severe, but again has the same symptoms as both the *ordinary* and *modified*. It lasts up to four days with the oral rash becoming extensive. By the seventh day of the rash, the lesions flatten out and are filled with less fluid than the *ordinary* type of smallpox. The umbilication of the vesicles is absent and the lesions feel velvety, soft to the touch, and may contain blood. Most cases of *flat* smallpox are fatal (CDC, 2002c).

Hemorrhagic

Hemorrhagic signs can occur either early or late in the course of the disease. The prodomal phase can be prolonged with additional symptoms of dusky flesh and sepsis. Bleeding from the mouth and gums, subconjunctiva, epistaxis, and hematuria can occur at any time. By the seventh day death usually occurs. If patients survive to the tenth day, the rash remains as flat vesicles and never progresses to the pustule phase. Little is known about further rash progression because most patients die

within ten days.

Infection and Exposure Control

Any suspected case of smallpox is considered a public health emergency and must be reported to the health department in the local area. Patient isolation, both respiratory and contact, is critical to prevent secondary transmission. All persons having contact with patients must use proper personal protective equipment such as properly fitted respirators of N95 or higher, disposable gloves, gowns, eye protection, and shoe covers. Reusable bedding and clothing can be autoclaved and reused but all other material must be disposed of as hazardous biological waste.

Within an institutional setting it is important that rooms inhabited by smallpox patients not share the same ventilation system as the rest of the hospital. Droplets are easily airborne and can travel through the ventilation system.

Prevention or Prophylaxis

Global vaccination against smallpox officially stopped after WHO declared the disease eradicated in 1980. Before September 11, 2001, vaccinations were only recommended for laboratory workers who came in contact with variola and military personnel. As of January 11, 2003, the Office for Homeland Security released its vaccination recommendation to include "Public health, hospital, and other personnel, generally 18-65

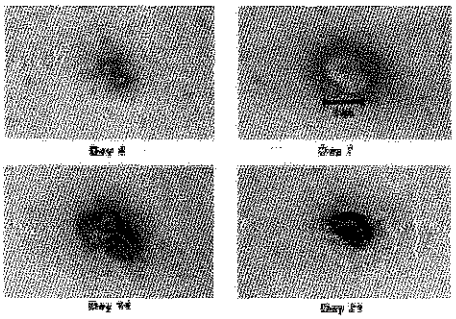
years of age, who may respond to a smallpox case or outbreak" (Department of Health and Human Services, 2003, p. 1).

The smallpox vaccine is created from the live virus *vaccinia* which is similar to variola but less severe. The vaccination lasts anywhere from three to five years for the first immunization with longer protection for subsequent vaccinations (CDC, 2002b).

Smallpox vaccine is administered differently than the typical vaccine that most people have received. The smallpox vaccine is given in the upper arm using a two-pronged needle that is dipped into the vaccine solution and then repeatedly (from 3 to15 times depending on previous vaccination history) pricked into the skin. A drop/trace of blood should appear at the vaccination site. A scab will form at the vaccination site and until that scab falls off the *vaccinia* virus can be spread to other parts of the body or other people. The vaccination site must be covered using both a gauze bandage and semi-permeable dressing that is changed at least every three to five days (Department of Health and Human Services, 2003).

During the first three to four days, the vaccination site should develop a red itchy macule. Within seven days the macule will begin to blister, fill with pus, and begin to drain. Within the second week the blister will dry up and form a scab, which sloughs off within the third week leaving a telltale scar. Figure 2.1 shows the progression of the vaccination site.

Figure 2.1
Smallpox Vaccination Site
Days 4 through 21



Source: CDC (2003d)

There is a vast wealth of knowledge about who should not get the smallpox vaccination and the side effects and complications associated with smallpox vaccination due to the large volume of persons vaccinated in the early 20th century.

Given an actual biological attack, the risk of the smallpox vaccination must be weighed against the likelihood for developing the disease after a known exposure. According to the CDC (2003d),

> Individuals who have any of the following conditions, or live with someone who does, should not get the smallpox vaccine unless they have been exposed to the smallpox virus:
>
> - Eczema or atopic dermatitis. (This is true even if the condition is not currently active, mild, or experienced as a child.)
> - Skin conditions such as burns, chickenpox, shingles, impetigo, herpes, sever acne, or psoriasis. (People with any of these

conditions should not get the vaccine until they have completely healed.)

- Weakened immune system. (Cancer treatment, an organ transplant, HIV, some severe autoimmune disorders and medications to treat autoimmune disorders, and other illnesses can weaken the immune system.)
- Pregnancy or plan to become pregnant within one month of vaccination.

In addition, individuals should not get the smallpox vaccine if they:

- Have allergies to the vaccine or any of its ingredients.
- Are younger than 12 months of age.
- Have a moderate or severe short term illness. (These people should wait until they are completely recovered to get the vaccine.)
- Are currently breastfeeding.
- Use steroid drops in their eyes. (They should wait until they are no longer using the medication to get the vaccine.)

Reactions after the smallpox vaccination can be divided into three categories: normal, moderate, and life-threatening. Table 2.1 outlines the various reactions and their prevalence.

TABLE 2.1
Reactions after Smallpox Vaccination

Type of Reaction	Description	Prevalence/Occurrence
For every million people vaccinated in the past, between 14-52 had a life-threatening reaction to smallpox vaccine and 1-2 died		
Normal, Typical, Mild Reaction—self–limiting with no need for medical intervention	Redness, soreness at the vaccination site	Unknown but assumed very common
	Glands in armpit become large and sore	Unknown but assumed very common
	Mild rash lasting 2-4 days	
	Fever of over 100° F	About 10% of adults
	Blisters elsewhere on the body	About 1 per 9,100
	General feeling of illness that would prevent someone from going to work or school or participating in recreational activities. Temporary sleeping difficulties	One-third of adults
Moderate, Serious, Severe Reaction—needs immediate medical attention	A vaccinia rash or outbreak of sores limited to another area other than the vaccination site. • Usually caused by accidental spreading of the vaccinia virus by touching the vaccination site and then touching another body part • Eye infection can lead to loss of vision	1,000 out of every 1 million
	A widespread vaccine rash that is spread through the blood	1 of 4,000
Life-Threatening Reaction	Eczema vaccinatum: serious rash that is caused by widespread infection of the skin in people with eczema or atopic dermatitis	1 of 26,000
	Postvaccinal encephalitis	1 of 83,000
	Progressive vaccinia: serious infection of the skin	1 of 667,000

Sources: CDC (2002b); CDC (2003d)

Vaccinia immune globulin (VIG) is an investigational new drug that may be used in the treatment of the most severe cases of reactions associated with the administration of smallpox vaccine. The CDC is the only source of this treatment which should be reserved for the most severe adverse reactions.

Treatment

Post-Exposure Management

Should a bioterrorist attack occur and smallpox released, the immunization of exposed individuals should occur within three days. While this may not totally prevent the disease it will substantially decrease symptoms.

Due to the events of September 11, 2001, the CDC has stockpiled enough smallpox vaccine to respond to an outbreak or large-scale terrorist attack (CDC, 2002b).

Management of Smallpox Patients

There are no proven treatments for patients with clinical smallpox. Multiple antiviral drug studies have been done and failed to show significant benefit in the treatment of smallpox (CDC, 2002a).

Supportive therapy can be used with all smallpox patients to prevent respiratory, secondary skin, and other infections. Some patients may require parental nutrition and assisted breathing through the use of mechanical ventilation.

Anthrax

History

Anthrax is an acute bacterial infectious disease caused by a spore forming, gram positive bacillus called *Bacillus anthracis*. The term "anthracis" is taken from the Greek word for "coal" because of the color of the dark lesions that is associated with the disease. For centuries anthrax has been causing disease in animals such as sheep, goats, and cattle which acquired the disease from eating spore contaminated soil. Humans become infected from handling, ingesting, or inhaling the *B. anthracis* spores. One of the first occupational diseases associated with *B. anthracis* was "wool sorter's disease", a disease that afflicted workers who had been exposed to goat hair (English, 1999). The Bacillus spores can not been seen with the naked eye, and have no color, smell, or taste (CDC, n.d.).

Anthrax is differentiated into three categories: inhalation, cutaneous, and gastrointestinal. Each is vastly different in the way the disease is acquired and progresses. As seen in the fall and winter of 2001, bioterrorists used aerosolized anthrax to wreak havoc, cause fear, and kill five people in the United States. During that tragedy there were "twenty-two confirmed or suspected cases (11 confirmed inhalational; 7 confirmed and 4 suspected cutaneous) in Florida, New York, New Jersey, the District of Columbia, and Connecticut" (Ashford, 2002, p. 223). Before these U.S. cases, there were only 18 cases of inhalational anthrax from

1900-1978; 224 cases of cutaneous anthrax from 1944-1994; and no gastrointestinal anthrax reported. During these same time periods there were episodic outbreaks of gastrointestinal anthrax in Africa, Asia, and Thailand due to eating improperly cooked meat. Very little is known or documented about occurrence of gastrointestinal anthrax.

Mode of Transmission/Communicability

Inhalational

Inhalational anthrax refers to the way the spores are introduced into the human body. It is also the most lethal of all anthrax types resulting in a mortality rate of 89% (Ingelsby, 1999). In fatal cases "the interval between onset of symptoms and death averaged 3 days" (Ingelsby, 1999, p. 1737). The number of spores needed to cause infection is unknown but it is believed that anywhere between 2,500 to 55,000 spores would kill approximately 50% of the population who were exposed (Ingelsby, 1999). Person-to-person transmission of inhalational anthrax does not occur. The incubation period for inhalational anthrax ranges from 1 to 60 days with the most common period of between one and seven days.

Cutaneous

Cutaneous anthrax is the most common (>95%) of all naturally occurring anthrax infections with an incubation period from one to twelve days. Transmission occurs from the deposition of spores onto the skin through cuts, abrasions, or other weakened areas. Toxins are then produced which form the tell-tale lesions. If antibiotics are administered,

cutaneous anthrax has a very low mortality rate. If antibiotics are not administered, the mortality rate can be as high as 20% (Ingelsby, 1999). It is thought that transmission of cutaneous anthrax may occur from direct contact with the lesion secretions but this is very rare and still under investigation.

Gastrointestinal

The incubation period for gastrointestinal anthrax is from one to seven days after the ingestion of undercooked, contaminated meat. Gastrointestinal anthrax is difficult to detect. It is believed that most cases are fatal but if they were detected early and antibiotic therapy were initiated, mortality rates would be decreased.

Signs & Symptoms

Inhalational

The first symptoms are non-specific and include "fever, dyspnea, cough, headache, vomiting, chills, weakness, abdominal pain, and chest pain" (Ingelsby, 1999, p. 1736). These symptoms can be easily confused with other conditions such as the flu. There may or may not be a brief period of improvement or recovery but within two to four days, the fulminate stage of inhalational anthrax begins. This stage occurs suddenly and is heralded by a widened mediastinum on chest x-ray, sudden fever, respiratory failure, hemodynamic collapse, meningitis, delirium, and obtundation. While inhalation anthrax is treatable with

antibiotics at the early stages, death occurs within a matter of hours at the later stages of disease.

Cutaneous

The first sign of cutaneous anthrax is often a pruritic papule that changes into a vesicle which is sometimes hemorrhagic. These vesicles contain a significant number of organisms at this stage. Within two to six days the vesicle develops into a painless, depressed eschar often accompanied by localized swelling and itching. Patients may also experience systemic symptoms such as fever and edema. If left untreated, toxemia may occur but this condition is rarely fatal if treated with antibiotics.

Gastrointestinal

The signs and symptoms of this form of anthrax are extremely non-specific and include abdominal pain, nausea, vomiting, fever, bloody diarrhea, and hematemesis (English, 1999). Gram-positive bacilli can be seen on blood cultures within two to three days but by then toxemia and sepsis have most likely already occurred, and resulted in death.

Infection and Exposure Control

According to Inglesby (1999), "There is no data to suggest patient-to-patient transmission of anthrax occurs" (p. 1737) Standard infection control or universal precautions should be used with patients who have cutaneous anthrax to prevent the potential for secondary transmission but no additional measures are warranted.

Proper burial or cremation procedures for animals and humans who have anthrax are necessary to prevent further transmission of the disease through the soil.

Prevention or Prophylaxis

A vaccine is available against anthrax. It is an inactivated cell-free product that must be administered in a series of three subcutaneous injections given two weeks apart, followed by boosters at six, twelve, and eighteen months. Annual boosters are also recommended. In 2003 the Centers for Disease Control and Prevention Advisory Committee on Immunization (ACIP) recommended that the following groups should be vaccinated against anthrax

1. persons who work directly with the organism in the laboratory;
2. persons who work with imported animal hides or furs in areas where standards are insufficient to prevent exposure to anthrax spores;
3. persons who handle potentially infected animal products in high-incidence areas; while incidence is low in the United States, veterinarians who travel to work in other countries where incidence is higher should consider being vaccinated; and
4. military personnel deployed to areas with high risk for exposure to the organism (CDC, 2003b, p. 1).

Adverse reactions to the anthrax vaccine are seen in greater than 30% of all recipients but are usually limited to local redness and

tenderness at the injection site. Systemic reactions are very rare and occur in less than 0.2% of recipients.

Treatment

Post-Exposure Management

In 1999 a working group of 21 medical, government, military, public heath, and emergency management professionals developed a consensus statement outlining what treatment protocols should be used in the event of a bioterrorist attack using inhalation anthrax. This treatment protocol was redefined after the events of 2001. The antibiotics ciprofloxacin, doxycycline, and penicillin G procaine are the only drugs approved by the FDA for the post-exposure treatment from inhalational anthrax. This prophylaxis is indicated should the person be in an airspace contaminated with aerosolized *B. anthracis* but final determination of the need for prophylaxis would be determined by the public health officials. The three different treatment options available are:

1. 60 days of antibiotics;
2. 100 days of antibiotics; or
3. 100 days of antibiotics and the investigational use of the anthrax vaccine (Ashford, 2002).

Management of Anthrax Patients

A multi-drug approach to the treatment of inhalational anthrax infection is currently recommended by the CDC. This therapy includes ciprofloxacin, doxycycline, and other agents to which the organism is

susceptible. This susceptibility can only be determined after the organism is cultured and put through a battery of antibiotic resistance tests. In cutaneous anthrax a similar multi-drug approach is taken with the addition of steroids to decrease the edema (cutaneous or meningial) that is associated with the disease. While there are no current recommendations for gastrointestinal anthrax, it is assumed that the multi-drug approach would be an appropriate treatment regime.

Tularemia

History

Tularemia is an acute infectious disease caused by the *Francisella tularensis* gram negative coccobacillus. It was first described in 1911 and has been reported in every state except Hawaii. "During 1999-2000, a total of 1,368 cases of tularemia were reported to CDC from 44 states, averaging 124 cases (range: 86 to 193) per year" (CDC, 2000, p. 182). The majority of cases occurred during the summer months and the highest numbers of cases were located in the middle of the country: Arkansas, Missouri, Okalahoma, Kansas, South Dakota, and Montana (CDC, 2000).

F. tularensis has been investigated and studied since 1932 when Japanese germ warfare experts began exploring its use as a biological weapon. In the 1950's and 1960's the United States developed a delivery method that would properly aerosolize and disseminate it as a weapon. Bacteria were stockpiled by the U.S. military until an executive order in 1970 demanded the destruction of all U.S. biological weapons (Dennis,

2001). In 1969 the World Health Organization estimated that an aerosol dispersal of "50 kg of virulent *F tularensis* over a metropolitan area with 5 million inhabitants would result in 250,000 incapacitating casualties, including 19,000 deaths" (Dennis, 2001, p. 2764).

Mode of Transmission/Communicability

In naturally occurring tularemia, people are commonly infected from

- biting arthropods (ticks and deerflies) that have fed on infected animals;
- handling infected animal carcasses;
- eating or drinking contaminated water or food; and
- inhaling infected aerosols.

Person-to-person transmission of the disease does not occur. Communicability is limited to the biological event.

There are two strains of *Francisella tularensis* that are differentiated by their virulence. Type A infection, caused by *Francisella tularensis biovar tularensis,* is the more severe and deadly type and is broken down into many clinical forms: ulceroglandular, glandular, oculoglandular, oropharyngeal, pneumonic, typhoidal, and septic (Dennis, 2001). Each clinical form varies given the organism, dose, and site on inoculums. Overall the death rate of Type A tularemia is from 5-15% with both untreated pneumonic and the septic forms ranging from 30-60%. Type B

infections, caused by the *Francisella tularensis biovar palaearctica*, are rarely, if ever, fatal.

The incubation period is typically three to five days but can go as high as 14 days.

Signs & Symptoms

Because of the numerous ways that tularensis can occur, Table 2.2 details the differentiating signs and symptoms.

Infection and Exposure Control

Universal precautions should be used with patients who have tularemia even though infections can not be spread from person-to-person.

According to Altman (2002), exposure to F. tularensis can be prevented by following these simple precautions

1. be knowledgeable about the potential risks in your area;
2. avoid contaminated and untreated water;
3. treat potentially contaminated water with iodine, appropriate filters, or boiling;
4. avoid undercooked meat, especially wild game;
5. use rubber gloves when skinning, cleaning, or cutting wild animals;
6. avoid insect bites, especially blood suckers and treat if bitten;
7. check body periodically for ticks and remove them by grasping with tweezers and pulling straight out; do not burn or twist;

Table 2.2
Differentiating Signs and Symptoms of Tularemia

Type	Clinical Manifestations
General Tularemia	Abrupt onset, fever, headache, chills, rigors, generalized body aches, sore throat
Ulceroglandular: typically arises from handling contaminated carcasses and/or an arthropod bite	• Papule appears at the inoculation site about the same time as the general symptoms begin • Papule changes to pustular and will ulcerate within a few days of its appearance • Ulcer is tender, indolent, and covered by eschar • Regional lymph nodes become enlarged and tender-may even become fluctuant and rupture
Glandular	• Lymphadenopathy without an ulcer
Oculoglandular: follows direct contamination to the eye	• Ulcers on the conjunctiva • Pronounced chemosis • Vasculitis • Regional lymphadenitis
Oropharyngeal: acquired from consuming contaminated water or food or inhaling contaminated droplets	• Stomatitis • Exudative pharyngitis • Tonsillitis sometimes with ulceration
Pneumonic: can be result of inhalation or from secondary hemotogenous spread from inoculums site	• Pharyngitis • Bronchiolitis • Pleuropneumonitis • Hilar lymphadentitis Advancing to: • Peribronchial infiltrates advancing to bronchopneumonia • Pleural effusions • Hilar lympadenopathy OR • Symptoms may be minimal or absent and include • small pulmonary infiltrates • discrete pulmonary infiltrates • scattered granulomatous lesions of lung parenchyma or pleura With either condition advancing to: • severe pneumonia • respiratory failure • death

Table 2.2
Differentiating Signs and Symptoms of Tularemia (cont.)

Type	Clinical Manifestations
Typhoidal	• No cutaneous lesion or regional lymphadentitis • Prominent gastrointestinal issues such as diarrhea and pain
Septic: begins by following the same course as typhoidal	• Patient appears toxic • Confusion • Coma • Systemic inflammatory response syndrome • Disseminated intravascular coagulation and bleeding • Acute respiratory distress syndrome • Organ failure

Source: Dennis (2001)

8. wear protective, light colored clothing to make ticks more noticeable;
9. wear long sleeves and tuck pants into boots;
10. avoid walking in tall grass or brush;
11. use insect repellent containing Pyrethrum in locations where ticks are common;
12. shower after being outdoors; and
13. check pets that have been outside for fleas and ticks.

Prevention or Prophylaxis

Currently there is a vaccine used to protect laboratory workers but it is not recommended for the general public due to limited effectiveness and lack of clinical studies. Since tularemia progresses at such a rapid pace, the vaccine administered post-exposure would not be as effective because the disease would progress faster than the vaccine could provide protection.

Treatment

Untreated tularemia of any kind can progress to sepsis and cause death within three days. Management of tularemia patients is the same regardless of when exposed. Antibiotics administered intravenously (IV) are the first treatment choice if there are limited numbers of people exposed. Streptomycin is the primary antibiotic of choice with gentamicin, doxycycline, chloramphernicol, and ciprofloxacin being acceptable alternatives. All antibiotics should be continued for 10 days. In the event

that an attack resulted in mass casualties, oral administration of streptomycin, gentamicin, doxycycline, chloramphernicol, and ciprofloxacin are acceptable and must be continued for 14 days.

Should the disease progress, other medical support measures such as artificial ventilation, IV nutrition, and skin care should also be performed in an advanced care setting.

Plague

History

Though the threat of overwhelming deaths associated with plague ended many years ago, the mere mention of plague still brings terror to people worldwide. The first pandemic episode of the plague occurred in 541 AD "that began in Egypt and swept across Europe with attributable population losses of between 50%-60% in North Africa, Europe, and central and South Asia" (Ingelsby, 2000, p. 2281). The second pandemic spanned over 130 years beginning in 1346. "The Black Death" took the lives of 24 million people between the years of 1346 and 1352 and claimed perhaps another 20 million by the end of the 14th century (McGovern, 2000). During this time physicians had no understanding of how the disease spread or how to treat it. In 1345 some French physicians postulated that the plague was caused by the conjunction of the planets Saturn, Mars, and Jupiter. Other physicians recommended a simple diet, exercise, and strong emotion. With ignorance matched only by lack of judgment, one church rector quarantined the entire population of

his township, both the sick and the well. The death toll in that community was 100%. The third or modern pandemic plague episode began in China in 1894, and aided by advances in transportation, spread throughout the world (McGovern, 2000). Early in the modern pandemic the etiologic agent was discovered, the investigation on how it spread began, and treatment options were identified. At first the disease was thought to be the "disease of rats" since large numbers of rats usually died in the weeks before a human outbreak occurred. It was not until 1898 that investigators began looking at fleas as the carrier between the rat and humans, and found the disease causing agent *Yersinia pestis*. The first case of plague in the United States occurred in 1900 when the lifeless body of a Chinese laborer was discovered in a hotel basement in San Francisco, California (McGovern, 2000). Although never eradicated, massive urban rat control, human hygiene measures, and significant advances in medicine have decreased both the occurrence and mortality rates of plague. According to the World Health Organization, global occurrences of plague are between 1, 000 to 3,000 cases per year with approximately 10 to 15 plague cases happening in the United States (CDC, 2003c).

Unfortunately the plague's history as a biological weapon is equally as terrifying. The first attempt to use the bacterium was in 1346 when Muslim Tatar leaders catapulted corpses of their plague ridden colleagues into the Christian Genoese camp in hopes that the Genoese soldiers would contract plague. It appeared to the Muslims that this strategy

worked as many Genoese soldiers succumbed to the plague and the Genoese army fled back to Italy. Rather than the corpses spreading the disease, the increased rat population in the Genoese camps caused the spread. During World War II, the Japanese army biological warfare division did extensive research and testing in the use of the plague as a weapon including alleged use against China.

Plague remains on every continent except Australia. The plague is divided into three distinct types: Bubonic, septicemic, and pneumonic. According to Ingelsby (2000), the type and fatality rate of plague are distributed as follows:

Table 2.3
Type and Fatality Rates of the Plague

Type	Percentage of Cases in Last 50 years	Fatality Rate Percentage
Bubonic	84%	14%
Septicemic	13%	22%
Pneumonic	2%	57%

Source: Ingelsby (2000)

Mode of Transmission/Communicability

Transmission of naturally occurring plague happens in these ways

- fleas: bites, inoculation from flea feces, and direct human removal of fleas by biting them from each other (as occurs in some cultural grooming practices);
- infected animals: draining abscesses, eating, handling pelts, and breathing aerosols; and

- other humans: aerosols or direct contact with infected body substances (McGovern, 2000).

The incubation period for naturally occurring plague is from two to eight days after being bitten. It is feared that if an aerosolization plague were released, the incubation period would be between one to six days.

Signs & Symptoms

Naturally Occurring Plague-Bubonic

Buboes, an inflamed swelling of the lymph nodes, begin after the incubation period and become visible usually in the groin within 24 hours. They are so intensely painful that even nearly comatose patients will "attempt to shield them from trauma and will abduct their extremities to decrease pressure" (McGovern, 2000, p. 14). Along with the buboes there is sudden fever, chills, and headache followed by nausea and vomiting. Other symptoms that may occur are altered mental status, abdominal pain, chest pain, bladder distention, apathy, confusion, fright, anxiety, oliguria, and anuria. In 5-15% of bubonic cases, patients will develop secondary pneumonic plague, thus making them at risk of infecting others with their lung secretions.

Plague as a Biological Weapon-Pneumonic

An intentional release of aerosoled *Y. Pestis* would differ substantially from the naturally occurring instances of the plague because it would result in large numbers of the pneumonic type. The symptoms would mimic many other severe respiratory infections such as fever,

cough, chest pain, hemoptysis, muco-purulent or watery sputum, and radiographic evidence of bronchopneumonia (English, 1999). The symptoms would begin within one to six days following the exposure with very high fatality rates.

Infection and Exposure Control

Naturally Occurring Plague-Bubonic

Unless there is a pneumonic component associated with the plague person-to-person transmission is not usually seen.

Plague as a Biological Weapon-Pneumonic

Person-to-person transmission is possible via infectious particle droplets so droplet precautions must be in place for all pneumonic plague patients for at least 48 hours post initiation of antibiotic therapy (Ingelsby, 2000). Patients can be grouped together but must be isolated from non-plague patients.

Prevention or Prophylaxis

Since fleas are the carrier of the plague, the easiest prevention strategy is to eliminate all fleas and rats. While this may be an excellent idea it is impractical. Exposure control and education must be the main thrusts of the efforts to control plague cases. Environmental sanitation and rat control in areas where humans live, work, and play have been achieved in many areas and must remain a key focus. Education on staying away from disease-bearing animals, avoiding their sources of food and nesting areas, wearing insect repellent, and wearing gloves when

handling dead animals must be included on any plague informational program (CDC, 2003c).

The manufacturing of a formaldehyde-killed vaccine stopped in 1999 and future plans are unclear. "Research is ongoing in the pursuit of a vaccine that protects against primary pneumonic plague" (Ingelsby, 2000, p. 2283).

Treatment

Streptomycin administered either intramuscularly or orally is the antibiotic of choice for plague. The Federal Drug Administration has also authorized the use of tetracycline and doxycycline but recent strains of *Y. Pestis* may be resistant to doxycycline. The key to the success of antimicrobial therapy is the speed of delivery verses symptom onset. "The fatality rate of patients with pneumonic plague when treatment is delayed more than 24 hours after symptom onset is extremely high" (Ingelsby, 2000, p. 2285).

In the event of a biological attack or if there is a community experiencing a plague outbreak, it is recommended that anyone "developing a temperature of 38.5°C or higher or new cough should promptly begin parenteral antibiotic treatment" (Ingelsby, 2000, p. 2285).

Botulism

History

Botulism is different from the other biological agents because *Clostridium botulinum* is not the harmful agent; it is the toxin that is

produced after the introduction of the bacteria that causes the disease called Botulism. *Clostridium botulinum* is a "sporeforming, obligate anaerobe whose natural habitat is soil...consists of 4 genetically diverse groups that would not otherwise be designated as a single species except for their common characteristic of producing botulinum toxin" (Arnon, 2001, p. 1060). When the *Clostridium botulinum* is introduced into the human cells, a toxin is formed. Botulinum toxin, one of the most poisonous substances on earth, is a neurotoxin that in humans prohibits the release of acetylcholine (English, 1999).

In 2001 botulinum toxin became the first biological toxin to be used in the treatment of medical conditions such as cervical torticollis, strabismus, and blepharospasm (Arnon, 2001). This is an amazing dichotomy compared to the devastation that a small amount of this toxin can inflict when used as a biological weapon. According to Arnon (2001), "a single gram of crystalline toxin, evenly dispersed and inhaled, would kill more than 1 million people" (p. 1061). Between 1990 and 1995 it is believed that the Aum Shinrikyõ cult attempted to release aerosolized botulism but due to technical difficulties, their attempts were unsuccessful. Foodborne botulism has been used as a weapon for over 60 years, the first time by the Japanese when they fed prisoners in Manchuria cultures of *C. botulinum*. Due to the fear of potential exposure during World War II, the Allied troops were given the toxoid vaccine before invading Normandy

on D-Day (Arnon, 2001). Both inhalation and ingestion are routes of entry that may be used as a biological weapon.

Mode of Transmission/Communicability

There are three forms of naturally occurring botulism: foodborne, wound, and intestinal, and one type of manmade: inhalational. Neither wound nor intestinal botulism would be caused by a biological attack.

Naturally occurring outbreaks of botulism are very rare in the United States and are usually caused by home canned foods that are not heated thoroughly. All types of foods have been associated with botulism. Food items such as beans, peppers, carrots, and corn are the most common sources of botulism outbreaks. Each state in the U.S. has had outbreaks of botulism with an average of 24 cases occurring annually (Arnon, 2001).

The inhalational form of botulism has been demonstrated experimentally in primates, has been attempted by terrorists, and has occurred accidentally in West Germany when veterinary workers were disposing of fur coated with botulinum toxin. Because the port of entry of botulism is not as important as the fact that a toxin is formed, it is believed that both the naturally occurring and inhalational forms will have the same clinical symptoms.

In the United States deaths associated with botulism have decreased "25% during 1950-1959 to 6% during 1990-1996" (Arnon, 2001, p. 1059).

Signs & Symptoms

English (1999) affirmed that patients with botulism will experience these signs and symptoms

- responsive patient with absence of fever;
- symmetric cranial neuropathies (drooping eyelids, weakened jaw clench, difficulty swallowing or speaking);
- blurred vision and diplopia due to extra-ocular muscle palsies;
- symmetric descending weakness in a proximal to distal pattern (paralysis of arms first, followed by respiratory muscles, then legs);
- respiratory dysfunction from respiratory muscle paralysis or upper airway obstruction due to weakened glottis; and
- no sensory deficits.

Because there is paralysis of the respiratory muscles, mechanical ventilation must be provided to prevent patients from dying.

These symptoms depend on the rate and the absorption of the toxin. They begin to appear 12 to 72 hours after the food is ingested but can present even after 72 hours. It is believed that inhalational botulism would follow a similar timeline as shown in the three cases that occurred in West Germany. All three victims developed symptoms within 72 hours.

Infection and Exposure Control

Botulinum toxin is generally acquired through undercooked food so the need for proper food handling and preparation techniques will prevent infection. The toxin can be eliminated from foods by elevating the internal

temperature of 85°C for at least five minutes during cooking. Botulism is not transferred person-to-person so only universal precautions are warranted.

Prevention or Prophylaxis

The Department of Defense has developed a petavalent vaccine that has been shown to produce detectable antitoxin levels 1-year post vaccination. Due to its scarcity and the elimination of the potential medicinal benefits, mass immunization is not recommended for the public or health care workers (English, 1999). It has been available through the CDC for laboratory workers and military personnel for over 30 years.

Post-exposure use of the vaccine is not appropriate because immunity takes several months to develop.

Treatment

Therapy for botulism consists of two techniques: passive immunization with equine antitoxin and supportive care. The antitoxin is used to prevent future nerve damage so it must be started as soon as botulism is suspected. The antitoxin can not reverse existent paralysis. There are side effects associated with the use of the toxin. Anaphylaxis occurs in 2% of patients and approximately 9% of the population experience "urticaria, serum sickness or other reactions suggestive of hypersensitivity" (Arnon, 2001, p. 1062).

Supportive therapy consists of parenteral nutrition, mechanical ventilation, and prevention of secondary infections. Depending on the

extent of the toxin proliferation, this therapy may need to be in place for an extended period of time.

CHAPTER 3

ROLE OF THE OCCUPATIONAL AND ENVIRONMENTAL HEALTH NURSE IN BIOLOGICAL THREAT PREPAREDNESS AND RESPONSE

All of America is at risk for terrorism but industries may be at greater risk due to their high visibility in the international community, their representation of the "capitalistic" system, and the fact that so many people can be housed in one facility at one time. These three factors make it imperative that industry prepare for a terrorist attack. As seen on 9/11, the targets were not only the specific businesses that represented America but also the ability to harm the most people and property at one time. When many people gather together, either at work or in recreation, they must be aware that terrorists may view this as an opportunity to inflict harm. There is also an economic reason to be prepared. If an attack were to happen, businesses must recover quickly to help both their employees and the economy as a whole. Industries must be prepared by having an emergency management plan that includes direction and control, communications, life safety, property protection, community outreach, recovery, restoration, and administration/logistics.

How does the occupational and environmental health nurse (OEHN) prepare and react to terrorism? Terrorism is different than any other occupational threat because it causes both economic and physical harm. While the OEHN needs to prepare for disasters at his/her facility, many can not imagine the trauma that would occur if a planned,

coordinated terrorist attack happened. According to Cangemi (2002), "These emergencies can involve mass destruction of company property, widespread injury and death, unsafe conditions for caregivers, and the emotional stress brought forth by the intentional devastation" (p. 1).

Emergency management is defined as "the process of preparing for, mitigating, responding to and recovering from an emergency" (FEMA, 2002, p. 2). The American Association of Occupational Health Nurses (AAOHN) recently published a position statement that defines the OEHN's role in all-hazard preparedness. "The OEHN should be prepared to perform multiple levels of response, both in the planning process and in the emergency event itself" (AAOHN, 2003, ¶ 2). The planning process, including education and emergency response, will be discussed with a focus on the preparedness needed for a biological terrorist attack.

Planning Process

Disaster planning is a complicated and intense process that involves developing strong coalitions both internal and external to occupational health. Many integral groups need to be consulted during the planning process to ensure a comprehensive plan. Groups to include are management, accounting, industrial hygiene, safety/risk management, security, union and employee representatives, local EMS, and local public health authorities (AAOHN, 2001a).

The OEHN must systematically evaluate his/her unique role in the planning process. The administrative roles of planning, organizing,

directing, coordinating, and controlling (Randolph, 1994) can guide this planning process.

The first step is planning. Planning is done to give participants the knowledge they need before an emergency event occurs. An emergency plan should include an emergency response procedure such as escape routes, how to report an emergency, and contact names. It should also include support documentation including call lists, resource lists, and building maps. During the planning cycle the OEHN should also identify how the response will be coordinated with community personnel, the specific business recovery priorities, and a training plan. Due to the complex nature of the occupational health (OH) department recovery process, the OH emergency plan must be a unique yet integrated part of the entire company emergency management plan. After the events of 9/11 and the relative "newness" of the terrorist threat in America, every OH department should be prepared for a terrorist attack.

Organizing must always be done before the emergency occurs. Frequent training must be provided to key people to ensure enough knowledgeable staff are available should an event occur. By establishing clear roles, OH staff can be used to the best of their abilities during an emergency. Budgeting is also a part of organizing and can not be overlooked. Emergency equipment must be purchased ahead of time so it is available. Isolated areas must be available to house employees should

they not be allowed to leave the facility or if they need to be air-lifted to a specialized hospital.

Directing is "the face-to-face interaction between managers and subordinates in accomplishing the goals of the organization" (Rogers, 1994, p. 54). This is critical to keeping threat preparation a priority of the organization. While the threat of terrorism is real, it is not as tangible as the daily needs of injury management, cost containment, and staff attrition. Directing uses the OEHN's skills in communication and persuasion to ensure the goal of being prepared is met.

Coordinating occurs in determining whether all the necessary emergency preparedness steps are in place. Emergency drills for biological threats can be conducted to evaluate if the planning, organizing, and directing were done adequately. Drills must be performed at least annually as staff changes commonly occur. Another example of coordinating is a third party audit of the emergency plan. This can shed light on areas where the plan was inadequate or missed critical information.

Controlling, the final function of the administrative role, determines if the goal of being prepared for a bioterrorist attack was achieved. Annual evaluation and review must be performed and changes made to improve any deficiencies.

The administrator role is complicated and tests the OEHN's strategic and tactical skills. In emergency preparedness the role of the

OEHN can not be underestimated. By using all five of the administrative functions, the OEHN becomes an integral part of the company's emergency preparedness plan.

With the unique knowledge of both health and business, the OEHN easily takes on the role of educator in a bioterrorism situation. The OEHN has at least three audiences to address: management, environmental health and safety (EHS) professionals, and employees. Because each has unique needs and focus areas, the OEHN considers these when developing an educational plan about bioterrorism.

Management will need to be educated as to the potential economic and business impact of a bioterrorist attack, their role in the event of an attack, and the preparedness plan of the OH department. The OEHN must have excellent communication skills to discuss management's financial and ethical responsibilities in disaster planning. This can be a very emotionally charged issue when management must decide between the reality of needing a new piece of equipment and a request for additional emergency equipment that they may never need. The OEHN must understand this delicate balance when educating management on preparedness for biological threats.

Another large group that the OEHN will need to educate is EHS professionals. These include other OEHNs and co-workers such as safety engineers, industrial hygienists, environmental engineers, and emergency response personnel. This training should focus on an overview of the

biological agents, their roles in the event of a biological attack, and proper protection of themselves and others should an event occur. OEHNs who are not bioterrorism experts but need to respond should receive more in-depth training of the disease process including transmission, communicability, signs and symptoms, and treatment of biological agents.

Education of employees should be tailored to meet their needs. A tremendous amount of information and misinformation is available to employees. This can be seen in the recent duct tape boom that occurred when someone of authority made the erroneous statement that people can be protected against biological agents if they duct tape all the vents. Employees should know the basics signs and symptoms of diseases, common treatment modalities, and outcomes. The education must also include information of emergency contacts, procedures, and plans.

Emergency Response

Generally people think of the OEHN as a first responder for any event in the worksite. In a bioterrorist attack the term first responder has two meanings: the first responder after a known event and the first responder after an unknown event.

As a first responder after a known event, the OEHN's primary function is to limit exposure. Because all of the biological agents have incubation periods ranging from 12 hours to 14 days, the OEHN will not immediately see large numbers of causalities or even a large number of ill people.

Until the biological agent used in the attack is known, great care must be taken to ensure that no one else is exposed. Isolation of the infecting host, such as an envelope with an unknown white substance inside or the package containing an aerosolized agent being dispersed, should be left to the proper authorities. This is when the term "Don't become the next victim" is critical for the OEHN to practice. Even though there is not an obvious gas leak, fire, or casualty event, the OEHN should not be placed in a hazardous situation and potentially exposed to deadly biological agents.

The OEHN must assess workers entering the hazardous area. If the industry has equipped its own Emergency Response Team (ERT) the OEHN must ensure that they, as well as those responders who may enter the facility, are provided with proper personal protective equipment. The Centers for Disease Control and Prevention issued interim recommendations for the selection of both protective equipment and respirators used against biological agents (CDC, 2003e). The recommendations are:

1. Responders should use a NIOSH-approved, pressure-demand SCBA in conjunction with a Level A protective suit when responding to a suspected biological incident where any of the following information is unknown or the event is uncontrolled
    - the type(s) of airborne agent(s);
    - the dissemination method; or

- if dissemination via an aerosol-generating device is still occurring or it has stopped but there is no information on the duration of dissemination, or what the exposure concentration might be.

2. Responders may use a Level B protective suit with an exposed or enclosed NIOSH-approved pressure demand SCBA if the situation can be defined in which
    - the suspected biological aerosol is no longer being generated; or
    - other conditions may present a splash hazard.
3. Responders may use a full face respirator with a P100 filter or powered air-purifying respirator (PAPR) with high efficiency particulate air (HEPA) filters when it can be determined that
    - an aerosol-generating device was not used to create high airborne concentration; or
    - dissemination was by a letter or package that can be easily bagged.

Along with the isolation of the substance, the OEHN must also consider whether isolation is necessary for people who have been exposed. Universal or standard precautions are the minimum requirements that must be applied to all victims. If the agent is unknown the strictest isolation precautions must be observed to ensure there is no disease transmission, including use of gloves, respirators, masks, eye

protection, shoe covers, and face shields. Table 3.1 outlines precautions needed based on the biological agent.

The more likely scenario is the OEHN functioning as the first responder in an unknown attack. The OEHN may be the first to see the onset of a biological disease process. Important epidemiologic principles can be applied to this situation, including

1. a rapidly increasing disease incident (e.g., within hours or days) in a normally health population;
2. an epidemic curve that rises and falls during a short period of time;
3. an unusual increase in the number of people seeking care especially with fever, respiratory, or gastrointestinal complaints;
4. an endemic disease rapidly emerging at an uncharacteristic time or in an unusual pattern;
5. lower attack rates among people who had been indoors, especially those areas with filtered air or closed ventilation systems, compared with people who had been outdoors;
6. clusters of patients arriving from a single locale;
7. large number of rapidly fatal cases; and/or
8. any patient presenting with a disease that is relatively uncommon and has bioterrorism potential (e.g., pulmonary anthrax, tularemia, or plague) (English, 1999).

Table 3.1
Precautions for Victims Exposed to Biological Agents

Biological Agent	Isolation Precautions	Respiratory Precautions	Contact Precautions	Additional Precautions
Anthrax	Patients can be placed together	Airborne transmission does not occur even with inhalational type anthrax	Routine use of gloves for contact with intact and non-intact skin	None
Plague	Isolation of patients to private rooms or with patients with similar symptoms	Droplet precaution as disease can be spread via sneezing, coughing etc	Universal	-Post-mortem droplet precautions -Perform surface de-contamination with approved sporicidal/ germicidal agent
Smallpox	-Monitored negative air pressure in relationship to outside room areas -6-12 air exchanges per hour -Appropriate discharge of air to outdoors or filtration if it is to return -Door must remain closed -Patients with smallpox can be placed together	Airborne precautions require the use of respiratory protection that includes a NIOSH N95 rated particulate respirator	Gloves and gown	-Airborne and contact precautions post-mortem -Single use equipment whenever possible

Source: English (1999)

The OEHN must use both knowledge of the disease processes of bioterrorism agents and his/her astute assessment skills. If the OEHN suspects the symptoms or patterns that are being seen might be related to a biological agent, he/she must contact either the local hospital or nearest state health department so a complete evaluation can begin.

Along with clinical skills of physical symptom diagnosis, the OEHN must also look after the employees' emotional and psychological needs. If an event has occurred at the facility, the OEHN must also treat employees who have not been exposed to the biological agent but have been exposed to terrorism. Post-traumatic counseling is needed immediately to help employees cope with seeing their co-workers, friends, and family harmed. On-going psychological counseling may also be needed. Even if an event were to occur away from the work location, employees may experience the common responses to trauma. These can include physical and emotional reactions, productivity effects, and delayed reactions. Table 3.2 details the common responses to trauma.

Follow-up and patient advocacy are also roles of the OEHN in this setting. Co-workers may be very confused and upset when their fellow employees are placed in isolation after a potential smallpox exposure but the OEHN can assist by educating and preparing them for the normal routine associated with these disease processes. Case management, one of the cornerstones of OEHN clinical practice, can be applied to assist the

Table 3.2

Common Responses to Trauma

Physical Reactions	Emotional Reactions	Productivity Effects	Delayed Reactions
Hyperactivity and nervous energy	Flashbacks	Inability to concentrate	Increased depression or flashbacks
Fatigue	Jumpiness	Increased errors or omissions	Decreased sex drive
Appetite changes	Irritability	Lapses in memory	Excessive or too little sleep
Muscle tremors	Anger	Absenteeism	Appetite change
Headaches	Anxiety or helplessness	Tendency to overwork	Loss of emotional control
Heart palpitations/ increased respiration	Fear/panic	Reduced alertness	Loss of interest in family or previously enjoyed activities
Chest pain	Guilt	Reduced awareness of job risks	Reevaluation of career or life
Dizziness	Withdrawal	Difficulty making decisions and problem solving	Anger/grief/ vulnerability
Excessive sweating	Changes in aggressiveness		Survivor guilt
Visual disturbances	Increased consumption of alcohol or drugs		
Grinding teeth			

Source: AAOHN (2001b)

employee to manage the disease through the healthcare system maze. If the injury happened at work and is an act of bioterrorism, is it covered under Workers' Compensation or private health insurance? Will communicable disease treatment be provided at a county or private hospital? All of these questions will need to be answered by the OEHN before an event occurs.

Whether the OEHN is viewed as an emergency responder, educator, or administer, he/she must be knowledgeable of biological threats and be able to communicate these issues efficiently and effectively so that companies can be prepared in these uncertain times.

CHAPTER 4

BIOLOGICAL THREAT ASSESSMENT TOOL

Development

While there are many challenges in emergency preparedness, a key challenge was to assess a large semiconductor company's occupational health departments' ability to respond to a biological emergency. A Systems Approach, as described by Rogers (1994), was used as it provided an organized and comprehensive approach. A series of questions were developed to assess the three major components of environmental influences, system inputs, and system throughputs and their sub-components as illustrated in Table 4.1.

The questions were designed to ask information specific to biological threat preparedness. The OEHNs in charge of the department at the three test sites were asked 51 questions. The goal of the tool was to assess the clinics' preparedness. The tool focused on the specific clinics' improvement plan and was not used as a grading scale for which clinic was the "best." Due to the global nature of the semiconductor company, it would be counterproductive to compare clinics across the world as each government and local municipality may have different emergency preparedness requirements. The Microsoft Excel worksheet designed to capture both the questions and answers is located in Appendices A-C.

Table 4.1
Systems Approach

Component	Sub-component
Environmental influences	Technology
	Population/health trends
	Economics
	Legislation/politics regulatory
System inputs	Corporate culture
	Workforce
	Work/processes and related hazards
	Human/operational resources
	Organizational/occupational health unit goals
System throughputs	Clinical skills
	Collaboration
	Decision making skills
	Program management
	Documentation

The participants were asked to rank each answer on a scale of one to five, with one being "Strongly Disagree", three being "Neutral" and five being "Strongly Agree". The individual question totals were compiled and then compared to a 95th, 75th, and 50th percentile. This was done to better understand where the site could improve. A score within 10 points of the 95th percentile within a sub-category was established as a benchmark of success. An example is a question in technology which states, "My community has an emergency broadcasting system." This may be scored as a "1" (strongly disagree), but because the community has another method to communicate the entire section may still score within the 75th-95th percentile.

Application and Gap Analysis

Due to the global nature of this company, a site from each of the three major regions (Asia, Europe, and the Americas) was selected to pilot the tool. It was felt that this would give more diverse results. The sites in Penang, Ireland, and Massachusetts volunteered to be the three test sites. The tool developer conducted interviews with each site nurse manager to collect the data. Face to face interviews were conducted in both Penang and Ireland, and a telephone interview was conducted to collect the data from Massachusetts. Each interview lasted approximately one hour. The tool was designed to provide real time results so the nurse manager received the results at the end of the interview. A preliminary gap analysis was completed during the last 30 minutes of the interview. The nurse

manager reviewed the results with the site occupational health team and developed a comprehensive list of improvement goals. A summary of each site will be reviewed.

Penang

The Penang site is located in Malaysia and is the largest assembly and test facility for this semiconductor manufacturer. The employee base is close to 6,000, with an occupational and environmental health nursing staff of seven. Nurses are available 24 hours a day, seven days a week and provide both occupational injury management and primary care nursing.

A key strength of the Penang team is their ability to manage programs and negotiate the needs of the OH department. During the interview it also became clear that Penang's deficits were primarily in the "environmental influences" section. The staff decided to focus on the specific areas, as noted by the red colored results, which have the lowest total score. Table 4.2 details the Penang site results.

The Penang gap analysis or areas for improvement included:

1. Develop a strategy within the OH department to understand how the community will communicate bioterrorist activities and put in place a process to stay "connected" to this system at all times.
2. Understand what the government is doing to prevent bioterrorism and how it impacts the occupational health department.

Table 4.2
Penang Site Assessment Results

Areas	Score	Total Possible	95%	75%	50%
Environmental influences	**43**	**85.00**	**80.75**	**63.75**	**42.50**
Technology	9	**20.00**	19.00	15.00	10.00
Population/health trends	17	**25.00**	23.75	18.75	12.50
Economics	8	**15.00**	14.25	11.25	7.50
Legislation/ politics/regulatory	9	**25.00**	23.75	18.75	12.50
Inputs	**74**	**115.00**	**109.25**	**86.25**	**57.50**
Corporate culture	13	**15.00**	14.25	11.25	7.50
Workforce	16	**30.00**	28.50	22.50	15.00
Work/process and related hazards	7	**10.00**	9.50	7.50	5.00
Human/operational resources	28	**45.00**	42.75	33.75	22.50
Informational resources	7	**10.00**	9.50	7.50	50.00
Organizational/occupational health unit goals	3	**5.00**	4.75	3.75	5.00
Throughputs	**38**	**55.00**	**52.25**	**41.25**	**27.50**
Clinical/analytical skills, knowledge, experience	21	**35.00**	33.25	26.25	17.50
Collaborative decision making skills and processes	5	**5.00**	4.75	3.75	2.50
Interpersonal/negotiation skills	5	**5.00**	4.75	3.75	2.50
Program management/objectives	5	**5.00**	4.75	3.75	2.50
Documentation	2	**5.00**	4.75	3.75	2.50

3. Conduct an assessment of the workforce to understand how they may be impacted by a bioterrorist attack.
4. Obtain additional information/training on the OEHN's role and bioterrorism agents.
5. Improve the documentation of the bioterrorism preparedness plan.

Ireland

The Ireland site, located in the rural town of Lexilip northeast of Dublin, used the tool next. There were two manufacturing facilities on the site and a third facility in the final stages of construction. There are six OEHN's on staff and two additional support personnel. The clinic is open 24 hours a day for the 7,500 employees who work there.

During the interview the Ireland nurse manager stated, "We have been dealing with internal terrorism from the Irish Republican Army (IRA) for many, many years." While this is true, it became clear, while answering the questions, that there was a lot more work that needed to be done. Table 4.3 details the Ireland results with the lowest results in red. Although the gaps were not as severe as the Penang site, there were very similar.

The Ireland gap analysis or areas for improvement found after application of the tool included:

1. Understand what the government is doing to prevent bioterrorism and how it impacts the OH department.

Table 4.3
Ireland Site Assessment Results

Areas	Score	Total Possible	95%	75%	50%
Environmental influences	**52**	**85.00**	**80.75**	**63.75**	**42.50**
Technology	12	**20.00**	19.00	15.00	10.00
Population/health trends	16	**25.00**	23.75	18.75	12.50
Economics	14	**15.00**	14.25	11.25	7.50
Legislation/ politics/regulatory	10	**25.00**	23.75	18.75	12.50
Inputs	**86**	**115.00**	**109.25**	**86.25**	**57.50**
Corporate culture	14	**15.00**	14.25	11.25	7.50
Workforce	20	**30.00**	28.50	22.50	15.00
Work/process and related hazards	7	**10.00**	9.50	7.50	5.00
Human/operational resources	34	**45.00**	42.75	33.75	22.50
Informational resources	7	**10.00**	9.50	7.50	50.00
Organizational/occupational health unit goals	4	**5.00**	4.75	3.75	5.00
Throughputs	**37**	**55.00**	**52.25**	**41.25**	**27.50**
Clinical/analytical skills, knowledge, experience	20	**35.00**	33.25	26.25	17.50
Collaborative decision making skills and processes	5	**5.00**	4.75	3.75	2.50
Interpersonal/negotiation skills	5	**5.00**	4.75	3.75	2.50
Program management/objectives	5	**5.00**	4.75	3.75	2.50
Documentation	2	**5.00**	4.75	3.75	2.50

2. Conduct an assessment of the workforce to understand how they may be impacted by a bioterrorist attack.
3. Obtain additional information/training on the OEHN's role and bioterrorism agents.
4. Improve the documentation of the bioterrorism preparedness plan.

Massachusetts

The final site to use the tool was Massachusetts. Being the only U.S. based site, the OH management in Hudson entered the process with a feeling of "preparedness" but left knowing that they still had many areas to improve. This interview was the only one done on the phone due to travel restrictions.

The Massachusetts site is located in the central part of the state. One manufacturing plant is located at this site with an employee base of less than 1,000 people. The nursing staff is small with three OEHNs. The site utilized a large number of contract or temporary nurses to manage their night shift coverage. Table 4.4 outlines their scores with the low scores highlighted in red.

The Massachusetts gap analysis or areas for improvement found after application of the tool included:

1. Conduct an assessment of the workforce to understand how they may be impacted by a bioterrorist attack.
2. Obtain additional information/training on the OEHN's role and the agents of bioterrorism.

Table 4.4
Massachusetts Site Assessment Results

Areas	Score	Total Possible	95%	75%	50%
Environmental influences	**68**	**85.00**	**80.75**	**63.75**	**42.50**
Technology	17	**20.00**	19.00	15.00	10.00
Population/health trends	20	**25.00**	23.75	18.75	12.50
Economics	10	**15.00**	14.25	11.25	7.50
Legislation/ politics/regulatory	21	**25.00**	23.75	18.75	12.50
Inputs	**94**	**115.00**	**109.25**	**86.25**	**57.50**
Corporate culture	15	**15.00**	14.25	11.25	7.50
Workforce	20	**30.00**	28.50	22.50	15.00
Work/process and related hazards	7	**10.00**	9.50	7.50	5.00
Human/operational resources	39	**45.00**	42.75	33.75	22.50
Informational resources	8	**10.00**	9.50	7.50	50.00
Organizational/occupational health unit goals	5	**5.00**	4.75	3.75	5.00
Throughputs	**36**	**55.00**	**52.25**	**41.25**	**27.50**
Clinical/analytical skills, knowledge, experience	21	**35.00**	33.25	26.25	17.50
Collaborative decision making skills and processes	4	**5.00**	4.75	3.75	2.50
Interpersonal/negotiation skills	5	**5.00**	4.75	3.75	2.50
Program management/objectives	4	**5.00**	4.75	3.75	2.50
Documentation	2	**5.00**	4.75	3.75	2.50

3. Improve the documentation of the bioterrorism preparedness plan.

Findings and Evaluation

The three sites had similar issues after completing the tool. Since Penang was the first to use the tool, the OH staff developed improvement goals that both Ireland and Massachusetts used to determine their OH departments' improvement plans. The glaring global finding was the OH departments' lack of knowledge about the nurse's role in biological threat preparedness and the disease processes associated with biological terrorism. Massachusetts, the only U.S. site, was very surprised not to have higher scores and set goals to reach the 95 percentile by the end of 2003.

The OEHN leaders within the company met and reviewed the results from the three pilot sites. The team decided that instead of having all 25 sites use the tool that they would set the following global occupational health goals for 2003 and 2004

- educate all OEHNs about their role in biological threat preparedness;
- train all OEHNs in the disease processes of the top biological threats as assigned by the Centers for Disease Control; and
- document a biological threat preparedness plan for each site.

A training session was completed using the biological threat profiles described earlier. The initial training focused on the biological agents.

Subsequent training will focus on chemical, nuclear, and other weapons of mass destruction.

The three test sites will complete the biological threat assessment tool again in 2004 to see if their total scores improved particularly in areas affected by education.

Even though it is difficult to prepare for a terrorist attack, there are actions that an OH department can take to minimize the impact of these events on themselves, their workforce, and their community. After using the tool, the OH departments developed a plan to move forward with preparedness, thus taking the first steps to being prepared for a bioterrorist attack.

CHAPTER 5

CONCLUSION

Knowledge and preparedness are the only defense against terrorism of any type. Whether that knowledge comes from having an emergency preparedness plan or employee education, the OEHN must play an active role to ensure a safe and healthful working environment. The U.S. government has provided direction on what disease agents may be used in a biological attack. The OEHN must now educate him/herself not only on the physical signs and symptoms of disease but also the treatment expectations associated with each disease process. The role of the OEHN is varied and complex and includes the administrative roles of planning, organizing, directing, coordinating, and controlling. Preparation can begin through a systematic assessment of the current situation and development of a plan that will close the gaps found in the analysis. The OEHN has the expertise to see where all the pieces of the puzzle fit together and provide a safe environment for his/her employees and community.

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APPENDICES

APPENDIX A

Sample Assessment Tool

Scoring Scale

Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
1	2	3	4	5

Environmental Influences

		Score
Technology		
	My community has an emergency broadcasting system	**0**
	My community has the ability to communicate to my company should bioterrorism occur	**0**
	My community does not house or produce biological agents	**0**
	The WWW is accessible within my community	**0**
Population/ Health Trends		
	My community does not have a group of people that may be more susceptible to biological agents i.e. those with lower immune systems, the young or the elderly	**0**
	My community does not have a subgroup that supports the use of biological agents as an act of terrorism	**0**
	My community does not have a subgroup that has been called up to active duty in the armed forces	**0**
	My community does not have a subgroup of spouses/significant others of those called up in the armed forces	**0**
Economics		
	My community has a positive economy (stable unemployment rates, low inflation etc)	**0**
	My community would be negatively affected if a biological event were to happen	**0**
	My community would be positively affected if a biological event were to happen	**0**

APPENDIX A

Sample Assessment Tool (cont.)

Environmental Influences

Legislation/ Politics/ Regulatory		**Score**
	My federal government has a policy in place to fight bioterrorism	**0**
	My state/local government has a policy in place to fight bioterrorism	**0**
	My community has an Emergency Operations Center structure	**0**
	My local emergency preparedness office has a post-biological attack plan	**0**
	My Nursing/Occupational Health Association has information on what to do should a biological attack occur	**0**

APPENDIX B

Sample Assessment Tool

Scoring Scale

Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
1	2	3	4	5

Inputs

		Score
Corporate Culture		
	The company supports biological threat preparedness	0
	The company supports employees and their families in regards to biological threat preparedness	0
	The workforce is concerned about the threat of biological attack	0
Workforce		
	The workforce does not have a group of people that are more susceptible to biological agents i.e. those with lower immune systems, the young, or elderly	0
	The workforce does not have a subgroup that may support the use of bioterroism against the workforce	0
	The workforce does not have a subgroup of spouses/significant others of those called up in the armed forces	0
	The workforce has a "history" with the control of communicable diseases.	0
Work/Processes and Related Hazards		
	There are no work hazards where employee's may be exposed to biological agents	0
	Employee's do not travel to areas that may be impacted by biological agents	0

APPENDIX B

Sample Assessment Tool (cont.)

Inputs

Human/ Operational Resources		**Score**
	The companies resources include	**0**
	Occupational Physician	**0**
	Industrial Hygienist	**0**
	Toxicologist	**0**
	Emergency Preparedness Coordinator with knowledge of biological threats	**0**
	Psychologists/post disaster counseling/EAP	**0**
	Relationship with community physicians	**0**
	The community provides me with the resources (money/people) to prepare for biological threats	**0**
	The OHN department has adequate supplies, space, and equipment should a biological attack occur	**0**
Informational Resources		
	The OH department has the information it needs to deal with biological agents	**0**
	The OH department has access to the Internet	**0**
Organizational/ Occupational Health Units Goals		
	Biological threat preparedness is one of the OH department goals	**0**

APPENDIX C

Sample Assessment Tool

Scoring Scale

Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree
1	2	3	4	5

Throughputs

		Score
Clinical/Analytical Skills, Knowledge, Experience		
	The OEHN staff knowledgeable of the federal/local policies to fight bioterrorism	**0**
	The OEHN staff knowledgeable of the history, mode of transmission, communicability, signs & symptoms, response protocol, infection and exposure control, prevention or prophylaxis, and treatment of Class A biological threats	
	Anthrax	**0**
	Botulism	**0**
	Plague	**0**
	Smallpox	**0**
	Tularemia	**0**
Collaborative Decision Making Skills and Processes		
	The OEHN staff is comfortable working on teams	**0**
Interpersonal/ Negotiation Skills		
	The OEHN staff is excellent at project management	**0**
Documentation		
	There is a documented OEHN plan should an act of bioterrorism occur	**0**

APPENDIX D

Assessment Totals and Percentages

Areas	Score	Total Possible	95%	75%	50%
Environmental influences		**85.00**	**80.75**	**63.75**	**42.50**
Technology		**20.00**	19.00	15.00	10.00
Population/health trends		**25.00**	23.75	18.75	12.50
Economics		**15.00**	14.25	11.25	7.50
Legislation/ politics/regulatory		**25.00**	23.75	18.75	12.50
Inputs		**115.00**	**109.25**	**86.25**	**57.50**
Corporate culture		**15.00**	14.25	11.25	7.50
Workforce		**30.00**	28.50	22.50	15.00
Work/process and related hazards		**10.00**	9.50	7.50	5.00
Human/operational resources		**45.00**	42.75	33.75	22.50
Informational resources		**10.00**	9.50	7.50	50.00
Organizational/occupational health unit goals		**5.00**	4.75	3.75	5.00
Throughputs		**55.00**	**52.25**	**41.25**	**27.50**
Clinical/analytical skills, knowledge, experience		**35.00**	33.25	26.25	17.50
Collaborative decision making skills and processes		**5.00**	4.75	3.75	2.50
Interpersonal/negotiation skills		**5.00**	4.75	3.75	2.50
Program management/objectives		**5.00**	4.75	3.75	2.50
Documentation		**5.00**	4.75	3.75	2.50