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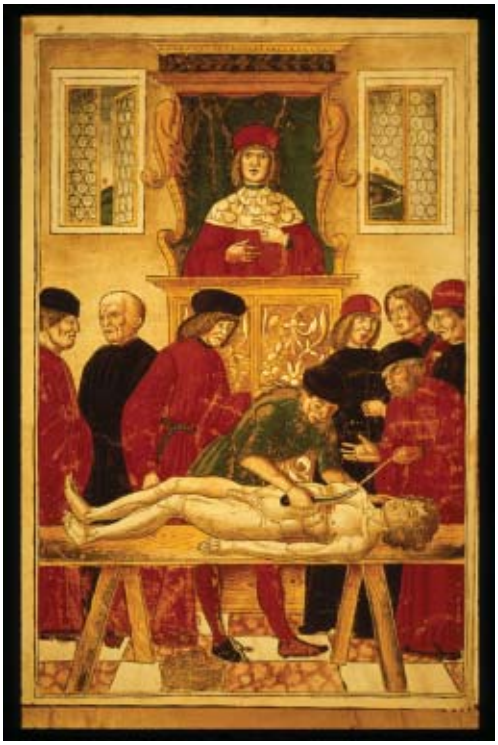
Medical Examiners, Coroners, and Biologic Terrorism

A Guidebook for Surveillance and Case Management



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DEPARTMENT OF HEALTH AND HUMAN SERVICES
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On the Cover: Historic woodcut of the dissection of a human corpse, Anonymous in Johannes de Ketham, *Fasciculus Medicinae* (1493). Reprinted courtesy of Yale University School of Medicine.

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Medical Examiners, Coroners, and Biologic Terrorism

A Guidebook for Surveillance and Case Management

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Summary

Medical examiners and coroners (ME/Cs) are essential public health partners for terrorism preparedness and response. These medicolegal investigators support both public health and public safety functions and investigate deaths that are sudden, suspicious, violent, unattended, and unexplained. Medicolegal autopsies are essential for making organism-specific diagnoses in deaths caused by biologic terrorism. This report has been created to 1) help public health officials understand the role of ME/Cs in biologic terrorism surveillance and response efforts and 2) provide ME/Cs with the detailed information required to build capacity for biologic terrorism preparedness in a public health context. This report provides background information regarding biologic terrorism, possible biologic agents, and the consequent clinicopathologic diseases, autopsy procedures, and diagnostic tests as well as a description of biosafety risks and standards for autopsy precautions. ME/Cs' vital role in terrorism surveillance requires consistent standards for collecting, analyzing, and disseminating data. Familiarity with the operational, jurisdictional, and evidentiary concerns involving biologic terrorism-related death investigation is critical to both ME/Cs and public health authorities. Managing terrorism-associated fatalities can be expensive and can overwhelm the existing capacity of ME/Cs. This report describes federal resources for funding and reimbursement for ME/C preparedness and response activities and the limited support capacity of the federal Disaster Mortuary Operational Response Team. Standards for communication are critical in responding to any emergency situation. This report, which is a joint collaboration between CDC and the National Association of Medical Examiners (NAME), describes the relationship between ME/Cs and public health departments, emergency management agencies, emergency operations centers, and the Incident Command System.

Introduction

Terrorist events in recent years have heightened awareness of the risk of terrorist acts involving unconventional agents, including biologic and chemical weapons. The need for terrorism preparedness and planning for response at multiple levels is now recognized, including planning and response by medical examiners, coroners (ME/Cs), and the medicolegal death-investigation system.

Federal, state, and local agencies have developed plans to detect and respond to terrorism by using a multidisciplinary approach that requires active participation of health-care providers, law enforcement, and public health and safety staff. Because ME/Cs have expertise in disease surveillance, diagnosis, deceased body handling, and evidence collection, they serve a vital role in terrorism preparedness and response. ME/Cs should ensure that their role in surveillance for unusual deaths — and response to known terrorist events — is a critical part of the multidisciplinary response team. Terrorism-related drills and practical exercises conducted by public health, law enforcement, and public safety agencies should include training on postmortem operations and services.

This report, prepared as a joint effort between the National Association of Medical Examiners (NAME) and CDC, is a first step in providing specific guidance to ME/C death investigators and public health officials. This report can help bridge gaps that exist in local terrorism preparedness and response planning. By discussing the substantial contributions of

* Member of the National Association of Medical Examiners (NAME).

The material in this report originated in the Epidemiology Program Office, Stephen B. Thacker, M.D., M.Sc., Director; the Division of Public Health Surveillance and Informatics, Richard Hopkins, M.D., M.S.P.H., Acting Director; the National Center for Infectious Diseases, James M. Hughes, M.D., Director; and the Division of Viral and Rickettsial Diseases, James LeDuc, Ph.D., Sc.D., Director.

ME/Cs, this report can also serve as a foundation for identifying the needs of medicolegal death-investigation systems and for addressing those needs through adequate training and funding.

This report provides guidance, identifies support services and resources, and discusses the roles and responsibilities of ME/Cs and affiliated personnel in recognizing and responding to potential biologic terrorism events. Certain questions being asked by ME/Cs and their public health partners are answered in this report, including the following:

- What are the likely biologic agents to be encountered?
- What are the expected case fatality rates and time courses for the different agents?
- What types of ongoing surveillance are needed to detect potential biologic terrorism-associated incidents?
- What protective equipment and procedures are needed to ensure the safety of death investigation and forensic pathology personnel?
- What are the appropriate facilities in which to perform postmortem examinations in cases of suspected biologic terrorism?
- What are the best methods for ensuring biosafety during the mortuary process?
- How will hospitals, emergency personnel, health departments, and ME/Cs effectively communicate during a suspected or known incident?
- How will local ME/C systems interact with the Federal Bureau of Investigation (FBI) and other investigative agencies?
- What is the minimum extent of examination that will be required? For example, will a complete autopsy be required in every suspected case to support the criminal justice process?
- What pathology-specific tests are available; which ones are the best to use to make an accurate diagnosis; and which ones are the best for making a rapid diagnosis?
- Which laboratories are best suited to perform the necessary postmortem testing?
- What role does public health law play in determining disposition of bodies?
- What legal authority do public health agencies have in making decisions during potential biologic terrorism events?
- What federal resources are available to assist ME/Cs?

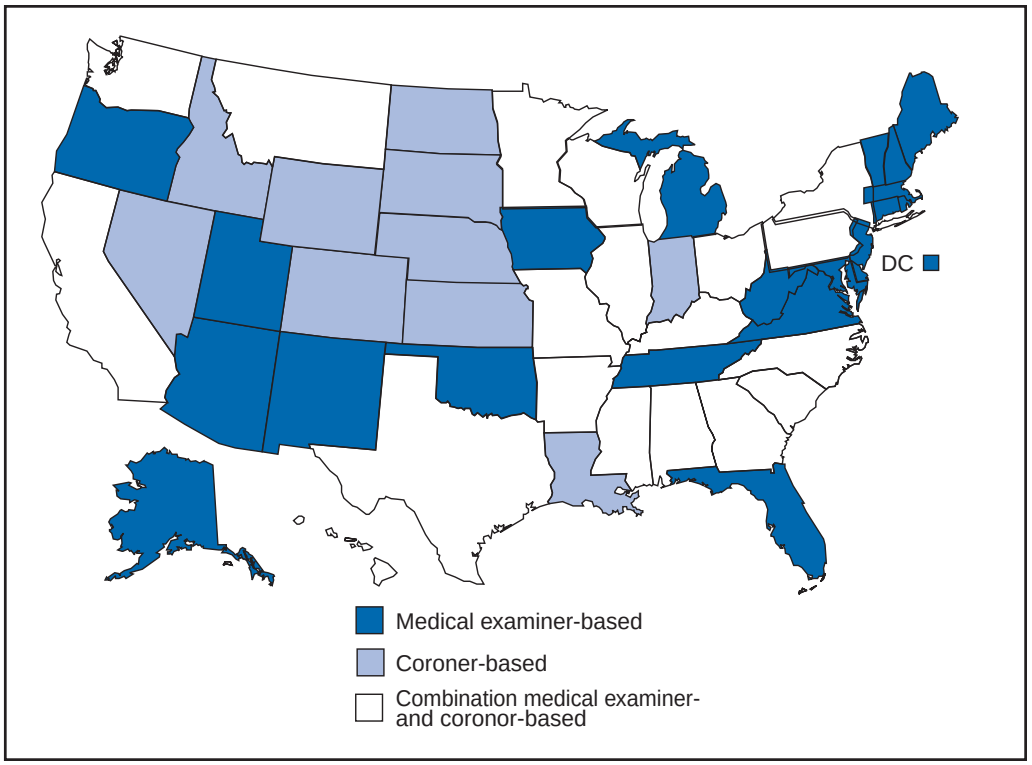
Background

Medicolegal Death Investigators

CDC has identified medicolegal death investigators (i.e., ME/Cs) as essential partners in terrorism preparedness and response (*1*). This report is designed to assist ME/Cs and their public health partners in developing appropriate capacity for recognizing and responding to deaths that are potentially a consequence of biologic terrorism.

The organization of medicolegal death investigative systems within the United States varies by state (*2*). As ME/Cs and public health and public safety departments prepare to respond to terrorism-associated events, each state should consider how its medicolegal death investigation system is organized. These systems can be medical examiner-based (21 states and the District of Columbia), coroner-based (10 states), or both (19 states) (Figure 1). Typically, coroners are elected lay persons who use medical personnel to assist in death investigation and autopsy performance. Medical examiners are

FIGURE 1. U.S. death investigation systems by state, 2001



usually appointed physicians and pathologists who have received special training in death investigation and forensic pathology.

Medicolegal death investigation systems can be either centralized (i.e., investigations emanate from one state-level office) or decentralized (i.e., investigations are conducted in more than one regional-, county-, or city-based office). A total of 23 states plus the District of Columbia have centralized systems; 27 states are decentralized. States with medical examiner systems might have a state-based medical examiner office, and also have county-level autonomous medical examiner offices that perform their own autopsies and manage their own data and administrative systems.

ME/C offices can also vary in their organizational position within the government. ME/C offices might be a component of the public health department or the public safety department, or be independent of other government agencies. All types of medicolegal death investigation systems should be considered when determining the roles, responsibilities, and participation of ME/Cs in a jurisdiction's terrorism preparedness and response plans.

Biologic Terrorism

Biologic terrorism is defined as "the use or threatened use of biologic agents against a person, group, or larger population to create fear or illnesses for purposes of intimidation, gaining an advantage, interruption of normal activities, or ideologic activities. The resultant reaction is dependent upon the actual event and the population involved and can vary from a minimal effect to disruption of ongoing activities and emotional reaction, illness, or death" (*3*). In the United States in 1984, an outbreak of terrorism-related *Salmonella* dysentery caused 715 persons to become ill, but no fatalities resulted (*4*). In 2001, the intentional distribution of anthrax spores through the U.S. Postal Service resulted in five deaths from inhalational anthrax (*5–8*). MEs were critical members of the response team during the anthrax outbreak, performing autopsies on each fatality to confirm the cause of death as anthrax and to identify the manner of death as homicide.

ME/Cs have state statutory authority to investigate deaths that are sudden, suspicious, violent, unattended, or unexplained (*9*); therefore, these investigators have a role in recognizing and reporting fatal outbreaks, including those that are possibly terrorism-related, and a role in responding to a known terrorist event (*10–12*). Deaths of persons at home or away from health-care facilities fall under the jurisdiction and surveillance of medicolegal death investigators (*13*), who often identify infectious diseases that are not terrorism-related. For example, in 1993, MEs recognized an outbreak of hantavirus pulmonary syndrome, a disease with symptoms that can mimic terrorism-related illnesses (*14*). Deaths of patients in hospitals can also fall under medicolegal jurisdiction if the patient dies precipitously before an accurate diagnosis is made or if a public health concern exists (*10*). Fatalities caused by known terrorist events are homicides and therefore fall under the statutory jurisdiction of ME/Cs.

Risk assessment for potential biologic terrorism is an uncertain process. Hypothetical terrorism scenarios can involve a limited number of cases or millions of cases, with proportionate numbers of fatalities. For example, in 2002, the Dark Winter smallpox exercise included in the scenario 3 million fourth-generation cases of smallpox and approximately 1 million deaths (*15*). In 2000, the TOPOFF (Top Officials) plague exercise included in the scenario 2,000 fatalities in a 1-week period (*16*). Given such possibilities if a biologic terrorist event occurred, ME/Cs should proactively identify appropriate resources and links to the public health, emergency response, health-care, and law enforcement communities. With appropriate resources and links, ME/Cs can assist with surveillance for infectious disease deaths possibly caused by terrorism and provide confirmatory diagnoses and evidence in deaths clearly linked to terrorism. Conversely, public health agencies should recognize ME/Cs as a vital part of the public health system and keep them informed of infectious disease outbreaks occurring in their jurisdictions so that they are better able to recognize related fatalities. Additionally, public health agencies should provide ME/Cs with appropriate resources to enhance their surveillance and response capacities for terrorism.

An ME/C's principal diagnostic tool is the autopsy. This procedure enables pathologists to identify the dead, observe the condition of the body, and reach conclusions regarding the cause and manner of death. Autopsies are valuable in diagnosing unrecognized infections, evaluating therapy, understanding the pathogenesis and route of infection for uncommon or emerging infections, and developing evidence for subsequent legal proceedings (*10,17*). In 1979, an anthrax outbreak occurred that was associated with an unintentional release of spores from a bioweapons factory in the Soviet city of Sverdlovsk; pathologists used autopsies to identify the cause of death as anthrax and the route of infection as inhalation (*18*). In a 1945 smallpox outbreak, autopsy pathologists, rather than clinicians, were the physicians who recognized the sentinel case (*19*).

Probable Biologic Terrorism Agents, Diseases, and Diagnostic Tests

Agent Categories

In this report, the list of potential biologic terrorism agents has been prioritized on the basis of the risk to national security (Box 1) (*1*). Biologic agents are classified as high-risk, or Category A, because they can 1) be easily disseminated or transmitted person to person; 2) cause high mortality, with potential for major public health impact; 3) might cause public panic and social disruption; or 4) require special action for public health preparedness. The second highest priority, or Category B, agents include those that 1) are moderately easy to disseminate; 2) cause moderate morbidity and low mortality; or 3) require enhanced disease surveillance. The third highest priority, or Category C, agents include emerging pathogens that can be engineered for future mass dissemination because of 1) availability; 2) ease of production and dissemination; or 3) potential for high morbidity and mortality and major health impact.

Recognizing pathologic features of different biologic agents is important, as demonstrated by the inhalational and cutaneous anthrax cases that occurred in the United States during 2001 (*5,8,20–23*). The autopsy of the index patient was performed to determine how the person had acquired anthrax (cutaneous, gastrointestinal, or inhalational). After inhalational anthrax was diagnosed, public health officials were able to better define potential sources of the airborne *Bacillus anthracis* spores.

BOX 1. Classification of biologic terrorism agents

Category A Agents
- Variola major (smallpox)
- *Bacillus anthracis* (anthrax)
- *Yersinia pestis* (plague)
- *Clostridium botulinum* toxin (botulism)
- *Francisella tularensis* (tularemia)
- Hemorrhagic fever viruses, including
  - — Filoviruses including Ebola and Marburg hemorrhagic fever
  - — Arenaviruses, including Lassa (Lassa fever) and Junin (Argentine hemorrhagic fever) and related viruses

Category B Agents
- *Coxiella burnetii* (Q fever)
- *Brucella* species (brucellosis)
- *Burkholderia mallei* (glanders)
- Alphaviruses including Venezuelan encephalomyelitis and eastern and western equine encephalomyelitis viruses
- Ricin toxin from *Ricinus communis* (castor beans)
- Epsilon toxin of *Clostridium perfringens*
- *Staphylococcus* enterotoxin B
- Food- and waterborne pathogens
  - — *Salmonella* species
  - — *Shigella dysenteriae*
  - — *Escherichia coli* O157:H7
  - — *Vibrio cholerae*
  - — *Cryptosporidium parvum*

Category C Agents
- Nipah virus
- Hantaviruses
- Tickborne hemorrhagic fever viruses
- Tickborne encephalitis viruses
- Yellow fever virus
- Multidrug-resistant *Mycobacterium tuberculosis*

Diagnostic Tests

If possible, given the constraints of case volume and biosafety concerns, complete autopsies with histologic sampling of multiple organs should be performed in deaths potentially caused by infections with biologic terrorism agents. Autopsy diagnostic procedures for the Category A agents include microscopic examination, combined with the collection of specimens for additional tests that will aid in determining a definitive organism-specific diagnosis. Blood, cerebrospinal fluid, and tissue samples or swabs should be placed in transport media that will allow bacterial and viral isolation. Serum should be collected for serologic and biologic assays. Tissue samples should be frozen for polymerase chain reaction (PCR). Tissue samples should also be placed in electron microscopy fixative (glutaraldehyde). Microscopic examination of formalin-fixed, paraffin-embedded tissues stained with hematoxylin and eosin (H&E) is essential to characterizing the patterns of tissue damage defining a syndrome and establishes a list of possible microorganisms in the differential diagnosis. To enhance surveillance for these conditions, a matrix of potential pathology-based syndromes (Table 1) has been developed to guide autopsy pathologists in recognizing potential cases (*24*). Special stains (e.g., tissue Gram and silver impregnation stains [Steiner's or Warthin-Starry]), can be helpful in identifying bacterial agents. Additionally, specific immunohistochemical (IHC) and direct fluorescent assays (DFA) for the Category A terrorism agents have been developed and are available at CDC.[†] These tests can be performed on formalin-fixed tissues. Clinical and pathologic characteristics of the Category

[†] Additional information is available by contacting CDC by telephone (404-639-3133) or by fax (404-639-3043).

TABLE 1. Matrix of autopsy pathologic syndromes and potential terrorism-related illnesses* or agents

Illness or agent	Autopsy pathologic syndrome
Plague, tularemia, Q fever, inhaled staphylococcal enterotoxin B, ricin	Community-acquired pneumonia; diffuse alveolar damage (ARDS)
Smallpox, viral hemorrhagic fevers, T-2 mycotoxins	Diffuse rash
Plague, tularemia, anthrax, viral hemorrhagic fevers, T-2 mycotoxins	Sepsis syndromes (i.e., disseminated intravascular coagulopathy [DIC])
Anthrax	Hemorrhagic mediastinitis or meningitis
Brucellosis, viral hemorrhagic fevers	Hepatitis, fulminant hepatic necrosis
Venezuelan equine encephalitis and other equine encephalomyelitis agents	Encephalitis, meningitis
Viral hemorrhagic fever (Lassa)	Pharyngitis, epiglottitis and other upper airway infections
Cutaneous anthrax, bubonic plague, tularemia	Soft tissue infections — cellulitis, abscess, necrotizing fasciitis
Escherichia coli and *Shigella colitis*, gastrointestinal anthrax	Hemorrhagic colitis

* Adapted from Med-X, New Mexico Surveillance Program.

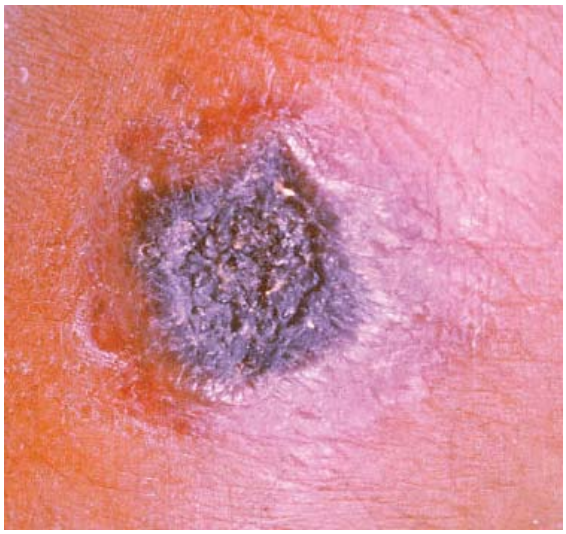
A agents and corresponding diagnostic methods are summarized in this report (Tables 2 and 3).

Anthrax

Agent: *Bacillus anthracis*

Pathologic Findings. Anthrax has three pathologic forms. Cutaneous anthrax is characterized by an eschar that forms where the bacteria entered the skin (Figure 2). Microscopically, the epidermis has necrosis and crusts, whereas the dermis demonstrates necrosis, edema, hemorrhage, perivascular inflammation, and vasculitis. The lymph nodes that drain the skin site eventually become enlarged, necrotic, and hemorrhagic. Gastrointestinal anthrax is distinguishable by hemorrhagic ulcers in the terminal ileum and caecum accompanied by mesenteric hemorrhagic lymphadenitis and peritonitis. Inhalational anthrax is characterized by hemorrhagic mediastinal lymphadenitis (Figure 3) accompanied by pleural effusions. Histologically, lymph nodes have abundant edema, hemorrhage, and necrosis with limited inflammatory infiltrate (Figure 4) (*18,25–29*). As any of the three anthrax forms progresses, the bacteria can spread to abdominal organs, producing petechial hemorrhages, and to the central nervous system, producing hemorrhagic meningitis (i.e., cardinal's cap) (Figure 5).

FIGURE 2. Cutaneous anthrax — eschar lesion



Public Health Image Library, CDC

Diagnostic Specimens. Performing a complete autopsy with histologic sampling of multiple organs will help determine the distribution of bacilli and the portal of entry. The specimens that harbor the highest number of *B. anthracis* organisms vary by the pathologic form of anthrax. For example, diagnosis of cutaneous anthrax requires skin samples from the center and periphery of the eschar, whereas for inhalational anthrax, pleural fluid cell blocks, pleura tissue, and mediastinal lymph nodes have the highest amounts of bacilli and antigens.

Diagnostic Tests. If the patient has not received antibiotics, bacilli can be observed in tissues with H&E, Gram, and silver impregnation stains and IHC assays (Figures 6 and 7). However, after antibiotic treatment

TABLE 2. Selected epidemiologic characteristics of illnesses caused by Category A biologic agents*

Disease	Incubation period	Durationof illness	Case fatality rates
Inhalational anthrax	1–6 days	3–5 days	Untreated, 100% Treated, 45%
Botulism	6 hr–10 days	24–72 hrs	Outbreak-associated, first patient, 25% Subsequent patients, 4% Overall, 5%–10%
Tularemia	1–21 days	2 weeks	Untreated, 33% Treated, <4%
Pneumonic plague	2–3 days	1–6 days	Untreated, 40%–70% Treated, 5%
Smallpox	7–17 days	4 weeks	Overall, 20%–50%
Viral hemorrhagic fevers	4–21 days	7–16 days	Overall, 53%–88%

* **Source:** CDC. Bioterrorism : agent summary. Atlanta, GA: US Department of Health and Human Services, CDC, 2001.

TABLE 3. Primary pathologic features and differential diagnoses of illnesses caused by Category A biologic agents

Agent/disease	Primary pathologic features	Differential diagnosis
Smallpox virus (variola major)	Multiloculated vesicles, ballooning degeneration of epithelial cells, intracytoplasmic inclusions (Guarnieri bodies)	Chicken pox, monkeypox, parapox, tanapox, herpes simplex, secondary syphilis
Bacillus anthracis (anthrax)	Inhalational anthrax — hemorrhagic mediastinitis, hemorrhagic lymphadenitis, hemorrhagic pleural effusion	Inhalational anthrax — community acquired pneumonia, pneumonic tularemia or plague, hantavirus pulmonary syndrome, bacterial/fungal/tuberculous mediastinitis or meningitis, fulminate mediastinal tumors, aortic dissection
	Cutaneous anthrax — hemorrhage, edema, necrosis, perivascular infiltrate, vasculitis	Cutaneous anthrax — rickettsialpox, spider bite, ecthyma gangrenosum, ulceroglandular tularemia
	Gastrointestinal anthrax — hemorrhagic enteritis, hemorrhagic lymphadenitis, mucosal ulcers with necrosis in the terminal ileum and cecum, peritonitis	
	CNS involvement — hemorrhagic meningitis	
Yersinia pestis (plague)	Bubonic plague — acute lymphadenitis with surrounding edema	Bubonic plague — tularemia, other bacterial adenitis
	Pneumonic plague — severe, confluent, hemorrhagic, and necrotizing bronchopneumonia, often with fibrinous pleuritis	Pneumonic plague — inhalational anthrax, community acquired pneumonia, pneumonic tularemia, hantavirus pulmonary syndrome
	Septicemic plague — generalized lymphadenitis, foci of necrosis in lymph nodes and other reticuloendothelial organs, disseminated intravascular coagulation (DIC) with widespread hemorrhages and thrombi	Septicemic plague — other bacterial sepsis
	CNS involvement — meningitis	Plague meningitis — other bacterial or fungal meningitis
Francisella tularensis (tularemia)	Ulceroglandular tularemia — skin ulcer with associated suppurative necrotizing lymphadenitis	Ulceroglandular tularemia — cutaneous anthrax, rickettsialpox, spider bite, ecthyma gangrenosum
	Glandular tularemia — suppurative necrotizing lymphadenitis without associated skin ulcer	Glandular tularemia — pyogenic bacterial infections, cat-scratch disease, syphilis, chancroid, lymphogranuloma venereum, tuberculosis, nontuberculous mycobacterial infection, toxoplasmosis, sporotrichosis, rat-bite fever, anthrax, plague
	Oculoglandular tularemia — eyelid edema, acute conjunctivitis and edema, small conjunctival ulcers, regional lymphadenitis	Oculoglandular tularemia — pyogenic bacterial infections, adenoviral infection, syphilis, cat-scratch disease, herpes simplex virus infection
	Pharyngeal tularemia — exudative pharyngitis or tonsillitis with ulceration, pharyngeal membrane formation, regional lymphadenitis	Pharyngeal tularemia — streptococcal pharyngitis, infectious mononucleosis, adenoviral infection, diphtheria
	Typhoidal tularemia — systemic involvement, DIC, focal necrosis of major organs	Typhoidal tularemia — typhoid fever, brucellosis, Q fever, disseminated bacterial, mycobacterial or fungal infection, rickettsioses, malaria
	Pneumonic tularemia — acute inflammation, diffuse alveolar damage	Pneumonic tularemia — community-acquired pneumonia, pneumonic plague, hantavirus pulmonary syndrome
Viral hemorrhagic fevers	Filoviruses (Ebola and Marburg) — massive hepatocellular necrosis, filamentous inclusions in hepatocytes, extensive necrosis in other major organs, diffuse alveolar damage	Other systemic infections caused by viral, bacterial, or rickettsial agents
	Arenaviruses (Lassa, Junin, Machupo, Guanarito) — massive hepatic necrosis, diffuse alveolar damage	

FIGURE 3. Inhalational anthrax — hemorrhagic mediastinal lymphadenitis surrounding trachea; inset, cross-section of trachea surrounded by hemorrhagic soft tissue and lymph nodes

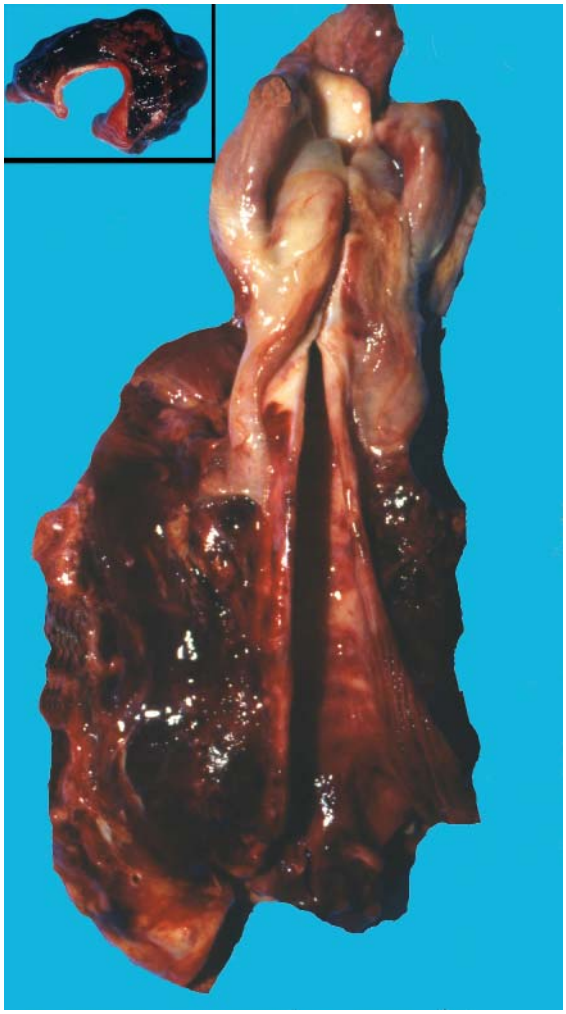


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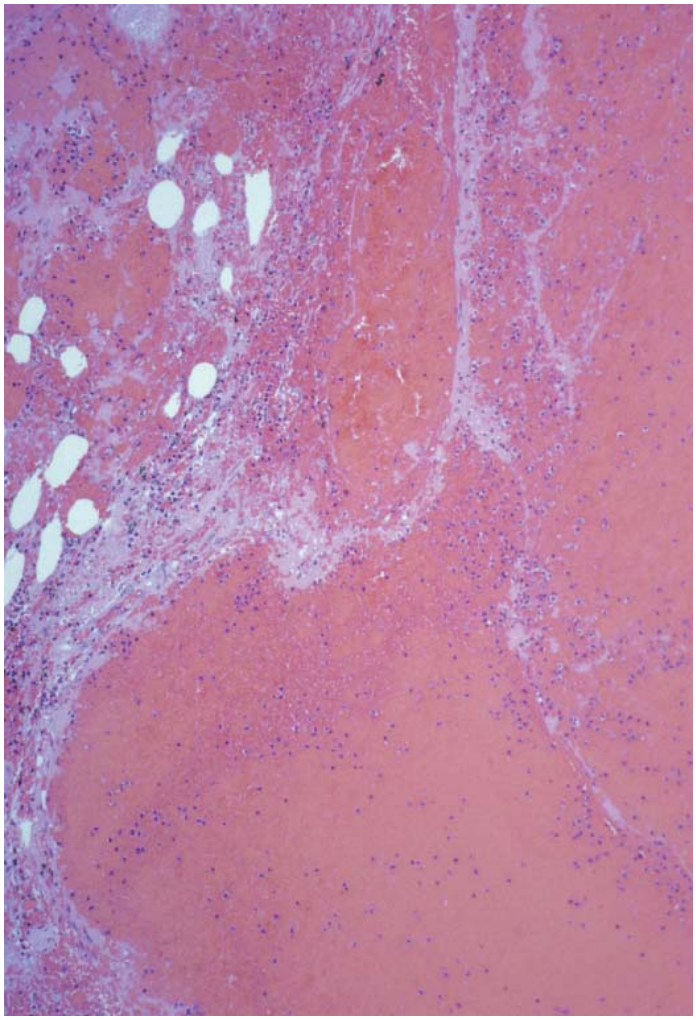
FIGURE 4. Inhalational anthrax — histologic section of mediastinal lymph node with hemorrhage, necrosis, and sparse inflammatory cell infiltrate (hematoxylin and eosin stain)



Infectious Disease Pathology Activity, CDC

has been instituted, only silver stains and IHC assays will highlight the bacilli. IHC assays for *B. anthracis* can demonstrate bacilli, bacillary fragments, and granular bacterial fragments in formalin-fixed tissues, even after 10 days of antibiotic treatment. Although a DFA test is available for *B. anthracis*, it is not used on formalin-fixed tissues.

Plague

Agent: *Yersinia pestis*

Pathologic Findings. Similar to anthrax, the clinicopathologic manifestations of plague are classified on the basis of the portal of entry of *Y. pestis*. Bubonic plague refers to an acute lymphadenitis that occurs after the bacteria have penetrated the skin (Figure 8). Usually, skin lesions are inconspicuous or have a small vesicle or pustule that might not be evident at the time the infected lymph node (bubo) appears. Histologically, the bubo exhibits edema, hemorrhage, necrosis, and a ground-glass amphophilic material that represents masses of bacilli. Primary pneumonic plague refers to the infection caused by inhalation of airborne bacteria, producing intra-alveolar edema accompanied by varying amounts of acute inflammatory infiltrate and abundant bacteria. Primary septicemic plague occurs when *Y. pestis* enters through the oropharyngeal route. In septicemic plague, the cervical lymph nodes draining the infected region will display the previously described pathologic features. As the disease progresses, bacteria are distributed widely throughout the body, and findings consistent with shock and disseminated intravascular coagulation are observed.

FIGURE 5. Anthrax — hemorrhagic meningitis

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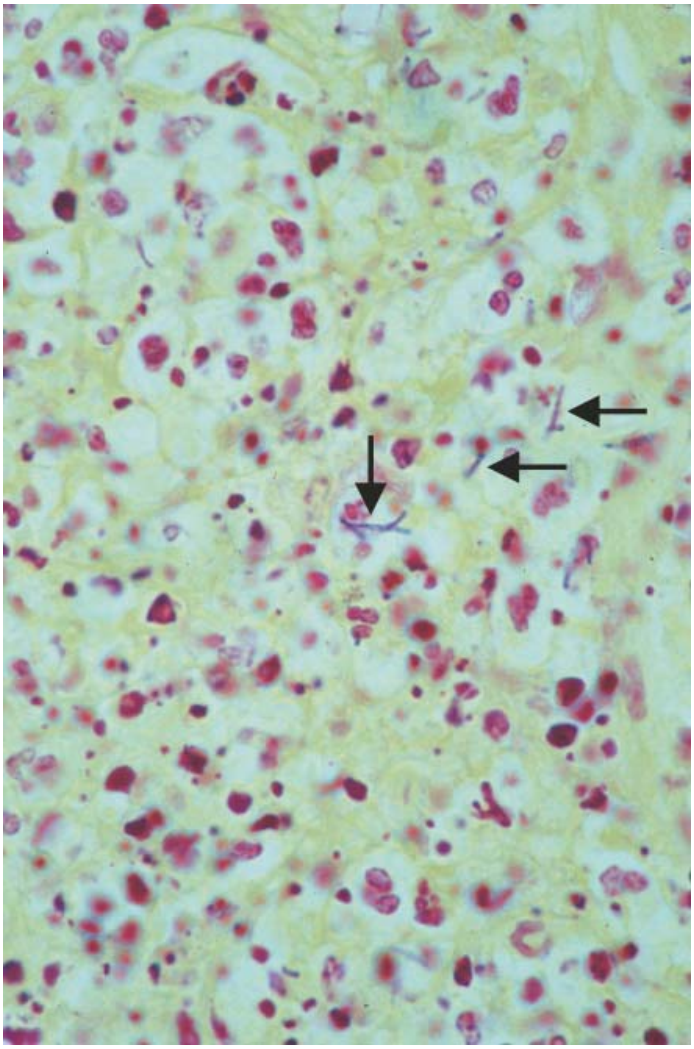
Septicemic plague with bacterial seeding of the lungs results in secondary pneumonic plague (Figure 9, left [A]) (*30–35*).

Diagnostic Specimens. Performing a complete autopsy with histologic sampling of multiple organs will help determine the distribution of bacteria and the portal of entry. Enlarged, soft, hemorrhagic lymph nodes should be sampled and tested for *Y. pestis*. The lungs should be sampled to determine whether a primary or secondary infection existed (*30*).

Diagnostic Tests. *Y. pestis* can be visualized in formalin-fixed tissues by using H&E, Gram, silver impregnation, and Giemsa stains; however, specific identification of the bacilli in tissues can only be performed by using IHC or DFA (Figure 9, right [B]).

FIGURE 6. Anthrax — *Bacillus anthracis* rods in mediastinal lymph node (Gram stain)



Infectious Disease Pathology Activity, CDC

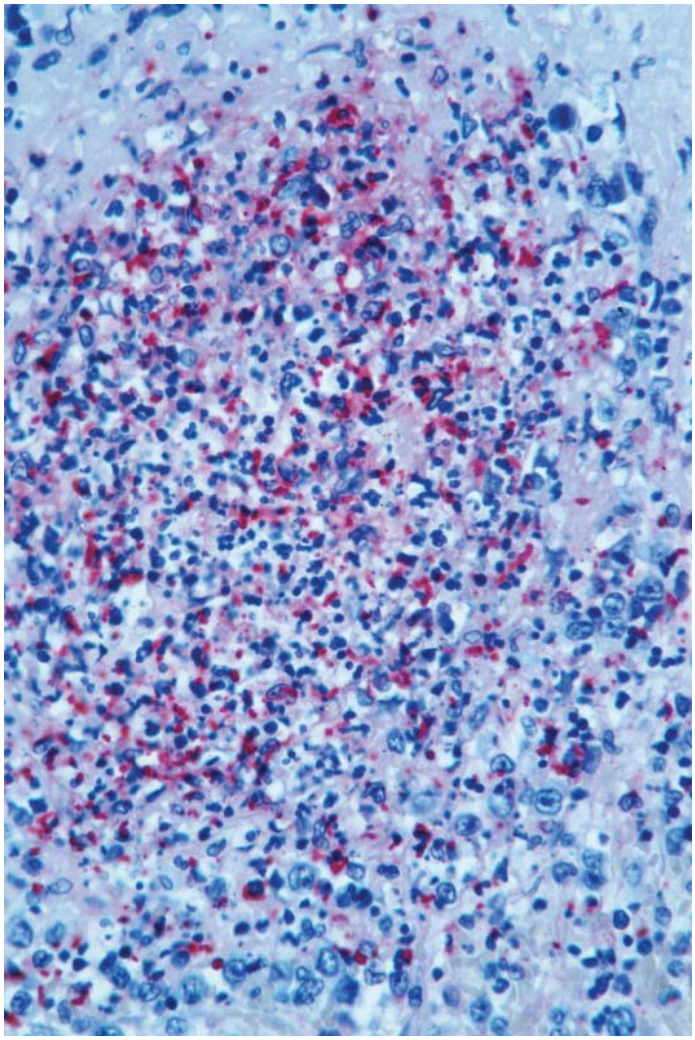
Tularemia

Agent: *Francisella tularensis*

Pathologic Findings. Tularemia can also have multiple clinicopathologic forms, depending on the portal of entry, including ulceroglandular, oculoglandular, glandular, pharyngeal, typhoidal, and pneumonic. In all forms, the primary draining lymph nodes demonstrate necrotizing lymphadenitis surrounded by a neutrophilic and granulomatous inflammatory infiltrate. In the ulceroglandular form, a skin ulcer or eschar with corresponding lymph node involvement is present, but skin lesions are absent in the glandular form. In the oculoglandular form, the eye exhibits conjunctivitis with ulcers and soft-tissue edema. The pharyngeal form is characterized by pharyngitis or tonsillitis with ulceration. The lungs in pneumonic tularemia exhibit abundant fibrinous necrosis accompanied by varying amounts of mixed inflammatory infiltrate (Figure 10, left [A]). Typhoidal tularemia refers to systemic involvement with focal areas of necrosis in the major organs and disseminated intravascular coagulation, but lacks a group of primary draining lymph nodes (*36–40*). In cases of tularemia sepsis, organisms can be seen with blood smears (Figure 11).

Diagnostic Specimens. Performing a complete autopsy with histologic sampling of multiple organs will help determine the distribution of bacteria and the portal of entry. Enlarged, necrotic lymph nodes should be sampled and tested for *F. tularensis*. Culture swabs from the potential portals of entry (e.g., skin, conjunctiva, or throat) can be useful.

FIGURE 7. Anthrax — *Bacillus anthracis* rods, bacillary fragments and granular bacterial fragments in spleen (immunohistochemistry)



Infectious Disease Pathology Activity, CDC

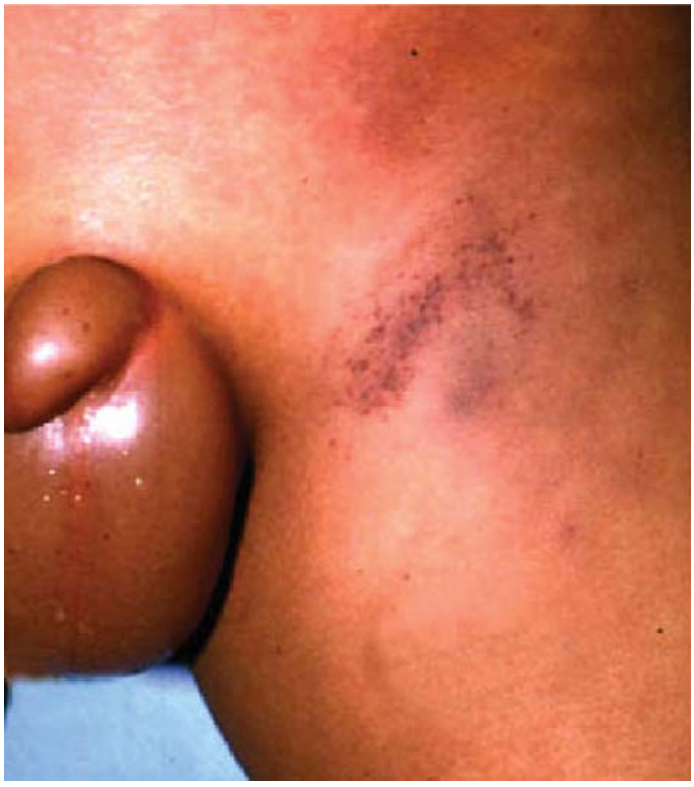
Diagnostic Tests. The microorganisms are difficult to demonstrate with special stains; however, IHC and DFA have been successfully used in formalin-fixed tissues to demonstrate the bacteria (Figure 10, right [B]).

Botulism

Agent: Absorption of *Clostridium botulinum* Toxin

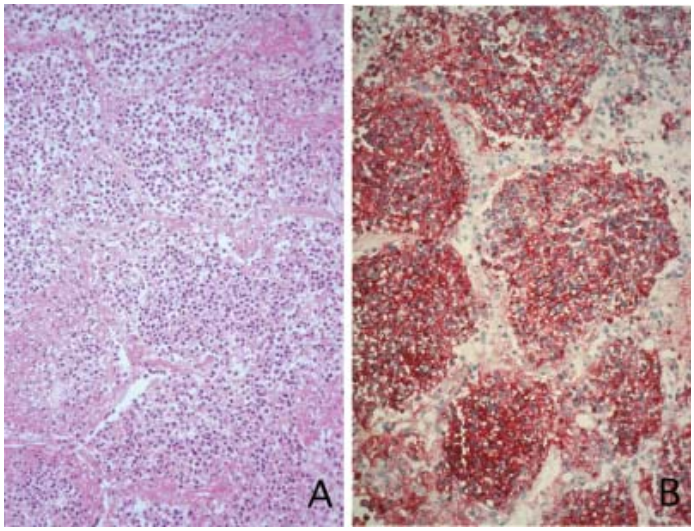
Pathologic Findings. *C. botulinum* elaborates a potent, preformed neurotoxin. The most important diagnostic feature of botulism is the clinical history because the histopathologic changes are nonspecific (e.g., central nervous system hyperemia and microthrombosis of small vessels) (*41*).

FIGURE 8. Bubonic plague — lymphadenitis



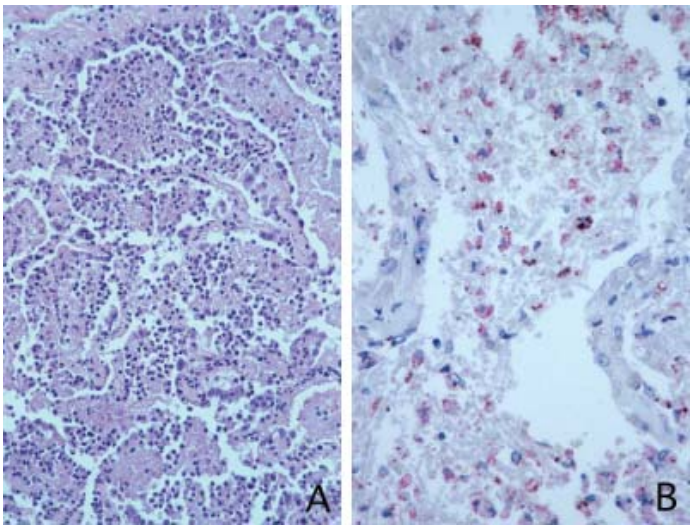
New Mexico Office of the Medical Investigator

FIGURE 9. Secondary pneumonic plague — histologic sections of lung with (A, left) neutrophilic infiltrate in alveolar space (hematoxylin and eosin stain) and (B, right) *Yersinia pestis* bacteria (immunohistochemistry)



Infectious Disease Pathology Activity, CDC

FIGURE 10. Primary pneumonic tularemia — histologic sections of lung with (A, left) neutrophilic infiltrate in alveolar space (hematoxylin and eosin stain) and (B, right) *Francisella tularensis* bacteria (immunohistochemistry)



Infectious Disease Pathology Activity, CDC

Diagnostic Specimens. When botulism is suspected because of a symmetrical, descending pattern of weakness and paralysis of cranial nerves, limbs, and trunk, the pathologist should obtain tissue for anaerobic cultures from the suspect entry sites (i.e., wound, gastrointestinal tract, or respiratory tract) and serum for botulinum toxin mouse bioassay.

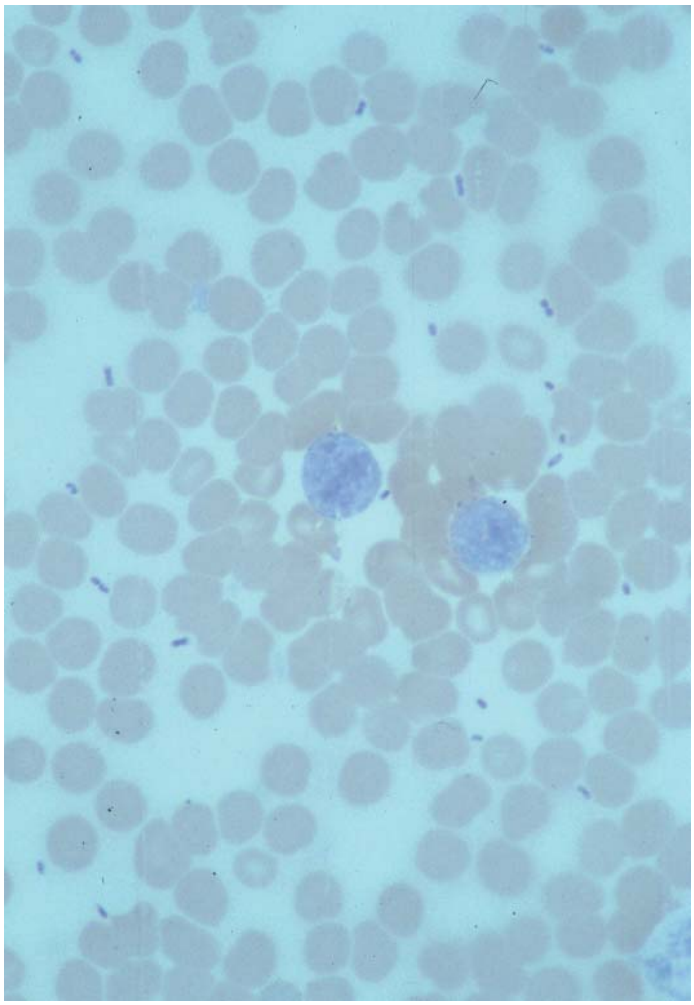
Diagnostic Tests. Microbiologic culture and botulinum toxin mouse bioassay with serum are necessary.

Smallpox

Agent: Variola virus (Orthopoxvirus)

Pathologic Findings. Smallpox is an acute, highly contagious illness caused by a member of the *Poxviridae* family. Variola major refers to the form with a higher mortality rate, and variola minor or alastrim is a milder form. The lesions develop at approximately the same time and rate, starting in the palms and soles and spreading centrally; they first appear as macules and papules, and then progress to vesicles and umbilicated pustules (Figure 12), followed by scabs and crusts, and end as pitted scars. Occasionally, a hemorrhagic and uniformly fatal form occurs. This form has extensive bleeding into the skin and gastrointestinal tract and can be grossly taken for meningococcemia, acute leukemia, or a drug reaction (*42*). Microscopically, the skin exhibits multiloculated, intraepidermal vesicles; ballooning degeneration of epithelial cells; intracytoplasmic, paranuclear, and eosinophilic viral inclusions (i.e., Guarnieri bodies) (Figure 13); and occasionally

FIGURE 11. Tularemia — blood smear demonstrating *Francisella tularensis* bacteria (Giemsa stain)



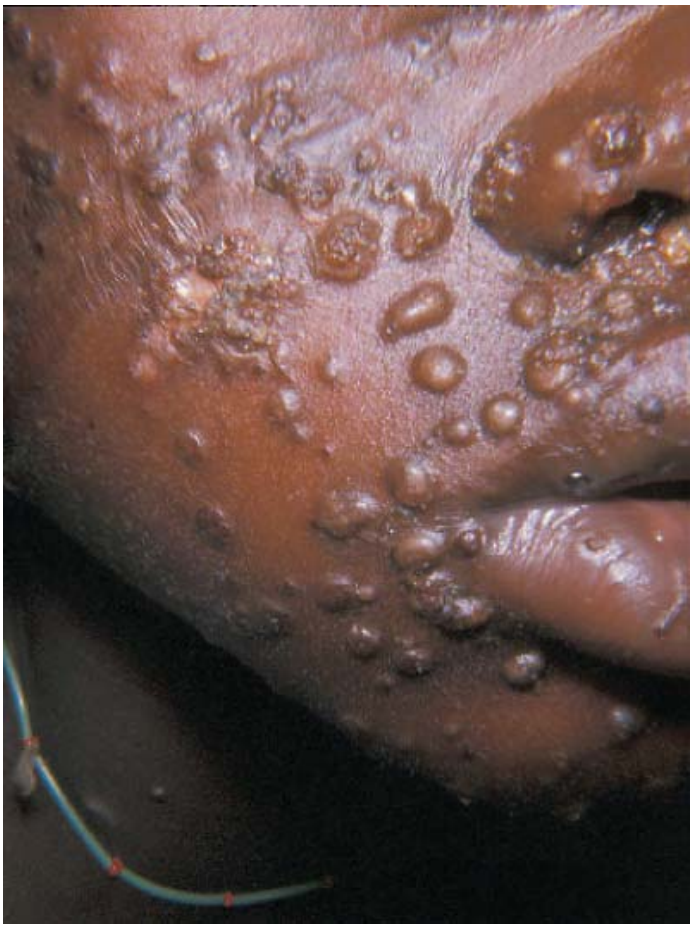
Infectious Disease Pathology Activity, CDC

intranuclear viral changes. Secondary infections (e.g., bronchitis, pneumonia, and encephalitis) can complicate the clinical appearance (*43–48*).

Diagnostic Specimens. Cutaneous lesions are the most important sample for smallpox. Samples should include fluid from vesicles to be studied by electron microscopy, and skin samples fixed in formalin for histopathology and immunohistochemistry. Performing a complete autopsy with histologic sampling of multiple organs will help determine the extent and distribution of the virus, as well as the occurrence of secondary infections.

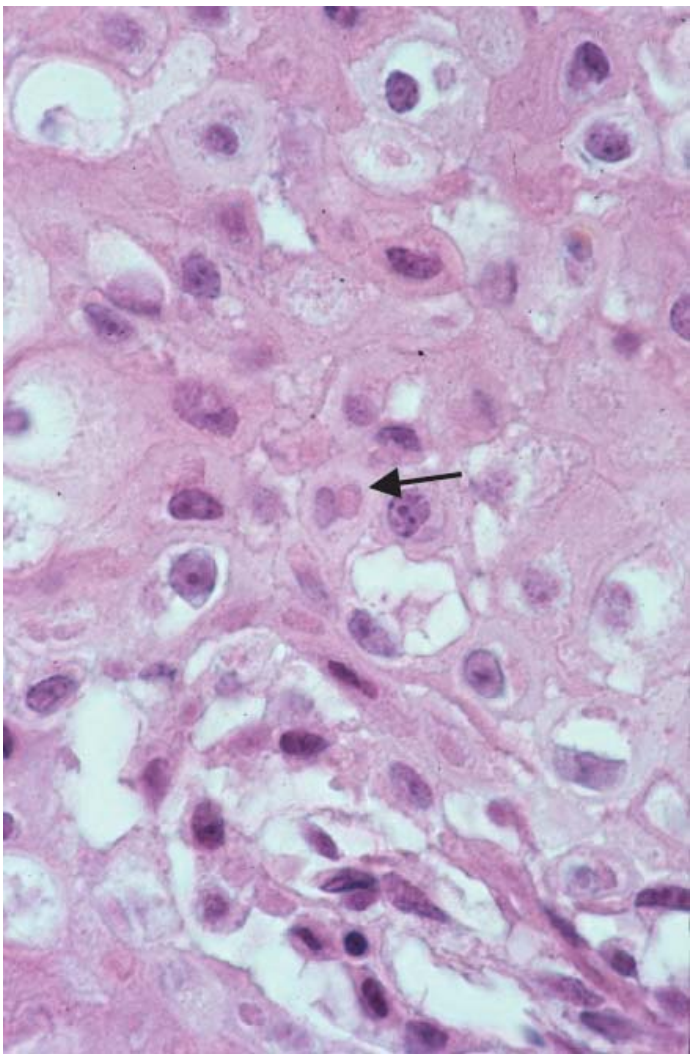
Diagnostic Tests. Electron microscopic studies of vesicle fluid or skin samples can identify characteristic viral particles (Figure 14). IHC studies have demonstrated the virus in the epithelial cells and in the subjacent fibroconnective tissue.

FIGURE 12. Smallpox — cutaneous papules and vesicles



Public Health Image Library, CDC

FIGURE 13. Smallpox — histologic section of skin with intraepidermal vesicles and ballooning degeneration of epithelial cells with viral inclusions (Guarnieri bodies [arrow]) (hematoxylin and eosin stain)



Infectious Disease Pathology Activity, CDC

Viral Hemorrhagic Fevers

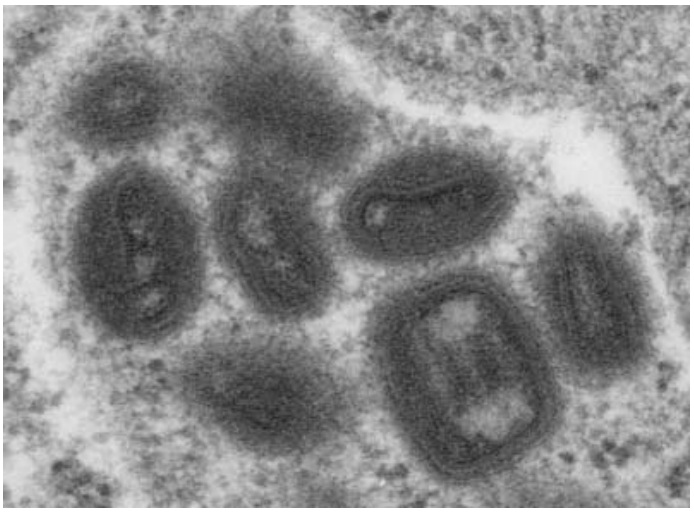
Agents: Multiple

Viruses that can cause hemorrhagic fevers belong to different families, including *Filoviridae* (Ebola, Marburg viruses), *Flaviviridae* (yellow fever, dengue viruses), *Bunyaviridae* (Rift Valley fever, Crimean Congo, Hantaan, Sin Nombre viruses), and *Arenaviridae* (Junin, Machupo, Guanarito, Lassa viruses).

Pathologic Findings. The term viral hemorrhagic fever is reserved for febrile illnesses associated with abnormal vascular regulation and vascular damage. Common pathologic findings at autopsy include petechial hemorrhages and ecchymoses of skin (Figure 15), mucous membranes, and internal organs. Although systemic hemorrhages occur in the majority of viral hemorrhagic fevers, certain agents infect specific cells and thus histopathologic features can differ among agents. Necrosis of liver and lymphoid tissues, as well as diffuse alveolar damage, occur in the majority of viral hemorrhagic fevers, but can be more prominent for certain infections (e.g., midzonal hepatocellular necrosis is prominent in yellow fever, but not in dengue). Viral inclusions can be visualized in hepatocytes with Ebola or Marburg infections by using light and electron microscopy (Figure 16) (*49–54*).

Diagnostic Specimens. Performing a complete autopsy with histologic sampling of multiple organs can determine the extent of the disease and help identify the specific virus. After a specific etiologic agent has been isolated or identified from an index case, targeted sampling of additional cases with similar symptoms can decrease the exposure of autopsy personnel to these hazardous agents and still yield diagnostic material. For example, during outbreaks of Ebola hemorrhagic fever in Africa, using IHC on skin punch biopsy samples was sufficient to provide a diagnosis in a substantial number of

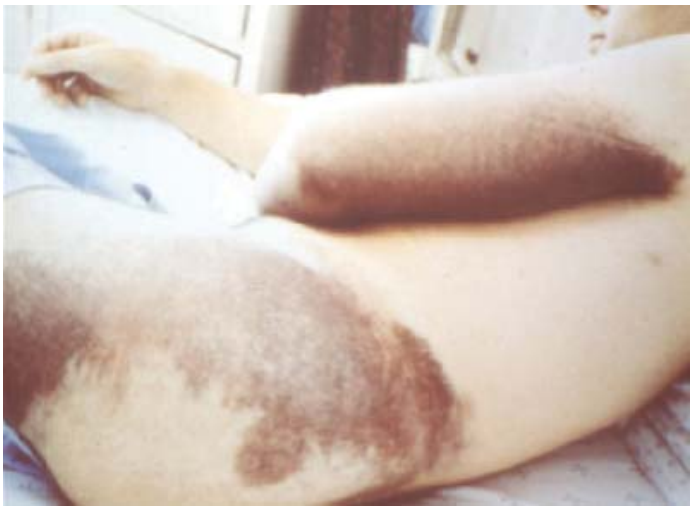
FIGURE 14. Intracellular mature variola virus particles grown in cell culture*



Infectious Disease Pathology Activity, CDC

* **Note:** The barbell-shaped inner core and two lateral bodies are surrounded by an outer membrane. One brick-shaped particle is also illustrated (thin section electron microscopy).

FIGURE 15. Crimean-Congo hemorrhagic fever — cutaneous petechiae and ecchymoses



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fatalities and minimized the risk to the medical personnel who obtained the specimens (*49*).

Diagnostic Tests. Serum and skin samples can be tested by using PCR, immunohistochemistry, and electron microscopy (Figure 17). Additionally, serum can be inoculated into experimental animals or culture cells for viral isolation.

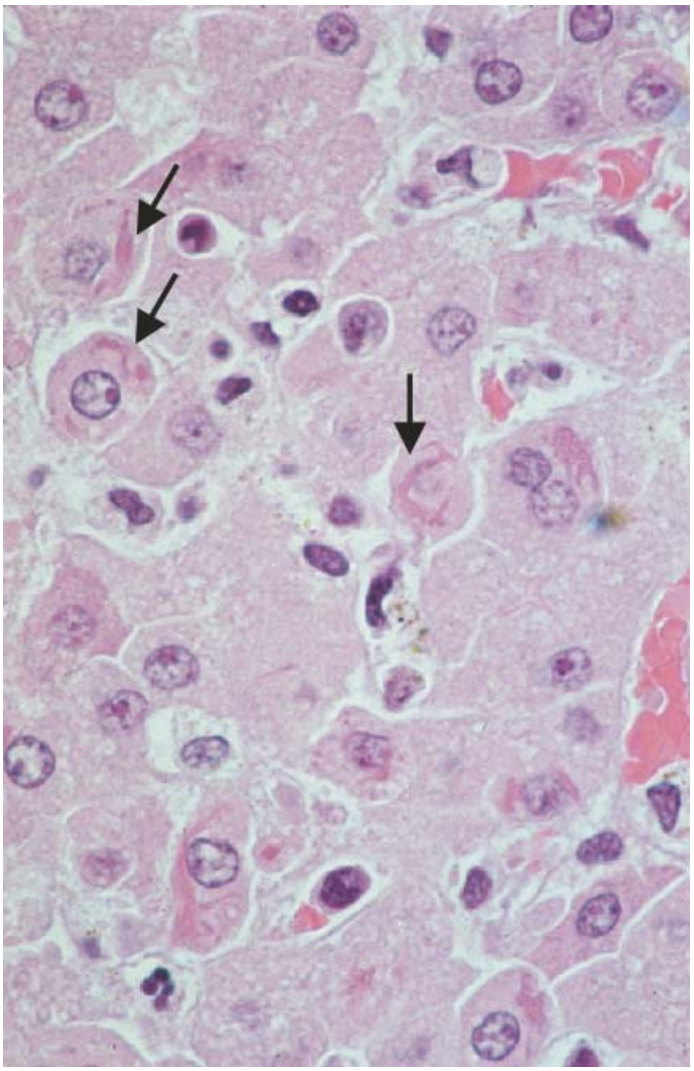
Laboratory Response Network

CDC, in collaboration with the Association of Public Health Laboratories (APHL), the FBI, and other federal agencies, has developed the Laboratory Response Network (LRN) as a multilevel system of linked local, state, and federal public health laboratories as well as veterinary, food, and environmental laboratory partners (*55–57*). The primary components of LRN are the state public health laboratories representing each of the 50 states. Within certain states, laboratories are located in different counties and more populated cities. In addition, federal laboratories within LRN include CDC, the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA), the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID), and other Department of Defense laboratories.

Each laboratory has been assigned a designation (Table 4), predicated on their diagnostic capability, ranging from sentinel status (i.e., Level A for presumptive-level screening) through national laboratory status (i.e., Level D for genetic subtyping and confirmatory testing) (*55–57*). Hospital clinical laboratories are designated as sentinel laboratories (Level A); they have a rapid rule out and forward mission when handling presumptive clinical cases. County, city, and state public health laboratories are designated as confirmatory reference facilities (Level B, core, or Level C, advanced), depending on their degree of containment capacity and technical proficiency in performing agent-specific confirmatory analyses and rapid presumptive testing by PCR for nucleic acid amplification and time-resolved fluorescence for antigen detection. The Level D designation is reserved for CDC and USAMRIID laboratories. No regional laboratories exist; the network functions by channeling the specimens through the designated levels to a pathogen-specific conclusion.

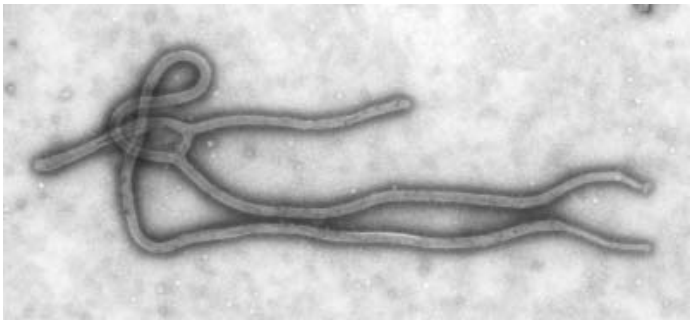
ME/Cs should submit specimens from suspected biologic terrorism-related cases to the state public health laboratory through the local or county laboratory that serves their jurisdiction, unless their standard reporting protocol makes them a direct client of the state laboratory. These primary laboratories conduct the tests that fall within the scope of their ability and refer specimens to the state laboratory for more advanced tests. The state laboratory processes and refers specimens in a similar manner to other state laboratories or CDC (Figure 18). Contact information for all state diagnostic laboratories is included in this report (Appendix A). The point of contact for ME/Cs should remain the laboratory where the specimens were first submitted, unless they are directed to contact a reference laboratory (e.g., a state laboratory) to track the progress of the testing. Before the need for LRN services arises, ME/Cs should establish contact with the public health laboratory serving their jurisdiction and determine how the laboratory

FIGURE 16. Ebola hemorrhagic fever — necrotic hepatocytes with filamentous intracytoplasmic inclusions (arrows) (hematoxylin and eosin stain)



Infectious Disease Pathology Activity, CDC

FIGURE 17. Ultrastructural appearance of Ebola virus (electron microscopy negative stain)



Infectious Disease Pathology Activity, CDC

services can be best accessed when needed. Such a relationship might require a memorandum-of-understanding, which should be prepared and agreed to in advance.

All specimens that are to be tested for potential biologic terrorism pathogens are handled through the same reporting and submission process except specimens potentially containing smallpox virus. Because smallpox virus should only be handled in a Biosafety Level 4 facility, the specimen should be transported to CDC (*57*). If ME/Cs suspect this agent, they should notify their state public health department, which can test for other agents that cause a vesiculopustular rash (i.e., varicella zoster, vaccinia, and monkeypox viruses) and either further test or refer the specimen for rapid presumptive screening for smallpox virus by PCR. The same laboratories will be able to coordinate submission of the specimen to CDC as needed for pathogen confirmation. In advance, ME/Cs should establish contact with the state health department representative who would coordinate smallpox specimen submission. In their surveillance capacity and concurrent with specimen submission, ME/Cs should notify the epidemiologic investigation unit in their local or state health department of the suspected smallpox-infected decedent.

Biosafety Concerns

Autopsy Risks

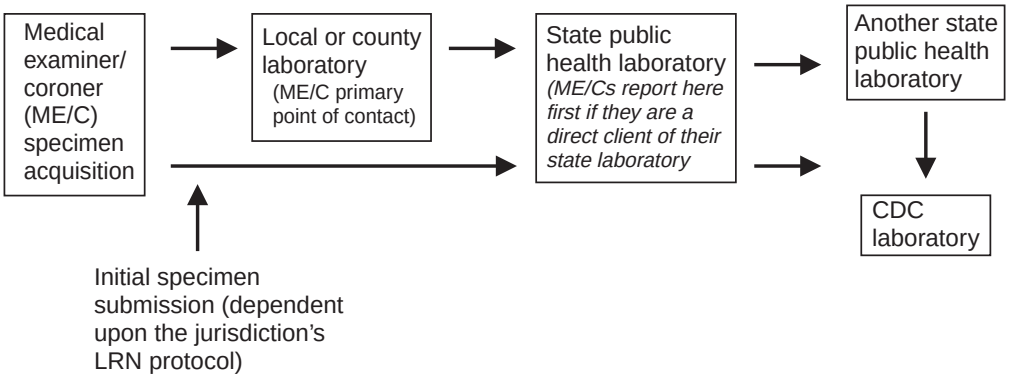
Biosafety is critical for autopsy personnel who might handle human remains contaminated with biologic terrorism agents. Tularemia, viral hemorrhagic fevers, smallpox, glanders, and Q fever have been transmitted to persons performing autopsies (i.e., prosectors); certain infections have been fatal (*49,58–70*). Infections can be transmitted at autopsies by percutaneous inoculation (i.e., injury), splashes to unprotected mucosa, and inhalation of infectious aerosols (*71*). All of the Category A pathogens are potentially transmissible to autopsy personnel, although the degree of risk varies considerably among these organisms.

Additionally, autopsies of persons who die as the result of terrorism-related infections might expose autopsy personnel to residual surface contamination with infectious material. For example, botulinum toxin has the potential to be inhaled by autopsy personnel if it is present on the body surface at the time of examination (*72*). Heavy surface contamination of the body is unlikely because of the incubation period for the majority of infectious agents and the likelihood that a victim will have bathed and changed clothes after exposure and before becoming symptomatic and dying (*73*). However, if such residual material (e.g., powder) is present, examination

TABLE 4. Selected characteristics and capabilities by functional level of the Laboratory Response Network for terrorism

Laboratory level	Biosafety level (BSL)	Capabilities	Testing Resource
D	BSL-4	• Probe for universal agents • Perform all Level A–C tests • Validate new assays • Detect genetic recombinants • Provide specialized reagents • Bank isolates • Molecular typing • Negative stain electron microscopy for smallpox virus	CDC; U.S. Army Medical Research Institute of Infectious Diseases
C	BSL-3	• Nucleic acid amplification assays • Molecular typing • Toxicity testing • Provide surge capacity	Selected state public health laboratories
B	BSL-3Recommended or BSL-2 facilities with BSL-3 practices	• Rule in specific agents • Isolate and identify • Forward specimens to higher level laboratories • Process environmental samples • Perform confirmatory testing • Antimicrobial susceptibility testing	Selected state and county public health laboratories and other veterinary, environmental, and food testing laboratories
A	BSL-2	• Rule out specific agents • Early detection of presumptive cases • Forward specimens to higher level laboratories	Clinical and other sentinel laboratories

FIGURE 18. Process for submitting specimens containing suspected Category A, B, or C* biologic agents (except smallpox virus) for testing within the Laboratory Response Network (LRN)



* **Note:** Dependent upon the LRN-designated capacity (Level A, sentinel; Level B, core; Level C, advanced), laboratory confirmation might occur on-site or require referral to the next higher-level laboratory for confirmatory testing or correct biocontainment.

and specimen collection should be undertaken by using appropriate biosafety procedures to protect autopsy and analytic laboratory personnel from possible exposure to more concentrated infectious material.

Because human remains infected with unidentified biologic terrorism pathogens might arrive at autopsy without warning, basic protective measures described in this report should be maintained for all contact with potentially infectious materials (*74,75*). In addition to these measures, certain high-risk activities (e.g., use of oscillating saw) are known to increase the potential for worker exposure and should be performed with added safety precautions.

Autopsy Precautions

Existing guidelines for biosafety and infection control for patient care are designed to prevent transmission of infections from living patients to care providers, or from laboratory specimens to laboratory technicians (*76,77*). Although certain biosafety and infection-control guidelines are applicable to the handling of human remains, inherent differences exist in transmission mechanisms and intensity of potential exposures during autopsies that require specific consideration (*71*).

As with any contact involving broken skin or body fluids when caring for live patients, certain precautions must be applied to all contact with human remains, regardless of known or suspected infectivity. Even if a pathogen of concern has been ruled out, other unsuspected agents might be present. Thus, all human autopsies must be performed in an appropriate autopsy room with adequate air exchange by personnel wearing appropriate personal protective equipment (PPE) (*71*). All autopsy facilities should have written biosafety policies and

procedures; autopsy personnel should receive training in these policies and procedures, and the annual occurrence of training should be documented.

Standard Precautions are the combination of PPE and procedures used to reduce transmission of all pathogens from moist body substances to personnel or patients (*77*). These precautions are driven by the nature of an interaction (e.g., possibility of splashing or potential of soiling garments) rather than the nature of a pathogen. In addition, transmission-based precautions are applied for known or suspected pathogens. Precautions include the following:

- airborne precautions — used for pathogens that remain suspended in the air in the form of droplet nuclei and that can transmit infection if inhaled;
- droplet precautions — used for pathogens that are transmitted by large droplets traveling 3–6 feet (e.g., from sneezes or coughs) and are no longer transmitted after they fall to the ground; and
- contact precautions — used for pathogens that might be transmitted by contamination of environmental surfaces and equipment.

All autopsies involve exposure to blood, a risk of being splashed or splattered, and a risk of percutaneous injury (*71*). The propensity of postmortem procedures to cause gross soiling of the immediate environment also requires use of effective containment strategies. All autopsies generate aerosols; furthermore, postmortem procedures that require using devices (e.g., oscillating saws) that generate fine aerosols can create airborne particles that contain infectious pathogens not normally transmitted by the airborne route (*71,78–81*).

PPE

For autopsies, Standard Precautions can be summarized as using a surgical scrub suit, surgical cap, impervious gown or apron with full sleeve coverage, a form of eye protection (e.g., goggles or face shield), shoe covers, and double surgical gloves with an interposed layer of cut-proof synthetic mesh (*71*). Surgical masks protect the nose and mouth from splashes of body fluids (i.e., droplets >5 µm); they do not provide protection from airborne pathogens (*82,83*). Because of the fine aerosols generated at autopsy, prosectors should at a minimum wear N-95 respirators for all autopsies, regardless of suspected or known pathogens (*84*). However, because of the efficient generation of high concentration aerosols by mechanical devices in the autopsy setting, powered air-purifying respirators (PAPRs) equipped with N-95 or high-efficiency particulate air (HEPA) filters should be considered (*85–87*). Autopsy personnel who cannot wear N-95 respirators because of facial hair or other fit limitations should wear PAPRs.

Autopsy Procedures

Standard safety practices to prevent injury from sharp items should be followed at all times (*77*). These include never recapping, bending, or cutting needles, and ensuring that appropriate puncture-resistant sharps disposal containers are available. These containers should be placed as close as possible to where sharp items are used to minimize the distance a sharp item is carried. Filled sharps disposal containers should be discarded and replaced regularly and never overfilled (*77*).

Protective outer garments should be removed when leaving the immediate autopsy area and discarded in appropriate laundry or waste receptacles, either in an antechamber to the autopsy suite or immediately inside the entrance if an antechamber is unavailable. Handwashing is requisite upon glove removal (*77*).

Engineering Strategies and Facility Design Concerns

Air-handling systems for autopsy suites should ensure both adequate air exchanges per hour and correct directionality and exhaust of airflow. Autopsy suites should have a minimum of 12 air exchanges/hour and should be at a negative pressure relative to adjacent passageways and office spaces (*84*). Air should never be returned to the building interior, but should be exhausted outdoors, away from areas of human traffic or gathering spaces (e.g., air should be directed off the roof) and away from other air intake systems (*88,89*). For autopsies, local airflow control (i.e., laminar flow systems) can be used to direct aerosols away from personnel; however, this safety feature does not eliminate the need for appropriate PPE.

Clean sinks and safety equipment should be positioned so that they do not require unnecessary travel to reach during routine work and are readily available in the event of an emergency. Work surfaces should have integral waste-containment and drainage features that minimize spills of body fluids and wastewater.

Biosafety cabinets should be available for handling and examination of smaller infectious specimens; however, the majority of available cabinets are not designed to contain a whole body (*76,90*). Oscillating saws are available with vacuum shrouds to reduce the amount of particulate and droplet aerosols generated (*80*). These devices should be used whenever possible to decrease the risk of dispersing aerosols that might lead to occupationally acquired infection.

Vaccination and Postexposure Prophylaxis

Vaccines are available that convey protection against certain diseases considered to be potentially terrorism-associated, including anthrax, plague, and tularemia (*76*). However, these

vaccines are not recommended for unexposed autopsy workers at low risk. Consistent application of standard safety practices should obviate the need for vaccination for *B. anthracis* and *Y. pestis*. In 2003, the U.S. Department of Health and Human Services (DHHS) initiated a program to administer vaccinia (smallpox) vaccine to first responders and medical personnel. In this context, persons who might be called on to assess remains or specimens from patients with smallpox should be included among this group (*91*) (Box 2).

The administration of prophylactic antibiotics to autopsy workers exposed to potentially lethal bacterial pathogens is sometimes appropriate. For example, autopsy personnel exposed to *Y. pestis* aerosols should consider receiving such treatment regardless of vaccination status (*92*). Similarly, because tularemia can result from infection with a limited number of organisms, an exposure to *F. tularensis* should also prompt consideration of antimicrobial prophylaxis. However, decisions to use antimicrobial postexposure prophylaxis should be made in consultation with infectious disease and occupational health

BOX 2. Smallpox immunization considerations for medicolegal death investigators*

Because the distribution of the smallpox vaccine to the civilian U.S. population was discontinued in 1983,† essentially all U.S. residents having contact with a smallpox case are at increased risk for infection. Although probably susceptible to smallpox, with appropriate precautions, medicolegal death investigators can reduce their risk of smallpox infection if they must examine or autopsy a decedent suspected to be infected with smallpox. Three risk-reduction activities during the postmortem period might be considered, 1) voluntary vaccination after the occurrence of smallpox has been confirmed in the community; 2) modification of autopsy procedures to limit the possible aerosolization of smallpox virus; and 3) exclusion of embalming procedures (see text).

In the event of mass fatalities resulting from a smallpox outbreak, CDC recommends that health departments consider planning for vaccinating mortuary personnel and their families.§ This recommendation is relevant for medical examiners, coroners, and other forensic death investigators who have a high likelihood of handling smallpox-infected decedents during a mass fatality event.

In considering vaccination plans, attention should be given to the risk of adverse effects from smallpox vaccination as well as to its potential benefits. During a smallpox-associated mass fatality event, the federal government might propose that vaccinia inoculations be offered on a voluntary basis to appropriate personnel. Vaccinia inoculations have been effective in preventing smallpox infection but also pose certain risks for causing adverse reactions in the vaccinee and, less frequently, for spreading the vaccinia virus to other close contacts.

Because of the increased risk of adverse effects, the Advisory Committee on Immunization Practices (ACIP) recommends that the following persons not receive vaccinia inoculation:

- persons with immunosuppressive conditions;
- those receiving immunosuppressive medical treatments or pharmaceutical regimens;
- those with eczema or who have a close contact having eczema;
- anyone who is allergic to the vaccine or any of its components;
- women who are breastfeeding;
- anyone aged <12 months; and
- pregnant women or women expecting to become pregnant within 4 weeks.¶

ACIP recommends that persons be excluded from the pre-event smallpox vaccination program who have known underlying heart disease, with or without symptoms, or who have ≥3 known major cardiac risk factors (i.e., hypertension, diabetes, hypercholesterolemia, heart disease at age 50 years in a first-degree relative, and smoking).** Persons at increased risk for adverse reactions to the vaccine should be counseled regarding the potential risks before being vaccinated.

* **Source:** Adapted from Payne DC. Smallpox considerations for forensic professionals. National Association of Medical Examiners (NAME) News 2003;11(1):2.

† **Source:** CDC. Smallpox vaccine no longer available for civilians—United States. MMWR 1983;32:387.

§ **Source:** CDC. Smallpox response plan, smallpox vaccination clinic guide. Annex 3–38. Atlanta, GA: US Department of Health and Human Services, CDC, 2002. Available at http://www.bt.cdc.gov/agent/smallpox/response-plan/files/annex-3.pdf.

¶ **Source:** CDC. Recommendations for using smallpox vaccine in a pre-event vaccination program: supplemental recommendations of the Advisory Committee on Immunization Practices (ACIP) and the Healthcare Infection Control Practices Advisory Committee (HICPAC). MMWR 2003;52(No. RR-7):1–16. Available at http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5207a1.htm.

** **Source:** CDC. Supplemental recommendations on adverse events following smallpox vaccine in the pre-event vaccination program: recommendations of the Advisory Committee on Immunization Practices [Notice to readers]. MMWR 2003;52:282–4. Available at http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5213a5.htm.

specialists, with consideration made of vaccination status, nature of exposure, and safety and efficacy of prophylaxis.

Decontamination of Body-Surface Contaminants

If human remains with heavy, residual surface contamination (i.e., visible) must be assessed, they should be cleansed before being brought to the autopsy facility and after appropriate samples have been collected in the field. Surface cleaning should be performed with an appropriate cleaning solution (e.g., 0.5% hypochlorite solution or phenolic disinfectant) used according to manufacturer's instructions. If the number of remains requiring autopsy is limited (i.e., one or two), cleaning of heavily contaminated remains can be undertaken in an autopsy facility that has the infrastructure, capacity, and hazardous materials (HAZMAT)-trained personnel to perform the cleaning safely. Heavily contaminated remains should not be brought to facilities where patient care is performed. Both personnel carrying contaminated remains and personnel occupying areas through which remains are being carried should wear PPE. HAZMAT personnel should perform large-scale decontamination outdoors in a controlled setting. To ensure mutual understanding of the roles and responsibilities of HAZMAT and death-investigation personnel in situations with contaminated remains, ME/Cs should develop response protocols with HAZMAT personnel before such an event occurs.

Waste Handling

Liquid waste (e.g., body fluids) can be flushed or washed down ordinary sanitary drains without special procedures. Pretreatment of liquid waste is not required and might damage sewage treatment systems. If substantial volumes are expected, the local wastewater treatment personnel should be consulted in advance. Solid waste should be appropriately contained in biohazard or sharps containers and incinerated in a medical waste incinerator (*73,75*).

Storage and Disposition of Corpses

The majority of potential biologic terrorism agents (*B. anthracis*, *Y. pestis*, or botulinum toxin) are unlikely to be transmitted to personnel engaged in the nonautopsy handling of a contaminated cadaver. However, such agents as the hemorrhagic fever viruses and smallpox virus can be transmitted in this manner. Therefore, Standard Precautions (*77*) should be followed while handling all cadavers before and after autopsy.

When bodies are bagged at the scene of death, surface decontamination of the corpse-containing body bags is required before transport. Bodies can be transported and stored (refrigerated) in impermeable bags (double-bagging is preferable), after wiping visible soiling on outer bag surfaces with 0.5% hypochlorite solution. Storage areas should be negatively pressured with 9–12 air exchanges/hour.

The risks of occupational exposure to biologic terrorism agents while embalming outweigh its advantages; therefore, bodies infected with these agents should not be embalmed. Bodies infected with such agents as *Y. pestis* or *F. tularensis* can be directly buried without embalming. However, such agents as *B. anthracis* produce spores that can be long-lasting and, in such cases, cremation is the preferred disposition method. Similarly, bodies contaminated with highly infectious agents (e.g., smallpox and hemorrhagic fever viruses) should be cremated without embalming. If cremation is not an option, the body should be properly secured in a sealed container (e.g., a Zigler case or other hermetically sealed casket) to reduce the potential risk of pathogen transmission. However, sealed containers still have the potential to leak or lose integrity, especially if they are dropped or are transported to a different altitude (*93*).

ME/Cs should work with local emergency management agencies, funeral directors, and the state and local health departments to determine, in advance, the local capacity (bodies per day) of existing crematoriums, and soil and water table characteristics that might affect interment. For planning purposes, a thorough cremation produces approximately 3–6 pounds of ash and fragments. ME/Cs should also work with local emergency management agencies to identify sources and costs of special equipment (e.g., air curtain incinerators, which are capable of high-volume cremation) and the newer plasma incinerators, which are faster and more efficient than previous incineration methods. The costs of such equipment and the time required to obtain them on request should be included in state and local terrorism preparedness plans.

ME/C's Role in Biologic Terrorism Surveillance

ME/Cs should be a key component of population-based surveillance for biologic terrorism. They see fatalities among persons who have not been examined initially by other physicians, emergency departments, or hospitals. In addition, persons who have been seen first by other health-care providers might die precipitously, without a confirmed diagnosis, and therefore fall under medicolegal jurisdiction. Autopsies are a critical component of surveillance for fatal infectious diseases, because they provide organism-specific diagnoses and clarify the route of exposure (*94*). With biologic terrorism-related fatalities, organisms identified in autopsy tissues can be characterized by strain to assist in the process of criminal attribution.

Models for ME surveillance for biologic terrorism mortality include sharing of daily case dockets with public health authorities (e.g., King County, Washington, and an active symptom-driven case acquisition and pathology syndrome-based public health reporting system developed in New Mexico [*24*]). Different areas of responsibility exist for ME/Cs regarding their role in effective surveillance for possible terrorism events. The following steps should be taken in local jurisdictions to enable ME/Cs to implement biologic terrorism surveillance:

- Death-investigation laws should be changed to enable ME/Cs to assume jurisdiction and investigate deaths that might constitute a public health threat, including those threats that are probably communicable.
- Any unexplained deaths possibly involving an infectious cause or biologic agent should be investigated to make etiology (organism)-specific diagnoses (*94*).
- Uniform standards for surveillance should be used. For example, the Med-X system developed in New Mexico (*24*) uses a set of antemortem symptoms to determine autopsy performance. The system's syndromic approach to postmortem diagnosis allows alerting of public health authorities to specific constellations of autopsy findings that could represent infectious agents before the specific agent is identified. Diseases caused by biologic terrorism agents are rare. To enhance surveillance for these conditions, a matrix of potential pathology-based syndromes (Table 1) has been developed to guide autopsy pathologists in recognizing potential cases (*24*).
- Electronic information and data systems should be designed to allow rapid recognition of excess mortality — incorporating the ability to assess possible commonalities among cases — and rapid communication/notification of such information to public health authorities who can use the information for effective response.
- Close working relationships should be developed between ME/Cs and local or state health departments to facilitate two-way communication that includes alerts to ME/Cs of possible outbreaks or clusters of nonfatal infectious diseases, which might have unrecognized fatal cases, and appropriate reporting by ME/Cs to public health authorities of notifiable disease conditions. Additionally, public health authorities should notify ME/Cs of the epidemiology of biologic terrorism-associated and other emerging infectious diseases in their community.

ME/C's Role in Data Collection, Analysis, and Dissemination

For public health surveillance, criminal justice, and administrative purposes, ME/Cs should promptly, accurately, and thoroughly collect, document, electronically store, and have available for analysis and reporting, case-specific death-investigation information. Initially, depending upon local resources and legal restrictions, all aspects of data management and use might not need to occur in-house. Recognizing that numerous entities use medicolegal death-investigation data, ME/Cs should establish collaborations with public health and law enforcement professionals to achieve the goal of complete, accurate, and timely case-specific death-investigation data. Advance planning and policy development should also clarify to whom such data may be released and under which circumstances. To facilitate this process, the following steps should be taken:

- Death-investigation information should be documented on standard forms that are consistent in content, at a minimum, with the Investigator's Death Investigation Report Form (IDIRF) and Certifier's Death Investigation Report Form (CDIRF) (*95*).
- Death-investigation data should be stored in an electronic database consistent with, at a minimum, the content outlined in the Medical Examiner/Coroner Death Investigation Data Set (MCDIDS) (*96*). These data elements should be updated periodically.
- Electronic death-investigation data sets should include the results of laboratory tests that are performed in the case in question.
- Entry of data into an electronic database should be prompt so that the database is current.
- Electronic databases should allow searching for and grouping of cases by disease or injury and circumstances of death.
- Electronic death-investigation data should be stored in open, nonproprietary formats so that it can be shared as needed.
- Death-investigation records should be stored in accordance with state or local regulations. Ideally, these records should be stored in perpetuity in a format that ensures future retrieval. The format or media of electronic records might require periodic updating.
- Mechanisms should be in place to ensure that electronic death investigation data can be shared with public health authorities, law enforcement agencies, and other death-investigation agencies while providing for appropriate confidentiality and control of the release of information to authorized personnel or organizations only.
- ME/Cs should have specific policies that outline the organizations and agencies that are authorized to receive death-investigation information and the conditions in which such information may be released.
- Policies and mechanisms should be in place to avoid releasing death-investigation information inappropriately and to avoid withholding information that should be available to the public.
- ME/C offices should consider establishing links with state/local public health agencies, academic institutions, or other health organizations to promote epidemiologic analysis and use of their medicolegal death-investigation data in an ongoing manner. Certain ME/C offices have determined that employing a staff epidemiologist is beneficial.

Jurisdictional, Evidentiary, and Operational Concerns

Federal Role

On February 28, 2003, Homeland Security Presidential Directive 5 (HSPD-5) modified federal response policy (*97*). Under the new directive, the Secretary of Homeland Security is the principal federal official for domestic incident management. Pursuant to the Homeland Security Act of 2002 (Public Law 107-296), the Secretary of the U.S. Department of Homeland Security (DHS) is responsible for coordinating federal operations within the United States to prepare for, respond to, and recover from terrorist attacks, major disasters, and other emergencies. The Secretary will coordinate the federal government's resources used in response to or recovery from terrorist attacks, major disasters, or other emergencies if and when any one of the following four conditions applies: 1) a federal department or agency acting under its own authority has requested the assistance of the Secretary; 2) the resources of state and local authorities are overwhelmed and federal assistance has been requested by the appropriate state and local authorities; 3) more than one federal department or agency has become substantially involved in responding to the incident; or 4) the Secretary has been directed to assume responsibility for managing the domestic incident by the President.

HSPD-5 further stipulates that the U.S. Attorney General, through the FBI, has lead federal responsibility for criminal investigations of terrorist acts or terrorist threats by persons or groups inside the United States, or directed at U.S. citizens or institutions abroad, where such acts are within the federal criminal jurisdiction of the United States. The FBI, in

cooperation with other federal departments and agencies engaged in activities to protect national security, will also coordinate the activities of the other members of the law enforcement community to detect, prevent, preempt, and disrupt terrorist attacks against the United States. In the event of a weapons of mass destruction (WMD) threat or incident, the local FBI field office special agent in charge (SAC) will be responsible for leading the federal criminal investigation and law enforcement actions, acting in concert with the principal federal officer (PFO) appointed by the U.S. Department of Homeland Security and state and local officials.

The FBI has a WMD coordinator in each of the agency's 56 field offices (Appendix B). These persons are responsible for pre-event planning and preparedness, as well as responding to WMD threats or incidents. ME/Cs are encouraged to contact their local FBI WMD coordinator before an incident to clarify roles and responsibilities, and ME/Cs should contact the coordinator in any case where concerns or suspicions exist of a potential WMD-related death.

The FBI assertion of jurisdiction at the scene of a terrorist event would not necessarily usurp (or relieve) ME/Cs from their statutory authority and responsibility to identify decedents and determine cause and manner of death. Such an arrangement is consistent with the performance of medicolegal death investigation where other federal crimes are involved. ME/Cs who conduct terrorism-associated death investigations should be prepared to present their medicolegal death investigation findings in federal court.

Public Health Agency Authority

State public health laws might establish the health department's specific authority to control certain aspects of operations, personnel, or corpses in a public health emergency. For example, the Center for Law and the Public's Health at Georgetown and Johns Hopkins Universities, at the request of CDC, has created a model state emergency health powers act for adoption by states (*98*). Different states have either enacted versions of this act or are in the process of introducing similar legislative bills (*99*). ME/Cs should know specifically how existing state laws might provide for the health department to take control and dictate the disposition of human remains (burial or cremation). A state's emergency health powers act might also provide for

- mandatory medical examinations for ME/C personnel;
- isolation and quarantine of the public or ME/C personnel;
- vaccination against and treatment for illnesses among ME/Cs; and
- control, use, and destruction of facilities.

ME/Cs and health departments should work together as part of the emergency planning process to determine which emergency health powers might be established by the health department and under what circumstances these might be invoked for each potential biologic terrorism agent. Determining how health departments and ME/C operations can best interact, including documenting concerns regarding the availability of death-investigation personnel and the control and disposition of human remains, should be emphasized. ME/Cs should take part in community exercises to clarify and practice their role in the emergency response process.

General Operations

In the majority of terrorism-associated scenarios, ME/Cs are responsible for identifying remains and determining the cause and manner of death. To that end, ME/Cs might need to enlist additional local, state, or federal assistance while maintaining primary responsibility for death investigation. ME/Cs should request this assistance from the local or state emergency operations center (EOC), as appropriate. The probable source of federal assistance is the Disaster Mortuary Operational Response Team (DMORT). However, DMORT has not yet developed capacity to respond to events precipitated by the release of biologic agents (further details regarding DMORT and other federal agencies are discussed in following sections).

Where possible, postmortem examinations for identifying remains and determining cause and manner of death should occur within the local or state jurisdiction where victims have died. Local resources dictate whether the statutory ME/C system can accomplish this with existing personnel and within existing facilities, or whether additional local, state, or federal assistance is necessary. Moving substantial numbers of human remains, particularly those contaminated by a biologic agent (known or unknown) to locations considerably distant from the scenes of death is neither feasible nor safe. Two potential strategies can be used to augment the biosafety capacity of local agencies having limited resources. One strategy would be to develop a mobile Biosafety Level 3 autopsy laboratory. Another strategy would be to develop regional Biosafety Level 3 autopsy centers that can handle cases from surrounding jurisdictions or states. A combination of the two approaches will probably achieve the best coverage of national needs.

Postmortem Examinations and Evidence Collection

A large-scale biologic event might create more fatalities than combined local, state, and federal agencies can store and

examine (*15*). Small or rural jurisdictions might be overwhelmed by a relatively limited number of fatalities, whereas larger state or city ME/C offices could conceivably process greater numbers of human remains. No formulas exist that can be used to determine in advance the autopsy rate and the extent of autopsy that might be needed. In the event of a biologic event, ME/Cs should perform complete autopsies on as many cases as feasible on the basis of case volume and biosafety risks. These autopsies should meet the standards that forensic pathologists usually meet for homicide cases. Conferring with the FBI and appropriate prosecutorial authorities early in the process will ensure that appropriate documentary and diagnostic maneuvers are employed that will support the criminal justice process. Similarly, interacting with public health authorities early in the death-investigation process should ensure that appropriate diagnostic evaluations are conducted to support the public health investigation and response.

After the etiologic agent has been determined, certain (or all) other potentially related fatalities can be selectively sampled to confirm the presence of the organism in question. ME/Cs should coordinate the decision to transition from complete autopsies to more limited examinations with law enforcement and public health professionals. Selective sampling could include skin swabs and needle aspiration of blood or other body fluids, tissues for culture, or biopsies of a particular tissue or organ for histologic diagnostic tests (e.g., immunohistochemical procedures and electron microscopy). The required specimens from a limited autopsy and the diagnostic procedures employed will be dictated by the nature of the biologic agent. Guidelines for targeted organs or tissues for culture or analysis were discussed previously. As with all homicides, chain-of-custody for specimens should be maintained at all times.

Whenever a complete autopsy is performed, the goals should be to 1) establish the disease process and the etiologic agent; 2) determine that the agent or disease is indeed the cause of death; and 3) reasonably rule out competing causes of death. When limited autopsies or external examinations are performed, ME/C personnel should

- identify the deceased;
- document the appearance of the body;
- establish that the presenting clinical symptoms and signs are consistent with the alleged etiologic agent;
- confirm the presence of the etiologic agent in the body;
- state with reasonable probability that the alleged agent was the underlying cause of death (e.g., inhalational anthrax infection); and
- state with reasonable probability the likely immediate cause of death (e.g., pneumonia, meningitis, or mediastinitis).

Forming a reasonably sound medical opinion regarding cause and manner of death can be accomplished with knowledge of the presenting syndrome and circumstantial events, external examination of the body, and testing of appropriate specimens to document the etiologic agent. For example, in a confirmed smallpox outbreak, identifying the deceased, externally examining the body and photographing the lesions, and obtaining samples from the lesions for culture or electron microscopy might be adequate.

Biologic evidence obtained at autopsy can be sent to local or state health department laboratories, and other physical evidence can be sent to the usual crime laboratory, unless otherwise instructed by the FBI. Laboratories within LRN, as described previously, are responsible for coordinating the transfer of evidence or results to the FBI, U.S. Attorney General, or local and state legal authorities, as appropriate. Consistent with routine practice, ME/Cs should document all evidence transfers adequately.

Cause and Manner of Death Statements

Death certificates are not withheld from the public record, even when the cause of death is terrorism-related. The cause of death section should be used to fully explain the sequence of the cause of death (e.g., "hemorrhagic mediastinitis due to inhalational anthrax"). If death resulted from a terrorism event, the manner of death should be classified as homicide. The "how injury occurred" section on the death certificate should be completed, and it should reflect how the infectious agent was delivered to the victim (e.g., "victim of terrorism; inhaled anthrax spores delivered in mail envelope"). The place of injury should be the statement of where (i.e., geographic location) the agent was received.

Reimbursement for Expenses and Potential Funding Sources

Additional funding for ME/Cs might be needed for either preparedness or use during an actual biologic terrorism event. ME/Cs should prepare financially for potential future terrorist events that might be similar to the anthrax attacks of October–November 2001. In crisis situations, funding is retroactive but no less a concern.

Preparedness funding can support multiple activities, including training of ME/Cs for large-scale terrorism events. Certain activities involving training of ME/Cs have occurred through DMORT, a program authorized by the DHHS Office of Emergency Preparedness to rapidly mobilize ME/Cs

to respond to incidents of mass fatality. Preparedness funding can also support surveillance activities in ME/C offices. As part of the Bioterrorism Preparedness and Response cooperative agreements with state health departments, CDC has provided funding to New Mexico and other states that are pursuing ME/C surveillance systems as an enhancement to their traditional surveillance systems. The New Mexico Office of the Medical Investigator has been a recipient of this funding through the New Mexico Department of Health since the inception of the cooperative agreement program. This funding has supported development of specialized surveillance techniques for deaths caused by potential agents of biologic terrorism (*24*) and recognition of ME/Cs as a key resource for all phases — early detection, case characterization, incident response and recovery — of a public health emergency response. CDC encourages pursuit of this enhanced (ME/C) surveillance capacity through cooperative agreements with states, if the state has made adequate progress with other critical capacity goals.

ME/Cs might obtain preparedness funding by integrating their response activities into the existing EOCs that have been established at selected state and county levels (integration of ME/C offices into this framework is discussed in Communications and the Incident Command System). When ME/C offices are integrated into the emergency response system, ME/Cs have an opportunity to make emergency management officials aware of ME/C emergency responsibilities and resource needs.

The sources of funding for consequence management, including medicolegal death investigation, will depend on the scope of the terrorism event. In events with a limited number of deaths, funding for activities related to the detection and diagnosis might remain at the office level. Because terrorism deaths are homicides, these deaths will contribute to an office's jurisdictional workload, and future planning for preparedness funding should be considered. Certain ME/C offices are already a part of the local or state public health department or are already affiliated with an EOC. ME/C offices, health departments, and EOCs are strongly encouraged to forge links for effective preparedness and response and to participate in joint training exercises to maximize preparedness funding.

In events with multiple deaths, a federal emergency might be declared. As long as ME/Cs' offices are officially working through the state or local EOC, certain expenses associated with the response (e.g., cost of diagnostic testing) can be submitted to the Federal Emergency Management Agency (FEMA) for reimbursement. In the majority of localities, these requests for resources required for appropriate response during an event should be submitted through local emergency management agencies that are part of state and local EOCs. Costs will probably be covered by the agency that has jurisdiction over the disaster (e.g., FEMA). In cases where a presidential disaster declaration is made, testing costs, victim identification, mortuary services, and those services that are covered by the National Disaster Medical System (a mutual aid network that includes DHHS, the Department of Defense, and FEMA) (*100*) are reimbursable under Emergency Support Function 8 (Health and Medical) of the Federal Response Plan (FRP).

Under FRP, FEMA covers 75% of reimbursement costs; the remaining 25% are covered by the state through emergency funds or in-kind reimbursement. FEMA also supports state emergency funds through the DHHS electronic payments management system. In an emergency, all requests for reimbursement flow from their point of origin, in this case from an ME/C, through the state EOC/emergency management agency, to FEMA.[§] Before an event, ME/Cs should clarify the procedures to follow to ensure that they will be reimbursed for expenses incurred as part of their emergency response.

DMORT

DMORT is a national program that includes volunteers, divided into 10 regional teams responsible for supporting death investigation and mortuary services in federal emergency response situations involving natural disasters and mass fatalities associated with transportation accidents or terrorism. Team members are specialists from multiple forensic disciplines, funeral directors, law enforcement agents, and administrative support personnel. Each team represents a FEMA region. DMORT members are activated through DHS after mass fatalities or events involving multiple displaced human remains (e.g., a cemetery washout after a flood).

The primary functions of DMORT include the identification of human remains, evidence recovery from the bodies, recovery of human remains from the scene, and assisting with operation of a family assistance center. Whenever possible, identification of the bodies is made by using commonly accepted scientific methods (e.g., fingerprint, dental, radiograph, or DNA comparisons).

Upon activation, DMORT members are federal government employees. When DMORT is activated, representatives from DHS are also sent to manage the logistics of deployment. The FBI most commonly staffs the fingerprint section of the

[§] Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended by Public Law 106-390, October 30, 2000, United States Code, Title 42, The Public Health and Welfare, Chapter 68, Disaster Relief.

morgue. The Armed Forces DNA Identification Laboratory in Rockville, Maryland, has traditionally performed DNA analyses; the arrangements for this testing are negotiated separately with the local ME/C.

After a request for DMORT assistance has been made, one of two Disaster Portable Morgue Units (DPMUs) and DMORT staff are sent to the disaster site. DPMUs contain specialized equipment and supplies, prestaged for deployment within hours to a disaster site. DPMUs include all of the equipment required for a functional basic morgue with designated workstations and prepackaged equipment and supplies. DPMUs can operate at Biosafety Level 2, but do not have the ventilatory capacity necessary to protect prosectors and other nearby persons from airborne pathogens. DPMUs also contain equipment for site search and recovery, pathology, anthropology, radiology, photography, and information resources, as well as office equipment, wheeled examination tables, water heaters, plumbing equipment, electrical distribution equipment, personal protective gear, and temporary partitions and supports. DPMUs do not have the materials required to support microbiologic sampling. When a DPMU is deployed, members of the DPMU team (i.e., a subset of DMORT) are sent to the destination to unload the DPMU equipment and establish and maintain the temporary morgue. Additional equipment is required locally after DMORT activation. At a minimum, this equipment includes a facility in which to house the morgue equipment, a forklift to move the DPMU equipment into the temporary morgue facility, and refrigerated trucks to hold human remains.

ME/Cs can request DMORT response after a mass fatality or after an incident resulting in the displacement of a substantial number of human remains. ME/Cs should follow state protocols for DMORT requests. Typically, ME/Cs contact the state governor's office, which then requests DMORT from DHS.[¶] The request should include an estimate of how many deaths occurred (if known), the condition of the bodies (if known), and the location of the incident. When deployed, DMORT supports ME/Cs in the jurisdiction where the incident occurred. All medicolegal death investigation records created by DMORT are given to ME/Cs at the end of the deployment, and ME/Cs are ultimately responsible for all of the identifications made and the documents created pertaining to the incident.

[¶] State requests should be directed to the Department of Homeland Security, National Disaster Medical System Section, by telephone at 301-443-1167 (or 800-USA-NDMS) or by fax at 301-443-5146 (or 800-USA-KWIK).

DMORT-WMD Team

The DMORT-WMD team is composed of national rather than regional volunteers. The primary focus of DMORT-WMD is decontamination of bodies when death results from exposure to chemicals or radiation. DMORT-WMD is developing resources to respond to a mass disaster resulting from biologic agents. However, this team might have difficulty in responding to such an event if the deaths occur in multiple locations.

The major forensic disciplines (i.e., forensic dentistry, forensic anthropology, and forensic pathology) as well as funeral directors, law enforcement, criminalists, and administrative support persons are represented on the DMORT-WMD team. Members of DMORT-WMD undergo specialized training that focuses on chemical and radiologic decontamination of human remains. The DMORT-WMD unit has separate equipment, stored separately from the DPMU, including PPE (up to and including level A suits), decontamination tents, and equipment to gather contaminated water. DMORT-WMD teams are requested and deployed in the same manner as general DMORTs.

Communications and the Incident Command System

ME/Cs are key members of the biologic terrorism detection and management response team in any community and should be integrated into the comprehensive communication plan during any terrorism-associated event. Routine and consistent communication among ME/Cs and local and state laboratories, public health departments, EOCs, communication centers, DMORT, and other agencies, is critical to the success of efficient and effective biologic terrorism surveillance, fatality management, and public health and criminal investigations. Planning for different emergency scenarios and participation in disaster response exercises are necessary to ensure effective response to a terrorism event.

Each state and certain counties have some type of emergency operation center that has been organized to provide a coordinated response during a terrorism event. ME/Cs should verify their jurisdiction's EOC contact point and work with them periodically regarding concerns related to preparedness and response.

All EOCs follow the Incident Command System (ICS) (*100*), an internationally recognized emergency management system that provides a coordinated response across organizations and jurisdictions. The ICS structure allows for individual EOC decision making and different information flow in each

state. ME/Cs should determine how the EOC functions in their jurisdiction.

Each ICS is composed of a managing authority that directs the response of health department, law enforcement, and emergency management officials during a planning exercise, emergency, or major disaster. In addition to assessing the incident and serving as the interagency contact, ICS also coordinates the response to information inquiries and the safety monitoring of assigned response personnel. The ICS organizational framework, includes planning, operations, logistics, and finance/administration sections (*101*). ME/Cs are most likely to participate in the operations team, which makes tactical decisions regarding the incident response and implements those activities defined in action plans. This team might also include public health, emergency communications, fire, law enforcement, EMS, and state emergency management agency staff.

During a suspected terrorism event, ME/Cs should be responsible for the following actions to facilitate communication:

- Promptly inform laboratory, public health, and law enforcement personnel of findings of investigations of suspected biologic terrorism-related deaths as well as personnel needs and new developments. To expedite information exchange, ME/Cs should familiarize themselves with the appropriate contact persons and agencies for response in their jurisdictions.
- Answer the EOCs' requests to collect and report data in a timely manner.
- Coordinate communication of their activities with the state emergency management agency and EOCs for their jurisdiction to avoid release of confidential or speculative information directly to the public or media (*102*).

Conclusion

ME/Cs are essential public health partners for terrorism preparedness and response. Despite state and local differences in medicolegal death-investigation systems, these investigators have the statutory authority to investigate deaths that are sudden, suspicious, violent, and unattended, and consequently play a vital role in terrorism surveillance and response. Public health officials should work with ME/Cs to ensure that these investigators can assist with surveillance for infectious disease deaths possibly caused by terrorism and provide confirmatory diagnoses and evidence in deaths linked to terrorism. This process should involve an assessment of local ME/C standards for accepting jurisdiction of potential infectious disease deaths and performing autopsies, laboratory capacity for making organism-specific diagnoses, and autopsy biosafety capacity. Ideally, ME/Cs should

- perform complete autopsies with histologic sampling of multiple organs in deaths potentially caused by biologic terrorism agents, given the constraints of case volume and biosafety concerns;
- have access to routine microbiologic testing for organism-specific diagnoses in potential infectious disease deaths;
- ensure protection from both airborne and bloodborne pathogens for all occupants of the autopsy facility (Biosafety Level 3);
- participate in a standardized ME/C surveillance model for infectious disease mortality (e.g., Med-X); and
- document death investigative information on standard forms that are stored in an searchable electronic format and that can be shared with public health authorities.

If biologic terrorism-related fatalities occur, ME/Cs are responsible for identifying remains and determining the cause and manner of death. Routine and consistent communication among ME/Cs and local and state laboratories, public health departments, EOCs, law enforcement, and other agencies is critical to the success of efficient and effective biologic terrorism surveillance, fatality management, and public health and criminal investigations. To prepare for this possibility, ME/Cs should

- contact their local FBI WMD coordinator to clarify roles and responsibilities;
- understand how local public health laws might impact ME/C function;
- become familiar with the capacity of local or state EOCs, ICS, and the process for submitting response-associated expenses for federal reimbursement;
- be aware of the process for submitting biologic and physical evidence in potential biologic terrorism-related fatalities;
- understand the procedure for writing cause and manner of death statements in terrorism-related fatalities; and
- identify appropriate health department officials for the reporting of notifiable or suspicious infectious diseases or potential biologic terrorism-related deaths.

The majority of ME/C facilities do not have the capacity to perform autopsies at Biosafety Level 3 as a consequence of facility design features that are expensive to fix. In addition, DMORT does not have the capacity to respond to events precipitated by the release of biologic agents. These limitations might affect local, state, and national surveillance for infectious disease deaths of public health importance, including those deaths potentially caused by terrorism. Two potential strategies might be used in the future to augment the biosafety

capacity of local agencies having limited resources. One strategy would be to develop a mobile Biosafety Level 3 autopsy laboratory. Another strategy might be to develop regional Biosafety Level 3 autopsy centers that can handle cases from surrounding jurisdictions or states. A combination of the two approaches will probably achieve the best coverage of national needs.

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Appendix A

Contact Information for State Public Health Laboratory Response Network (September 2002)

Contact information and laboratory specimen-collection systems are subject to change. Before sending specimens to a state laboratory, this information should be verified. Contact the Association of Public Health Laboratories by telephone at 202-822-5227 or by Internet at http://www.aphl.org/Public_Health_Labs/index.cfm.

Alabama
Bureau of Clinical Laboratories
State Department of Public Health
8140 University Drive
Montgomery, AL 36130-3017
Phone: 334-260-3400
Fax: 334-244-5083

Alaska
Alaska Department of Health and Social Services
Division of Public Health Laboratory
4500 Boniface Parkway
Anchorage, AK 99507
Phone: 907-334-2100
Fax: 907-334-2161

American Samoan
Department of Health Services
Government of American Samoa
LBJ Tropical Medical Center
Pago Pago, AS 96799
Phone: 684-633-4606
Fax: 684-633-5379

Arizona
Bureau of State Laboratory Services
Arizona Department of Health Services
1520 West Adams Street
Phoenix, AZ 85007
Phone: 602-542-0357
Fax: 602-542-0760

Arkansas
Arkansas Department of Health
4815 West Markham Street
Little Rock, AR 72205
Phone: 501-661-2191
Fax: 501-661-2310

California
California State Department of Health Service
2151 Berkeley Way, Room 703
Berkeley, CA 94704
Phone: 510-540-2408
Fax: 510-540-3075

Colorado
Colorado Department of Public Health and Environment
P.O. Box 17123
Denver, CO 80217
Phone: 303-692-3096
Fax: 303-692-3008

Connecticut
Division of Laboratories
Connecticut Department of Public Health
P.O. Box 1689
10 Clinton Street
Hartford, CT 06144
Phone: 860-509-8500
Fax: 860-509-8697

Delaware
Delaware Public Health Laboratory
P.O. Box 1047
Smyrna, DE 19977-1047
Phone: 302-653-2870
Fax: 302-653-2877

District of Columbia
Department of Health—Public Health Laboratory
300 Indiana Avenue, NW
Suite 6154
Washington, DC 20001
Phone: 202-727-8956
Fax: 202-724-1455

Florida
Department of Health
Bureau of Laboratories
P.O. Box 210
Jacksonville, FL 32331-0042
Phone: 904-791-1550
Fax: 904-791-1567

Georgia
Georgia Public Health Laboratory
Department of Human Resources
1749 Clifton Road
Decatur, GA 30033-4050
Phone: 404-327-7900
Fax: 404-327-7919

Guam
Inactive (as of 11/09/01)
Department of Public Health and Social Services
P.O. Box 2816
Agana, GU 96910
Phone: 671-735-7102
Fax: 671-734-5910

Hawaii
Laboratory Division
State of Hawaii Department of Health
2725 Wiamano Home Road, 3rd Floor
Pearl City, HI 96782
Phone: 808-453-6652
Fax: 808-453-6662

Idaho
Department of Health and Welfare
2220 Old Penitentiary Road
Boise, ID 83712
Phone: 208-334-2235
Fax: 208-334-2382

Illinois
Illinois Department of Public Health
825 North Rutledge Street
P.O. Box 19435
Springfield, IL 62794-9435
Phone: 217-782-6562
Fax: 217-524-7924

Indiana
Indiana State Department of Health
635 North Barnhill Drive
Indianapolis, IN 46202
Phone: 317-233-8006
Fax: 317-233-8003

Iowa
University Hygienic Laboratory
University of Iowa
H 101 Oakdale Hall
Iowa City, IA 52242
Phone: 319-335-4500
Fax: 319-335-4600

Kansas
Division of Health and Environmental Laboratories
Kansas Department of Health and Environment
Forbes Building, No. 740
Topeka, KS 66620
Phone: 785-296-1619
Fax: 785-296-1641

Kentucky
Department for Public Health
100 Sower Boulevard
Frankfort, KY 40601
Phone: 502-564-4446
Fax: 502-564-7019

Louisiana
State Office Building, Central Laboratory
325 Loyola Avenue, 7th Floor
New Orleans, LA 70112
Phone: 504-568-5375
Fax: 504-568-5393

Maine
Department of Human Services
221 State Street, Station 12
Augusta, ME 04333
Phone: 207-287-2727
Fax: 207-287-6832

Maryland
State Department of Health and Mental Hygiene
P.O. Box 2355
Baltimore, MD 21203
Phone: 410-767-6100
Fax: 410-333-5403

Massachusetts
State Laboratory Institute
305 South Street
Boston, MA 02130
Phone: 617-983-6201
Fax: 617-983-6927

Michigan
Michigan Department of Community Health
2250 North MLK Boulevard, Building 44
Lansing, MI 48909
Phone: 517-335-8063
Fax: 517-335-9631

Minnesota
Minnesota Department of Health
717 Delaware Street, SE
Minneapolis, MN 55440
Phone: 612-676-5331
Fax: 612-676-5514

Mississippi
State Public Health Laboratory
Mississippi Department of Health
570 East Woodrow Wilson Drive
Jackson, MS 39215-1700
Phone: 601-576-7582
Fax: 601-576-7720

Missouri
State Public Health Laboratory
Missouri Department of Health
P.O. Box 570
Jefferson City, MO 65102
Phone: 573-751-3334
Fax: 573-751-7219

Montana
Public Health Laboratory
P.O. Box 6489
Helena, MT 59601
Phone: 406-444-3444
Fax: 406-444-1802

Nebraska
Public Health Laboratory
University of Nebraska Medical Center
600 42nd Street
Omaha, NE 68198
Phone: 402-559-4116
Fax: 402-559-4077

Nevada
Nevada State Laboratory
University of Nevada School of Medicine
1660 North Virginia Street
Reno, NV 89503-1738
Phone: 775-688-1335
Fax: 775-688-1460

New Hampshire
Office of Community and Public Health
6 Hazen Drive
Concord, NH 03301
Phone: 603-271-4657
Fax: 603-271-4783

New Jersey
Public Health Laboratories
John Fitch Plaza, 4th Floor, P.O. Box 361
Trenton, NJ 08625-0361
Phone: 609-292-7783
Fax: 609-292-9285

New Mexico
New Mexico Department of Health
Scientific Laboratory Division
P.O. Box 4700
Albuquerque, NM 87196-4700
Phone: 505-841-2500
Fax: 505-841-2543

New York
Wadsworth Center
New York State Department of Health
P.O. Box 509
Albany, NY 12201
Phone: 518-474-7592
Fax: 518-474-3439

North Carolina
State Laboratory of Public Health
P.O. Box 28047
Raleigh, NC 27611-8047
Phone: 919-715-5874
Fax: 919-733-8695

North Dakota
Division of Microbiology
North Dakota Department of Health
P.O. Box 5520
Bismarck, ND 58506
Phone: 701-328-5262
Fax: 701-328-5270

Northern Mariana Islands
Inactive (as of 11/09/01)
Department of Public Health
Commonwealth Health Center
P.O. Box 409 CL
Saipan, MP 96950
Phone: 670-234-8950
Fax: 670-234-8930

Ohio
State Department of Health
P.O. Box 2568
Columbus, OH 43216
Phone: 614-644-4590
Fax: 614-752-9863

Oklahoma
Public Health Laboratory Services
State Department of Health
P.O. Box 24106
Oklahoma City, OK 73214
Phone: 405-271-5070
Fax: 405-271-4850

Oregon
Oregon Health Division
Center for Public Health Laboratories
P.O. Box 275
Portland, OR 97207
Phone: 503-229-5296
Fax: 503-229-5682

Pennsylvania
Bureau of Laboratories
Pennsylvania Department of Health
P.O. Box 500
Exton, PA 19341-0500
Phone: 610-280-3464
Fax: 610-594-9972

Puerto Rico
Institute of Health Laboratory
Department of Health
Commonwealth of Puerto Rico
Building A — Call Box 70184
San Juan, PR 00936-8184
Phone: 787-274-7817

Rhode Island
Rhode Island Department of Health
50 Orms Street
Providence, RI 02904-2283
Phone: 401-222-5554
Fax: 401-222-3332

South Carolina
Harold Dowda, PhD
Director, Bureau of Laboratories
Department of Health & Environmental Control
P.O. Box 2202
Columbia, SC 29202
Phone: 803-896-0800
Fax: 803-896-0983

South Dakota
Michael Smith
Laboratory Director
615 East Fourth Street
Pierre, SD 57501
Phone: 605-773-4757
Fax: 605-773-6129

Tennessee
Tennessee Department of Health
630 Hart Lane
Nashville, TN 37247
Phone: 615-262-6300
Fax: 615-262-6393

Texas
Texas Department of Health
110 West 49th Street
Austin, TX 78756
Phone: 512-458-7318, ext. 2418
Fax: 512-458-7221

Utah
Division of Epidemiology and Laboratory Services
46 North Medical Drive
Salt Lake City, UT 84113-1105
Phone: 801-584-8450
Fax: 801-584-8486

Vermont
Vermont Department of Health
108 Cherry Street
P.O. Box 70
Burlington, VT 05420-0070
Phone: 802-863-7246
Fax: 802-865-7701

Virgin Islands
Inactive (as of 11/09/01)
Roy L. Schneider Hospital
P.O. Box 7309
Charlotte Amalie, VI 00801
Phone: 340-776-8311
Fax: 340-714-6314

Virginia
Division of Consolidation Laboratory Services
Commonwealth of Virginia
One North 14th Street, Room 231
Richmond, VA 23219
Phone: 804-786-7905
Fax: 804-371-7973

Washington
Washington State Department of Health
Public Health Laboratories
1610 NE 150th Street
P.O. Box 550501
Shoreline, WA 98155-9701
Phone: 206-361-2885
Fax: 206-361-2904

West Virginia
Office of Laboratory Services
State of West Virginia
Department of Health & Human Resources
167 11th Avenue
South Charleston, WV 25303-1137
Phone: 304-558-3530
Fax: 304-558-2006

Wisconsin
State Laboratory of Hygiene
William D. Stovall Building
465 Henry Mall
Madison, WI 53706
Phone: 608-262-3911
Fax: 608-262-3257

Wyoming
Wyoming Public Health Laboratory
517 Hathaway Building
Cheyenne, WY 82002
Phone: 307-777-6066
Fax: 307-777-6422

Appendix B

Federal Bureau of Investigation Field Office Telephone Numbers

Alabama
Birmingham
205-326-6166

Mobile
334-438-3674

Alaska
Anchorage
907-258-5322

Arizona
Phoenix
602-279-5511

Arkansas
Little Rock
501-221-9100

California
Los Angeles
310-477-6565

Sacramento
916-481-9110

San Francisco
4l5-553-7400

Colorado
Denver
303-629-7171

Connecticut
New Haven
203-777-6311

Delaware
Baltimore, MD
410-265-8080

Florida
Jacksonville
904-721-1211

Miami
305-944-9101

Tampa
813-273-4566

Georgia
Atlanta
404-679-9000

Hawaii
Honolulu
808-521-1411

Idaho
Salt Lake City, UT
801-579-1400

Illinois
Chicago
312-431-1333

Springfield
217-522-9675

Indiana
Indianapolis
317-639-3301

Iowa
Omaha, NE
402-493-8688

Kansas
Kansas City, MO
816-221-6100

Kentucky
Louisville
502-583-3941

Louisiana
New Orleans
504-816-3000

Maine
Boston, MA
617-742-5533

Maryland
Baltimore
410-265-8080

Massachusetts
Boston
617-742-5533

Michigan
Detroit
313-965-2323

Minnesota
Minneapolis
612-376-3200

Mississippi
Jackson
601-948-5000

Missouri
Kansas City
816-221-6100

St. Louis
314-231-4324

Montana
Salt Lake City, UT
801-579-1400

Nebraska
Omaha
402-493-8688

Nevada
Las Vegas
702-385-1281

New Hampshire
Boston, MA
617-742-5533

New Jersey
Newark
973-792-3000

Philadelphia, PA
215-418-4000

New Mexico
Albuquerque
505-224-2000

New York
Albany
518-465-7551

Buffalo
716-856-7800

New York City
212-384-1000

North Carolina
Charlotte
704-377-9200

North Dakota
Minneapolis, MN
612-376-3200

Ohio
Cincinnati
513-421-4310

Cleveland
216-522-1400

Oklahoma
Oklahoma City
405-290-7770

Oregon
Portland
503-224-4181

Pennsylvania
Philadelphia
215-418-4000

South Carolina
Columbia
803-551-4200

South Dakota
Minneapolis, MN
612-376-3200

Tennessee
Knoxville
423-544-0751

Memphis
901-747-4300

Texas
Dallas
214-720-2200

El Paso
915-832-5000

Houston
713-693-5000

San Antonio
210-225-6741

Utah
Salt Lake City
801-579-1400

Vermont
Albany, NY
518-465-7551

Virginia
Norfolk
757-455-0100

Richmond
804-261-1044
Falls Church
703-762-3000

Washington
Seattle
206-622-0460

West Virginia
Pittsburgh, PA
412-471-2000

Wisconsin
Milwaukee
414-276-4684

Wyoming
Denver, CO
303-629-7171

Terms and Abbreviations Used in This Report

APHL	Association of Public Health Laboratories
CDIRF	Certifier's Death Investigation Report Form
DFA	direct fluorescent assays
DHHS	U.S. Department of Health and Human Services
DHS	U.S. Department of Homeland Security
DMORT	Disaster Mortuary Operational Response Team
DPMU	Disaster Portable Morgue Unit
EPA	Environmental Protection Agency
EOC	emergency operations center
FBI	Federal Bureau of Investigation
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FRP	Federal Response Plan
H&E	hematoxylin and eosin
HAZMAT	Hazardous materials
HEPA	high-efficiency particulate air
HSPD 5	Homeland Security Presidential Directive 5
ICS	Incident Command System
IDIRF	Investigator's Death Investigation Report Form
IHC	immunohistochemical
LRN	Laboratory Response Network
MCDIDS	Medical Examiner/Coroner Death Investigation Data Set
ME/Cs	medical examiners and coroners
NAME	National Association of Medical Examiners
NDMS	National Disaster Medical System
PAPRs	powered air-purifying respirators
PCR	polymerase chain reaction
PFO	principal federal officer
PPE	personal protective equipment
SAC	special agent in charge
USAMRIID	United States Army Medical Research Institute of Infectious Diseases
WMD	weapons of mass destruction

Medical Examiners, Coroners, and Biologic Terrorism

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MMWR™

Morbidity and Mortality Weekly Report

Recommendations and Reports June 11, 2004 / Vol. 53 / No. RR-8

Continuing Education Activity Sponsored by CDC
Medical Examiners, Coroners, and Biologic Terrorism
A Guidebook for Surveillance and Case Management

EXPIRATION — June 11, 2007

You must complete and return the response form electronically or by mail by **June 11, 2007**, to receive continuing education credit. If you answer all of the questions, you will receive an award letter for 3.5 hours Continuing Medical Education (CME) credit; 0.3 Continuing Education Units (CEUs); or 3.9 contact hours Continuing Nursing Education (CNE) credit. If you return the form electronically, you will receive educational credit immediately. If you mail the form, you will receive educational credit in approximately 30 days. No fees are charged for participating in this continuing education activity.

INSTRUCTIONS

By Internet

1. Read this *MMWR* (Vol. 53, RR-8), which contains the correct answers to the questions beginning on the next page.
2. Go to the *MMWR* Continuing Education Internet site at <http://www.cdc.gov/mmwr/cme/conted.html>.
3. Select which exam you want to take and select whether you want to register for CME, CEU, or CNE credit.
4. Fill out and submit the registration form.
5. Select exam questions. To receive continuing education credit, you must answer all of the questions. Questions with more than one correct answer will instruct you to "Indicate all that apply."
6. Submit your answers no later than **June 11, 2007**.
7. Immediately print your Certificate of Completion for your records.

By Mail or Fax

1. Read this *MMWR* (Vol. 53, RR-8), which contains the correct answers to the questions beginning on the next page.
2. Complete all registration information on the response form, including your name, mailing address, phone number, and e-mail address, if available.
3. Indicate whether you are registering for CME, CEU, or CNE credit.
4. Select your answers to the questions, and mark the corresponding letters on the response form. To receive continuing education credit, you must answer all of the questions. Questions with more than one correct answer will instruct you to "Indicate all that apply."
5. Sign and date the response form or a photocopy of the form and send no later than **June 11, 2007**, to
   Fax: 404-639-4198 Mail: MMWR CE Credit
   Office of Scientific and Health Communications
   Epidemiology Program Office, MS C-08
   Centers for Disease Control and Prevention
   1600 Clifton Rd, N.E.
   Atlanta, GA 30333
6. Your Certificate of Completion will be mailed to you within 30 days.

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Continuing Medical Education (CME). CDC is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians. CDC designates this educational activity for a maximum of 3.5 hours in category 1 credit toward the AMA Physician's Recognition Award. Each physician should claim only those hours of credit that he/she actually spent in the educational activity.

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Continuing Education Unit (CEU). CDC has been approved as an authorized provider of continuing education and training programs by the International Association for Continuing Education and Training and awards 0.3 Continuing Education Units (CEUs).

Continuing Nursing Education (CNE). This activity for 3.9 contact hours is provided by CDC, which is accredited as a provider of continuing education in nursing by the American Nurses Credentialing Center's Commission on Accreditation.

Goal and Objectives

This *MMWR* provides recommendations regarding how medicolegal investigators (i.e., medical examiners and coroners [ME/Cs]) can support public health and safety functions and provide terrorism surveillance and response efforts. These recommendations were developed by CDC staff in collaboration with the National Association of Medical Examiners (NAME). The goal of this report is to describe terrorism-related mortality surveillance and response, operational procedures during a potential terrorism event, and jurisdictional and evidentiary concerns for medicolegal death investigations. Upon completion of this educational activity, the reader should be able to 1) describe the responsibilities of ME/Cs in recognizing and responding to potential terrorism events; 2) list specific terrorism agents; 3) describe biosafety standards for autopsy precautions; 4) identify appropriate interjurisdictional support services; and 5) describe the Laboratory Response Network (LRN).

To receive continuing education credit, please answer all of the following questions.

1. Infectious disease mortality surveillance systems should be designed to do all of the following except . . .
- A. allow for rapid recognition of excess mortality occurring in a community.
- B. delay information transfer until the official death certificate has been submitted to the state health department.
- C. quickly notify public health authorities of potential biologic terrorism-related or emerging pathogens findings.
- D. incorporate the ability to assess possible commonalities among cases.

2. Which of the following is a disease caused by a Category A agent of terrorism?
- A. Brucellosis.
- B. Hantavirus pulmonary syndrome.
- C. Tularemia.
- D. Venezuelan encephalitis virus infection.
- E. Cholera.

3. LRN . . .
- A. is not relevant to biologic terrorism surveillance.
- B. channels specimens through a network of local, state, and federal public health laboratories to a pathogen-specific conclusion.
- C. are four regional laboratories named, A, B, C, and D.
- D. performs routine toxicology tests for ME/C offices.

4. Which of the following activities potentially pose an infectious disease risk to ME/Cs?
- A. Generation of fine particle aerosols through use of oscillating saws and other autopsy equipment.
- B. Exposure to blood.
- C. Contact with the contaminated surfaces of body bags.
- D. All of the above.
- E. None of the above.

5. Methods to improve surveillance and standardized collection of data include . . .
- A. documenting death investigation information on standard forms.
- B. storing death investigation data in an electronic database.
- C. including the results of laboratory tests in electronic death investigation data sets.
- D. correctly entering data into an electronic database.
- E. all of the above.

6. The Disaster Mortuary Operational Response Team (DMORT) has the capacity to . . .
- A. protect forensic professionals from airborne pathogens by using state-of-the-art ventilators.
- B. support microbiologic sampling for Class A and B biologic terrorism agents.
- C. respond to a mass disaster resulting from biological agents.
- D. store and archive all medicolegal death investigation records created during a mass fatality incident.
- E. none of above.
- F. all of above.

7. The Robert T. Stafford Disaster Relief and Emergency Assistance Act and the Federal Response Plan . . .
- A. requires the Federal Emergency Management Agency (FEMA) to reimburse 90% of expenses incurred by an ME/C office for death investigations resulting from a terrorism event.
- B. highlights the responsibilities of specific federal agencies during a terrorism event.
- C. designates consequence management to the Federal Bureau of Investigation during a terrorism event.
- D. None of the above.
- E. All of the above.

8. The Incident Command System defines functional teams of an emergency response organization as all of the following except . . .
- A. planning and intelligence.
- B. operations.
- C. logistics.
- D. finance and administration.
- E. public health surveillance.

9. Hemorrhagic mediastinal lymphadenitis and hemorrhagic meningitis (or cardinal's cap) are two pathologic findings consistent with . . .
- A. cholera.
- B. community-acquired pneumonia.
- C. Nipah virus infection.
- D. anthrax.
- E. botulism.

10. The risk of occupational exposure to Class A terrorism agents while embalming outweigh its advantages; therefore, bodies infected with these agents should not be embalmed.
- A. True.
- B. False.

11. Which best describes your professional activities?
- A. Medical examiner or coroner.
- B. Physician.
- C. Nurse.
- D. Health educator.
- E. Office staff.
- F. Other.

12. I plan to use these recommendations as the basis for . . . (*Indicate all that apply.*)
- A. health education materials.
- B. insurance reimbursement policies.
- C. local practice guidelines.
- D. public policy.
- E. other.

13. Each month, approximately how many autopsies do you perform?

A. None.
B. 1–5.
C. 6–20.
D. 21–50.
E. 51–100.
F. >100.

14. How much time did you spend reading this report and completing the exam?

A. <2.0 hours.
B. >2.0 hours but <3.0 hours.
C. >3.0 hours but <4.0.
D. >4.0 hours.

15. After reading this report, I am confident I can describe the responsibilities of ME/Cs in recognizing and responding to potential terrorism events.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

16. After reading this report, I am confident I can list specific terrorism agents.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

17. After reading this report, I am confident I can describe biosafety standards for autopsy precautions.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

18. After reading this report, I am confident I can identify appropriate interjurisdictional support services and resources.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

19. After reading this report, I am confident I can describe the Laboratory Response Network.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

20. The objectives are relevant to the goal of this report.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

(Continued on pg CE-4)

Detach or photocopy.

MMWR Response Form for Continuing Education Credit
June 11, 2004/Vol. 53/No. RR-8
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To receive continuing education credit, you must
1. provide your contact information;
2. indicate your choice of CME, CME for nonphysicians, CEU, or CNE credit;
3. answer all of the test questions;
4. sign and date this form or a photocopy;
5. submit your answer form by June 11, 2007.
Failure to complete these items can result in a delay or rejection of your application for continuing education credit.

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City *State* *ZIP Code*

Phone Number *Fax Number*

E-Mail Address

Check One
☐ *CME Credit*
☐ *CME for nonphysicians Credit*
☐ *CEU Credit*
☐ *CNE Credit*

Fill in the appropriate blocks to indicate your answers. Remember, you must answer all of the questions to receive continuing education credit!

1. [ ]A [ ]B [ ]C [ ]D	14. [ ]A [ ]B [ ]C [ ]D		
2. [ ]A [ ]B [ ]C [ ]D [ ]E	15. [ ]A [ ]B [ ]C [ ]D [ ]E		
3. [ ]A [ ]B [ ]C [ ]D	16. [ ]A [ ]B [ ]C [ ]D [ ]E		
4. [ ]A [ ]B [ ]C [ ]D [ ]E	17. [ ]A [ ]B [ ]C [ ]D [ ]E		
5. [ ]A [ ]B [ ]C [ ]D [ ]E	18. [ ]A [ ]B [ ]C [ ]D [ ]E		
6. [ ]A [ ]B [ ]C [ ]D [ ]E [ ]F	19. [ ]A [ ]B [ ]C [ ]D [ ]E		
7. [ ]A [ ]B [ ]C [ ]D [ ]E	20. [ ]A [ ]B [ ]C [ ]D [ ]E		
8. [ ]A [ ]B [ ]C [ ]D [ ]E	21. [ ]A [ ]B [ ]C [ ]D [ ]E		
9. [ ]A [ ]B [ ]C [ ]D [ ]E	22. [ ]A [ ]B [ ]C [ ]D [ ]E		
10. [ ]A [ ]B	23. [ ]A [ ]B [ ]C [ ]D [ ]E		
11. [ ]A [ ]B [ ]C [ ]D [ ]E [ ]F	24. [ ]A [ ]B [ ]C [ ]D [ ]E		
12. [ ]A [ ]B [ ]C [ ]D [ ]E	25. [ ]A [ ]B [ ]C [ ]D [ ]E		
13. [ ]A [ ]B [ ]C [ ]D [ ]E [ ]F	26. [ ]A [ ]B [ ]C [ ]D [ ]E [ ]F		

Signature *Date I Completed Exam*

21. The teaching strategies used in this report (text, figures, boxes, and tables) were useful.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

22. Overall, the presentation of the report enhanced my ability to understand the material.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

23. These recommendations will affect my practice.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

24. The content of this activity was appropriate for my educational needs.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

25. The availability of continuing education credit influenced my decision to read this report.

A. Strongly agree.
B. Agree.
C. Neither agree nor disagree.
D. Disagree.
E. Strongly disagree.

26. How did you learn about this continuing education activity?

A. Internet.
B. Advertisement (e.g., fact sheet, *MMWR* cover, newsletter, or journal).
C. Coworker/supervisor.
D. Conference presentation.
E. *MMWR* subscription.
F. Other.

Correct answers for questions 1–10.

1. B; 2. C; 3. B; 4. D; 5. E; 6. E; 7. B; 8. E; 9. D; 10. A.

trust•wor•thy: *adj*

('trəst-"wər-thē) 1 : worthy of belief

2 : capable of being depended upon;

see also *MMWR*.

know what matters.

MMWR™

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