When providing care to patients infected with a highly hazardous communicable disease (HHCD), everyone’s goal is to optimize their chances to survive and discharge them to live a long and happy life, but an unfortunate reality is that patients may not survive. Because death is an inevitable part of life, there are many traditions and rituals that have developed around when someone passes such as washing the body, touching a loved one, dressing them in their favorite clothes, and many more. Depending on the HHCD, none of these may be possible, and in some cases, families may not have a choice regarding the final disposition. If burial is the desired option and allowable by public health entities, there may be specific accommodations required. The casket may need to be sealed and the body contained in several layers of mortuary bags due to the postmortem viability of the pathogen. In other situations, such as the presence of an implanted pacemaker in the decedent that won’t be removed, cremation may be excluded as temperatures as high as 2400°F may cause the lithium battery to explode inside the cremator.

This chapter will focus on procedures that should be followed in a setting such as the United States. Significant human-to-human spread of viral hemorrhagic fever (most from Ebola viruses) has occurred in African settings related to contacts with the deceased during outbreaks. Much experience has been gained in those settings by working with communi-
ties to conduct safe, dignified burials that attempt to incorporate families and communities in the preparation and interment process.

There is a fine balance between respecting the decedent’s cultural traditions and ensuring the health and safety of those who come in contact with the body. For the health care provider, there are many facets to providing postmortem care for a deceased patient, but the most critical is the need to understand the risk of disease transmission after death. Understanding the hazards and postmortem stability of an organism will inform the provider on the appropriate infection control measures that need to be in place to protect those who are preparing the body and prevent the spread of infection in the community at large. The Ebola virus is an example of a pathogen capable of postmortem transmission as it remains viable for up to 7 days on the skin, and longer in blood and body cavities. The ability of the Ebola virus to spread postmortem resulted in many second- and third-generation infections during the 2014–16 West Africa Ebola outbreak, as was demonstrated in a case study where 28 individuals who participated in the burial practices of just one decedent contracted the disease. In addition to knowing how to protect oneself, it is essential to be knowledgeable of the law regulating mortuary affairs.

**Legal and Policy Considerations**

Legal and policy considerations have two main points of focus: the health and safety of workers and the issues related to the containment and final disposition of the remains. Workers are protected by the Occupational Safety and Health Act of 1970, which requires employers to provide employees with a workplace that is free from recognized hazards that are capable of causing severe physical harm or death. However, when the hazard is unavoidable, as in the case of providing postmortem care for a body infected with the Ebola virus, the General Duty Clause Section 5(a)(1) requires employers to take reasonable measures to lessen the risk from hazards. These measures can include the provision of personal protective equipment (PPE) and the development of protocols and training programs to direct safe practices. Additionally, employers must comply with the Bloodborne Pathogens standard (29 CFR 1910.1030) if there is a potential for the employee to come in contact with blood or other po-
tentially infectious materials. This includes the provision of tools and devices engineered for safety, employee postexposure contingency plans, and annual training, regardless of the employees’ past training and education. Federal guidelines on the containment of infected human remains are provided by the Centers for Disease Control and Prevention (CDC), but laws that govern the disposition of the deceased are provided by individual state statutes. Each state has its own regulations that govern the transportation and disposition of human remains. Generally, if it is determined that a hazard exists that could cause harm to a community, state governors can issue public health orders to direct measures to mitigate the risk. This may include a mandate for cremation instead of burial, but each state is unique in this regard.

Preparing and Containing the HHCD-infected Human Remains

The manner in which HHCD-infected human remains are prepared for cremation or interment will largely depend on guidance provided by the World Health Organization (WHO), the CDC, and each state’s public health department (PHD). In some cases, it is possible that normal processes will be sufficient, or it may be judicious to place a surgical mask over the decedent’s airway if there is concern for pathogens being forced out of the mouth or nose during manipulation of the decedent. Another method to consider is to wrap the decedent in fluid-impermeable material prior to placement in a mortuary bag if there is concern for pathogens that transmit by contact. It is not unreasonable to anticipate that if the disease process and treatment activities of a patient result in waste generation classified as Category A hazardous material (see chapter 19), the CDC or PHD may issue guidelines that reflect what was advised during the 2014–16 West Africa Ebola outbreak. In that situation, the CDC provided guidance for the safe handling of human remains infected with Ebola virus disease for US health care facilities and mortuaries, which includes a detailed process for postmortem preparation, transportation, and disposition of the remains. The instructions emphasize Ebola’s propensity for postmortem transmission, and accentuate the notion that only trained personnel should handle Ebola-infected human remains. Training should include instruction on how to use the equipment while
wearing PPE. Practices normally associated with postmortem care of a patient, including bathing the body and removing medical equipment such as intravenous lines, endotracheal tubes, and pacemakers, is not advised. Embalment and autopsy are also contraindicated; exceptions should only occur under guidance of the CDC. Burial is permitted but ultimately is at the discretion of individual state health departments. Some states have mandated cremation for Ebola-infected remains.

Preparing the decedent for transportation is a 21-step process designed to secure the remains within three different grades of mortuary bags. The process requires sectioning the working area into hot and cold zones with two distinct teams in each zone. The hot zone will require at least four personnel, while the cold zone can be managed with a team of two. The entire process requires strict infection control procedures with staff adhering meticulously to protocol to minimize the risk of cross contamination between the two teams. The hot zone team prepares and contains the body within three mortuary bags, while the cold zone team avoids any contact with the remains and any potentially contaminated surfaces. The role of the team in the cold zone is to receive the contained remains and proceed with transportation.

Required equipment (which must be moved into the patient's room [i.e., the hot zone]) includes:

- A hospital gurney.
- 3 mortuary bags opened and positioned on the gurney in the reverse order in which they will be used:
  - The outermost layer and third bag to be used (which should be placed on the bottom) is an 18-mil thickness (457 micrometers) heavy-duty mortuary bag made from laminated vinyl or compatible chlorine-free material that will contain the remains after they have been sealed within the heat-sealed pouch.
  - Other specifics of this bag include having factory-sealed seams with straps made from reinforced material that are riveted (not sewn) and run along the underside of the bag to create a sling to prevent the handles being ripped when the bag is lifted.
  - The zipper should be on top and have two zipper tabs to allow them to be locked together with a zip tie.
The middle layer is heat-sealable material that has been specially designed for decedent containment. It requires a thermal sealer to seal the edges to create a pouch that will encapsulate the remains after they are placed in the first bag. This material comes with a factory-sealed edge that, when opened, one side can hang down the side of the gurney to protect it from the contaminated bed during transfer of the body into this bag. Any imprinted indicators on where to seal and cut this material should not be followed as these are for the primary purpose of the material and not for biocontainment needs.

The innermost layer and first bag to be used (to be placed on top of the other two bags) is a 6-mil thickness (152 micrometers) mortuary bag made from vinyl or other chlorine-free fluid-impermeable material with sealed seams and a zipper on top.

- Scissors to cut the raw edges of the second bag after it has been heat-sealed.
- A camera or other device to take a photo of the patient prior to being contained.
- EPA-approved disinfectant wipes.
- Hand sanitizer.
- Zip tie for locking the zipper tabs on the third bag.

The required equipment in the cold zone includes:

- A hospital gurney or mortuary stretcher.
- An adhesive-backed pouch to attach to the decontaminated body bag to contain any necessary documentation.
- Single-use (disposable) gloves with extended cuffs and a long-sleeved disposable gown.
- Spill kit with PPE and spill cleanup supplies.
- Infectious substance labels that are applied to the decontaminated body bag, including the following:
  - Black and white “infectious substance” label
- United Nations (UN) 2814 Category A infectious substance label
- “Do not open” label
- Label with the name and phone number of the hospital administrator

The CDC 21-step process is available at https://www.cdc.gov/vhf/ebola/clinicians/evd/handling-human-remains.html. Although other facilities may use slightly different processes, the process shown in this publication has been adapted to include additional considerations that have been used successfully in the Nebraska Biocontainment Unit (NBU; see table 20.1). The process involves taking the gurney with the preopened bags into the hot zone and positioning it alongside the bed and transferring the decedent into each bag while in the hot zone. Consideration should be given to cleaning and disinfecting the floor and taking measures to protect the gurney from coming into contact with any contaminated surfaces in the room prior to wheeling it in to lessen the potential for contamination.

The CDC guidelines can be adapted to meet the needs and physical layout of individual facilities. For example, the NBU process follows the CDC principles, but they developed a method that did not require taking the gurney with all three bags into the hot zone. The NBU facility utilizes an additional zone referred to as the warm zone, in which the remains are transferred after being contained in the second bag by using a slide board to create a bridge from the foot of the bed to the head of the gurney that has the third bag ready to receive the remains. This allows staff to slide the disinfected double-bagged remains directly into the heavy-duty mortuary bag. This same technique is then repeated at the transition between the warm and cold zones into a second heavy-duty mortuary bag. At each transfer, staff in appropriate PPE for their assigned zones take custody of the remains. The teams for this process in the NBU consist of up to 4 staff in the hot zone, 2 in the warm zone, and 2 in the clean (cold) zone.
Transportation of Infected Human Remains

The US Department of Transportation (DOT) regulates the transportation of infectious substances including HHCD-infected human remains (see chapter 19 on waste handling), which are categorized into two main groups: Category A and Category B infectious substance. A Category A infectious substance is defined as:

A material known or reasonably expected to contain a pathogen, such as Ebola, that is in a form capable of causing permanent disability or life threatening or fatal disease in otherwise healthy humans or animals when exposed to it. (49 CFR, Parts 171–180)

Category B infectious substances are those that do not meet the criteria to be included in Category A and therefore do not require the same stringent measures as hazardous material. To determine the appropriate category for human remains, the DOT provides this guidance: “An infectious substance classification is based on the patient or animal's known medical history or symptoms, endemic local conditions, or professional judgment concerning the individual circumstances of the source human or animals.” Using this definition it would appear that transporting Ebola-infected human remains would be subject to the requirements for transporting Category A infectious substances. However, if the remains are being transported for cremation, interment, or medical research, they are exempted from Hazardous Materials Regulations (HMR) 49 CFR, Parts 171–180. However, infectious substance labels must still be applied to the external mortuary bags. Once sealed within the mortuary bags, the remains can be transported in the same manner as any other decedent with some caveats. The transport route should be predetermined and arranged in collaboration with all relevant authorities, according to state regulations. Consideration should be given to limiting the transit time from the point of containment to the final destination, as well as how to maintain chain of custody during transit. If the transport route involves interstate travel, it must be coordinated with the CDC Emergency Operations Center (EOC). Finally, in the unlikely event a spill
were to occur, the transportation team should have PPE readily available and be familiar with (or receive just-in-time training on) how to clean up a spill, and how to contain and dispose of the waste it will generate.

**Support for Family and Friends**

Family members and friends of patients who are in isolation are unlikely to have any physical contact with them during their illness. Visitation will be restricted to available resources, and at best communication will have been provided via two-way video connections. Although seeing a loved one on a screen is better than not seeing them at all, it does not replace the need to have direct physical or verbal contact when death is imminent. Visitation rules after the patient dies are unlikely to change, and being isolated from loved ones at times such as this can lead to a profound feeling of loss and helplessness. Supporting the family and making all attempts to comfort and provide what is required to help them cope during this period is a key element of preparedness that should be included in planning.

Each individual family will be unique in their needs, so it will be important to individualize support and assess their beliefs, which traditions they want to uphold and what needs are priorities for them. Many people have religious practices that are important at the time of death, so consideration should be given to facilitating these requests, when feasible. Using the video system to administer blessings is one way that can accommodate this need and will not place someone at risk with room entry. It may also be helpful to allow the family to write letters or provide other items such as photos that can be included when securing the decedent within the mortuary bags. This will give the family an opportunity to express their personal feelings and give them a sense of connection to their loved one.

**Supporting Staff**

In addition to the family, staff may also experience a sense of loss and perhaps failure at not being able to save their patient. At one US facility that experienced the death of an Ebola patient during the 2014 West Africa Ebola outbreak, a study that interviewed staff on their experience
asked about the emotional impact of providing care to a patient with an HCCD. Fully half of these staff members reported that the death of their patient was the most difficult experience they encountered. To prepare staff to cope, it is beneficial to have a behavioral health specialist on the team who can provide counseling and a safe place for them to express their feelings, but also to provide resiliency training in advance of an event to prepare them to use preidentified resiliency strategies. It may also be helpful for them to acknowledge the decedent by memorializing them in some way. This can be done through having a meeting or service to honor the person and give staff the opportunity to express condolences. It is important to acknowledge that staff will find this an emotional event, and opportunities need to be provided to allow the healing process to begin.

**Summary**

The postmortem care of a patient must be performed with attention to detail and a high level of infection control. Leadership and staff should be knowledgeable about the regulations that govern the health and safety of the worker, as well as how the decedent should be contained and transported. Methods for containing the decedent can range from placing a mask over their airway to containing them in several layers of differing standards of mortuary bags following a detailed procedure. Transportation of an HCCD-infected decedent needs to follow DOT regulations. As with any death of a patient, it will be an emotional time for family, friends, and staff, so in addition to strict infection prevention and control measures, it is important not to lose sight of the need for emotional and spiritual support needs of those involved.

**Table 20.1. Process for Handling of Human Remains**

1. Prepare the thermal sealer by plugging it into an electrical outlet and placing it in a safe location to avoid inadvertent burns to staff. Ensure it is plugged in where it will allow the sealer to reach the entire circumference of the second bag.

2. Use the camera or other device to take a photograph of the decedent's face for identification purposes. Make sure to follow your facility's compliance regulations when digitally transfer-
ring the image to not violate the Healthcare Insurance Portability Accountability Act (HIPAA).

3. Position the gurney with the three preopened body bags next to the hospital bed. The overhanging top of the heat-sealable material should be positioned toward the bed to protect the gurney. It is also useful to remove the head and footboard from the bed as this will allow easier access to the body.

4. Do not remove any inserted medical devices such as an IV line or endotracheal tube from the body. Simply disconnect any equipment and move them away from the work area. Do not remove dressings. Do not wash or clean the body. Do wrap the bed linens around the body as this will help absorb any liquids as well as immobilize the extremities.

5. Gently roll the body from one side to the other to clean the bed with EPA-registered disinfectant wipes to remove any body fluids and lower the bio burden on the mattress. Allow the mattress to dry, then remove the first bag from the gurney. Gently roll the body wrapped in the linen to one side while sliding the first bag under the body, and positioning it so that when the body is rolled back it will be positioned in the center of the bag.

6. Once the body is positioned on the first bag, zip it up, being careful not to let anyone’s gloves get caught in the zipper mechanism. Minimize the amount of air that will be trapped in the bag, as this will prevent a risk of aerosolizing pathogens when pressure is put on the bag during transfer.

7. Disinfect gloved hands using alcohol-based hand rub (ABHR) or EPA-registered disinfectant wipes after each step. If any areas of PPE have visible contamination, disinfect with an EPA-registered disinfectant wipe. Consider wearing a disposable apron over the PPE as this can be removed and replaced easily in the hot zone.
8. Disinfect the outside of the first bag with an EPA-registered hospital disinfectant applied according to the manufacturer’s recommendations. If there is any body fluid from the patient on the bag, be sure to clean it first, then disinfect. Ensure adequate wetness, friction, and dry time are provided when disinfecting.

9. Transfer the first bag with the body in it to the gurney, placing it on top of the second bag material. Consider adding a slider board to the list of required equipment as this will assist with the transfer and reduce the risk of tearing the first bag when lifting it with the weight of the body inside.

10. Disinfect gloved hands using ABHR or EPA-registered disinfectant wipes. If wearing a disposable apron, remove it and don a clean one.

11. Fold the overhanging side of the second bag material over the first bag, and heat-seal approximately 2 inches around the entire perimeter. Although one edge is factory sealed, it should be resealed to mitigate complications from a potential factory defect in the sealing process. For additional safety, consider adding small clamps to the equipment list as they are useful for holding the material edges together during the sealing process, and will prevent having to place hands close to the thermal sealer. After sealing around the entire circumference, heat-seal the bag a second time approximately 1 inch below the initial seal and then heat-seal diagonally across the corners. Use scissors to trim the excess material by cutting down the center of the outermost seal. This will result in a perfectly sealed edge. Turn off and unplug the thermal sealer and place it in a safe location to cool. The thermal sealer must be decontaminated before being removed from the hot zone or reused.

12. Disinfect the outside of the second bag with an EPA-registered hospital disinfectant applied according to the manufacturer’s recommendations. Be careful when wiping the edges, as they can be sharp.
13. Disinfect gloved hands using ABHR or EPA-registered disinfectant wipes.

14. Work the third bag around the second bag, and zip up the third bag, again being careful to not get any gloves caught in the zipper mechanism. When the zipper tabs meet, use a zip tie to lock them together.

15. Disinfect gloved hands using ABHR or EPA-registered disinfectant wipes. If wearing a disposable apron, remove it and don a clean one.

16. Wipe down the gurney with EPA-registered disinfectant, then wheel the gurney to the decontamination area for a more thorough cleaning and disinfection.

17. Decontaminate the surface of the body bag with an EPA-registered hospital disinfectant applied according to the manufacturer’s recommendations. Begin by applying the hospital disinfectant to the top of the bag and any exposed areas of the gurney. Engage the side rail, then roll the bag to one side to decontaminate half of the bottom of the bag and the newly exposed portion of the gurney. Repeat with the other side of the bag and gurney. When performing decontamination, remove any visible soil on surfaces of the bag or gurney with the EPA-registered disinfectant wipes. After the visible soil has been removed, reapply the hospital disinfectant, and allow sufficient contact time as specified by the manufacturer of the disinfectant.

18. Disinfect the surfaces of the gurney from the handles to the wheels with an EPA-registered hospital disinfectant applied according to the manufacturer’s recommendations.

19. Disinfect gloved hands using ABHR or EPA-registered disinfectant wipes.

20. Push the gurney gently so that only the gurney and the decontaminated body bag enter the cold zone. The workers in the
hot zone should not enter the cold zone. The cold zone team will receive the body and transport the body for disposition.

21. The hot zone team should proceed to the PPE doffing area and follow facility procedures for doffing PPE.