

FACT SHEET Posted October 18 2005

Remediation and Infection Control Considerations for Reopening Healthcare Facilities Closed due to Extensive Water and Wind Damage

During Hurricanes Katrina and Rita, many Gulf Coast hospitals suffered water and wind damage; some had standing water for more than one week due to flooding. Building structures, equipment, and supplies are presumed to be heavily contaminated with microorganisms, primarily mold, mold spores, and bacteria. Before reopening, hospitals must be evaluated to determine: 1) if the facility is damaged beyond repair and must be condemned; or 2) if the extent of the damage is such that the facility may be restored, repaired, and reopened.

Once the decision is made to repair and reoccupy the building(s), damaged or contaminated materials and structures must be removed and discarded, while salvageable materials and items can be thoroughly dried, repaired, cleaned, and restored to safe function. The restoration of a hospital to full function is a complex, multidisciplinary task, and the assistance of engineers, professionals trained in building remediation, and manufacturers of healthcare equipment will likely be necessary to complete the job. Once the work to restore the building is finished and the building is returned to service, periodic inspection of the remediated structure will be necessary to identify mold growth and initiate removal and control measures. Clinical- and laboratory-based surveillance in the healthcare facility for unusual clusters of infectious diseases due to pathogens in the environment will also be essential.

The following information is intended to assist healthcare facilities with the tasks involved during clean-up and reopening. Links to electronic copies of recommendations from Governmental agencies and professional associations are provided. Implementation of these measures is meant to be followed in accordance with state and local certification requirements, completion of building and fire inspections, and other relevant state or local regulations.

Worker Health and Safety

Persons involved in hurricane relief and clean up need to be protected from infectious diseases, chemical exposures, radiation, electrical shock, and potential fire hazards. Specific information for relief and clean up workers can be found at:

CDC: Hurricane Information for Response and Cleanup Workers
<http://www.bt.cdc.gov/disasters/hurricanes/workers.asp>

CDC/NIOSH: Hurricane Response: Storm and Flood Cleanup
<http://www.cdc.gov/niosh/topics/flood/>

Mold Remediation and Structural Recovery

Facilities with evident damage from wind, rain, and flooding as well as those that lost only electricity and ventilation (i.e., no standing water in the building, but sustained periods of high heat and humidity) should be evaluated to determine the extent of the damage and to decide if the clean-up can be managed safely with in-house resources and facility staff. Requirements for personal protective equipment and clean-up methods will vary based on the extent of the damage (Table). Containment of the remediation area(s) may not be needed if the building remains unoccupied during the process.

Facilities with extensive water damage (i.e., >32 sq ft in a given space) will benefit from assessment, remediation, and recovery work as provided by professionally-trained remediation firms.

The building(s) must first undergo a building and life safety evaluation to determine if the structure is safe to enter and if there is sufficient safe electrical power to assist clean-up operations. Furthermore, the building must be evaluated for fire safety and protection. Once the remediation is cleared to begin, the major activities typically associated with this process include:

- 1) Restoration of working sewage system;
- 2) Extraction of standing water and sewage;
- 3) Restoration of potable water system;
- 4) Installation of appropriate containment for bioaerosols as appropriate (i.e., if some portion of the building is occupied);
- 5) Ventilation of the work area (e.g., open windows where possible) and devise a process for removal of damaged materials from the work area;
- 6) Removal of heavily contaminated and/or damaged items and building materials, especially porous materials (Some building materials such as insulation may not be directly assessable, therefore moisture detection equipment should be used.);
- 7) Removal of surface contamination on non-porous materials by physical cleaning;
- 8) Biocide/disinfectant treatment of surfaces if determined to be needed;
- 9) Drying and reassessment for residual moisture in remaining structural materials;
- 10) Repair and renovation of the structure and replacement of damaged items;
- 11) Restoration of electrical power and backup generators;
- 12) Thorough cleaning and drying of salvageable porous items (e.g., curtains, draperies, linens) if possible;
- 13) Evaluation of equipment, medical support infrastructure (e.g., medical gases, steam, compressed air), furniture, records and documents, and supplies for damage; and
- 14) Cleaning and disinfecting surfaces in patient-care areas.

Details on these activities are discussed in material found at:

U.S. Navy Environmental Health Center: Guide to the Navy Industrial Hygiene Field Operations Manual, Chapter 13: Indoor Environmental Quality
<http://www-nehc.med.navy.mil/ih/ihfom.htm>

WHO/PAHO: Principles of Disaster Mitigation in Health Facilities <http://www.paho.org/English/PED/fundaeng.htm>

American Institute of Architects: Procedures for Cleaning out a House or Building Following a Flood
http://www.aia.org/liv_disaster_floodproc

University of Minnesota: Managing Water Infiltration into Buildings
<http://www.dehs.umn.edu/iaq/flood.html>

U.S. Army Center for Health Promotion and Preventive Medicine Mold Resources
<http://usachppm.apgea.army.mil/mold/>

U.S. Environmental Protection Agency Mold Resources
<http://www.epa.gov/iaq/molds/moldresources.html>

Guides to use of respirators are available at:

CDC/NIOSH Respiratory Protection Guidance
<http://www.cdc.gov/niosh/npptl/guidancedocs/>

Water and Electrical Utilities

Prior to any remediation effort getting underway, it is important to reestablish working electrical, sewage, and water systems. The integrity of the electrical system (e.g., wiring, insulation, generators) must be determined and repairs made so that remediation workers can have adequate lighting and power for equipment as needed. A working sewage system is necessary for effective extraction of standing water. The potable water distribution system must also be evaluated and repairs made as needed. "Boil water" advisories will most likely be in effect during this time. It will be helpful to consult with municipal water system officials to be appraised of water treatment issues as the community restores essential services. Fire safety systems within the building should be evaluated and repaired if needed. Local fire safety marshals should be consulted if fire safety systems cannot be fully restored prior to beginning remediation work. Water supply remediation information can be found at:

CDC: Healthcare Water System Repair Following Disruption of Water Supply
<http://www.bt.cdc.gov/disasters/watersystemrepair.asp>

CDC/HICPAC: Guideline for Environmental Infection Control in Health-Care Facilities
<http://www.cdc.gov/ncidod/hip/enviro/guide.htm>

EPA: Emergency Disinfection of Drinking Water
<http://www.epa.gov/safewater/faq/emerg.html>

WHO: Drinking Water Quality
http://www.who.int/water_sanitation_health/dwq?HPC12.pdf

CDC: Safe Use of "Tanker" Water for Dialysis
<http://www.bt.cdc.gov/disasters/watertanker.asp>

Ventilation System

The heating, ventilation, and air conditioning (HVAC) system should be evaluated to determine the extent of damage and contamination. Professional consultation is helpful in deciding if the system needs to be replaced or if repairs and cleaning are sufficient. If repairs are done on an existing system, the motorized components (e.g., fans, blowers) should be inspected for water damage, dirt and debris should be removed from the ductwork and other components, surfaces should be disinfected using EPA-registered disinfectants designated for ductwork treatment, and filters and insulation replaced.

HVAC system components, including ductwork that may not have been submerged, need to be cleaned thoroughly and disinfected to remove bacteria and mold that could be dispersed when the system is utilized. The following steps should be considered:

- 1) Isolating the HVAC remediation work from cleaned areas of the facility through the use of barriers, negative pressurization, venting exhaust air to the outside;
- 2) Respiratory protection and protection for skin, eyes, and hearing should be used by the workers;
- 3) Determining if asbestos is present in the HVAC system before undertaking remediation;

- 4) Removing and replacing water-damaged insulation in or around the HVAC system;
- 5) Cleaning and disinfecting surfaces within the HVAC system, or if this cannot be done, discarding the damaged equipment and replacing with new components;
- 6) Removing the HVAC system fan for thorough service and cleaning and replacing it into the system after testing.

These steps and other considerations are discussed in greater detail at:

CDC/NIOSH: Interim Recommendations for the Cleaning and Remediation of Flood-Contaminated HVAC Systems: A Guide for Building Owners and Managers
<http://www.cdc.gov/niosh/topics/flood/cleaning-flood-HVAC.html>

University of Minnesota: HVAC System Decontamination
<http://www.dehs.umn.edu/iaq/hvacsys.html>

Structural Building Materials

Mold remediation requires physical removal of mold rather than disinfecting mold-contaminated surfaces. Visibly contaminated and damaged materials must be removed. Plastic sheeting or bags can be used to contain these items to minimize dispersion of mold spores during removal. Removed, contaminated materials can be discarded as routine construction waste. Porous materials and items need to be discarded if they have been submerged, are difficult to clean, cannot dry out with 48-72 hours, or if odors remain. Hard, non-porous surfaces and items can be cleaned with detergent and water and dried. As the remediation progresses, the damaged structural materials are replaced, existing materials are cleaned, and the area is dried. There should be an assessment for residual moisture in structural materials using moisture detection devices (e.g., moisture meters, borescopes). Any structural material that cannot be thoroughly dried out within 48-72 hours should be removed and replaced.

Table: Mold Elimination Strategies for Recovery from Flood Damage Lasting >48 Hours*

| | Limited Damage (<32 sq ft) | | | Extensive Damage (>32 sq ft) | | |
|-----------------------------------|-----------------------------|---------|-------------|------------------------------|-----|-------------|
| | Clean-Up | PPE | Containment | Clean-Up | PPE | Containment |
| Cinder block and concrete | A, C | M or L1 | NR or L2 | A, C | F1 | F2 |
| Hard surfaces and porous flooring | A, B, C | M or L1 | M or L2 | A, B, C, D | F1 | F2 |
| Wallboard and gypsum drywall | C, D | M or L1 | NR or L2 | C, D | F1 | F2 |
| Wood surfaces | A, B, C | M or L1 | NR or L2 | A, B, C | F1 | F2 |
| Ceiling tiles and insulation | D | M or L1 | NR or L2 | D | F1 | F2 |
| Carpet and backing | A, C | M or L1 | NR or L2 | A, C, D | F1 | F2 |
| Upholstery and drapes | A, C, D | M or L1 | NR or L2 | A, C, D | F1 | F2 |
| Paper and books | C | M or L1 | NR or L2 | C | F1 | F2 |

* Adapted from "Mold Remediation Wheel," developed by the U.S. Navy Environmental Health Center

Key to Table Entries:

Clean-Up:

A: Wet vacuum. If material is porous, some mold fragments or spores may remain, but they will not grow if the material is completely dried.

B: Damp wipe surfaces with water / mild detergent solution. On wood floors, use a wood floor cleaner.

C: Use HEPA (high efficiency particulate air) vacuum after material is dry. Dispose of HEPA vacuum bag as contaminated waste in accordance with state waste regulations.

D: Remove and discard water-damaged materials and seal in plastic bags inside the containment area. HEPA vacuum area after it is dry.

Personal Protective Equipment (PPE):

M: Minimum – gloves, N95 respirator, goggles / eye protection.

L1: Limited – gloves, N95 respirator or half-face with N, P, R-100 filters, disposable coveralls, goggles / eye protection.

F1: Full – gloves, disposable full body coveralls, head and foot coverings, full face respirator with N, P, R-100 filters.

Containment:

NR: None required.

L2: Limited – contain remediation area with one layer of polyethylene sheeting. Block off supply and return air vents. Keep under negative pressure with HEPA-filtered fan unit.

F2: Full – contain remediation area with double poly sheeting. Use airlock entrance. Secure ventilation to/from the affected area. Maintain negative pressure with HEPA-filtered exhausted outside of the building.

Medical Equipment, Devices, and Supplies

After the healthcare facility has been determined to be safe to enter, all medical equipment, devices, and supplies should be inspected to determine what is salvageable and what should be discarded.

Medical Equipment

Two of the first services in the hospital that should be restored to function are the central sterile supply area and laundry. Ensure that there is stable electrical power, the potable water system is back on line, and natural gas supply is restored. Assess the instrument washing equipment and laundry equipment to see if these items can be restored to function. Check with the manufacturer of these pieces of equipment for additional guidance. Reestablish the hospital's source of steam and validate its quality so that steam autoclaves can be operational once the latter are evaluated for safe operation and can be tested with chemical and biological monitors.

In determining which patient-care equipment and medical devices should be discarded, the owner must assess each product's current condition and potential safety risks. Manufacturers may need to be contacted regarding the appropriate damage assessment for their equipment or instruments and specific cleaning and disinfection methods. Water can adversely affect electronics, and moisture trapped inside a piece of equipment may trigger the development of rust. Do not connect wet electronic equipment to electricity. Contact the original manufacturer regarding instructions for cleaning and drying the equipment or shipment back to the manufacturer for refurbishing. Items that can be salvaged should undergo appropriate cleaning, disinfection, and recertification as per manufacturers' instructions.

Regional disaster planning initiatives should be checked for standing agreements among area hospitals to see if the documents address temporary cleaning and reprocessing support of instruments, devices, and supplies. Hospitals not impacted by hurricane damage may help by offering their central sterile supply services and/or laundry while affected hospitals work to bring their reprocessing capacity back on line.

See the information on "Water" in CDC / HICPAC Guideline for Environmental Infection Control in Health-Care Facilities: <http://www.cdc.gov/ncidod/hip/enviro/guide.htm>

For more information about steam sterilizers, refer to ANSI/AAMI ST 46: 2002: Steam Sterilization and Sterility Assurance in Health Care Facilities: <http://www.aami.org/>

Additional information about medical instruments and equipment can be found at:
FDA: Information About Medical Devices and Disasters <http://www.fda.gov/cdrh/emergency/>

FDA: Medical Devices that Have Been Exposed to Heat and Humidity
<http://www.fda.gov/cdrh/emergency/heathumidity.html>

Medical Supplies and Records

All supplies, including furniture, need to be assessed to determine if they should be discarded, can be laundered or disinfected adequately to prevent the growth of mold, or can be reprocessed and repackaged by the manufacturer or healthcare facility.

Information to be considered includes:

- 1) Linens and curtains may be salvageable by removing gross soil and laundering in hot water and hot air drying. If discoloration from water damage remains visible after cleaning, it may be prudent to discard the item;
- 2) Upholstered furniture, drapery, and mattresses will need to be discarded if they have been under water or have mold growth or odor;
- 3) Non-porous (e.g., plastic or stainless steel) furniture may be salvageable if cleanable;
- 4) Furniture made with particle board should be discarded;
- 5) Packaged supplies (e.g., prepackaged bandages packaged in paper and sterile supplies packaged in paper-peel packs) should be inspected for tears, dampness, visible moisture, mold growth, or signs of having been wet (such as water stains or discoloration) and discarded if present;
- 6) Sterile supplies whose packaging is compromised will need resterilization; items in undamaged, intact waterproof packaging may be kept;
- 7) Manufacturers of affected supplies should be contacted to determine if in-house reprocessing of these items is appropriate and feasible; alternatively the manufacturer should provide the facility with instructions to return the items for reprocessing;
- 8) Essential paper files and records can be protected with plastic wrap and photocopied; documents can be frozen and dried; professional conservators may be contacted for assistance.

More information on preserving medical records can be found at:

Louisiana Department of Health and Hospitals Health Standards: Recovering Patient Records after a Water Disaster
<http://www.dhh.louisiana.gov/offices/publications.asp?ID=112&Detail=748>

Pharmacy Supplies and Biological Products

The U.S. Food and Drug Administration (FDA) is the federal resource for information regarding drugs and biological products. More information on these topics can be found at:

FDA: Safe Drug Use after a Natural Disaster
<http://www.fda.gov/cder/emergency/water-refrig.htm>

FDA: Impact of Severe Weather Conditions on Biological Products
<http://www.fda.gov/cber/weatherimpact.htm>

Food Service

After a flooding event, special care must be taken to ensure safe food preparation and service. Identify and throw away food that may not be safe to eat. Assess food preparation equipment for damage and replace or repair as appropriate. Evaluate natural gas line integrity and verify that potable water lines to refrigerators and washing equipment are flushed once potable water service is restored. Stabilize the cooling capacity of freezers and refrigerators before adding food items. Clean and sanitize food-contact surfaces. Since regulations regarding food service certification differ from state to state, refer to state and local government resources for more information.

Additional information about keeping food and water safe after a natural disaster or power outage can be found at:

CDC: Keep Food and Water Safe after a Natural Disaster or Power Outage
<http://www.bt.cdc.gov/disasters/foodwater.asp>

FDA: The Safety of Food Affected by Hurricane Katrina
<http://www.cfsan.fda.gov/~dms/fsdisas1.html>

Certification for Occupancy

Regulations regarding healthcare facility certification and licensing differ from state to state. Refer to specific state and local government resources for more information.

Louisiana:
<http://www.dhh.louisiana.gov/offices/?ID=112>

Mississippi:
http://www.msdh.state.ms.us/msdhsite/_static/30.0.83.html

Texas:
<http://www.tdh.state.tx.us/hfc/hfc-web.htm>

Special Considerations for Designated Activities

Dental Offices

Some dental devices and equipment may pose safety concerns to patients and personnel if not properly assessed for damage and contamination and made safe for use. Such devices and equipment include dental units (including waterlines, valves, and connections), waterline treatment systems, steam autoclaves, and air compressors. The degree and type of water and wind damage will vary by dental practice; therefore, evaluations of specific equipment should be made on a case-by-case basis. In general, however, equipment and devices that have been totally submerged in water are probably unsalvageable due to electrical damage and subsequent corrosion. Dental healthcare personnel should contact the manufacturer of the device or equipment for specific guidance on damage assessment, cleaning, and disinfection. If the manufacturer can not supply this information, it may be prudent for the dental practice to refrain from use of the item until further direction is provided and the safety of the device can be assured.

Dialysis Care

All dialysis units require purified, dialysis-quality water. Loss of potable water or loss of power to a water treatment system can result in the potential contamination of water. Specific information for dialysis facilities can be found at:

FDA: Advice to Follow when Reopening Hemodialysis Clinics after Restoration of Power and Water
<http://www.fda.gov/cdrh/emergency/dialysis.html>

CDC: Technical Considerations when Bringing Hemodialysis Facilities' Water Systems Back on Line after a Hurricane
<http://www.bt.cdc.gov/disasters/hurricanes/katrina/watersystems.asp>

CDC: Infection Control for Peritoneal Dialysis (PD) Patients After a Disaster
<http://www.bt.cdc.gov/disasters/icfordialysis.asp>

CMS: Emergency Preparedness for Dialysis Care Facilities: A Guide for Chronic Dialysis Facilities
<http://www.cms.hhs.gov/providers/EmergPreparedness2.pdf>

CDC: Guidelines for Dialysis Care Providers: What to Do When Your Municipal Water Supplier Issues a “Boil Water Advisory”
http://www.cdc.gov/ncidod/hip/dialysis/boilwater_advisory.htm

Laboratory

Laboratory services may be disrupted if the healthcare facility is extensively damaged such that power, lighting, natural gas, steam, and water utilities are unavailable. Healthcare facilities should have contingency plans in place to arrange for relocation of essential laboratory services to other facilities. Essential laboratory services may include blood gases and co-oximetry, electrolytes, hepatic and basic metabolic profiles, and hemograms and coagulation studies. Lab services (e.g., microbiological testing, serology, and toxicological testing) should be sent to a referral laboratory until a safe working environment can be reestablished in the healthcare facility.

The laboratory is heavily dependent on utilities support. The following measures should be considered when restoring lab function:

- 1) Assess the status of the electrical system and determine if any emergency power was available to power essential equipment and containment systems;
- 2) Assess if equipment was damaged by exposure to high temperatures and humidity;
- 3) Ensure that stable electrical power is reestablished;
- 4) Evaluate lab equipment, refrigerators, and freezers for damage, and consult with the manufacturers for guidance on disassembly, drying, evaluation, cleaning, and repair of the equipment. Alternatively, the manufacturer may indicate that the equipment be returned for repairs and refurbishing;
- 5) Restore adequate lighting and ventilation;
- 6) Replace damaged or contaminated reagents and supplies;
- 7) If the laboratory has a steam autoclave, verify the quality of the steam and determine if the equipment needs repair prior to validation testing with mechanical and biological indicators;
- 8) Clean and disinfect or sterilize reusable items;
- 9) Restore refrigeration to labs and morgues;
- 10) Clean, disinfect, and arrange for the recertification of biological safety cabinets; and
- 11) Clean all working surfaces with detergent and water and disinfect as appropriate.

Radiology

Manufacturers of radiological equipment may need to be contacted regarding the appropriate damage assessment for their equipment and specific cleaning and disinfection methods. Water can adversely affect electronics, and moisture trapped inside a piece of equipment may trigger the development of rust. Do not connect wet electronic equipment to electricity. Contact the original manufacturer regarding instructions for cleaning and drying the equipment or shipment back to the manufacturer for refurbishing. Items that can be salvaged should undergo appropriate cleaning, disinfection, and recertification as per manufacturers’ instructions. If radiological equipment has been damaged or if spills of radioisotopes have occurred, the following measures should be considered:

- 1) Perform inspections and decontamination using radiological control personnel with a valid Nuclear Regulatory Commission or State license;

- 2) Monitor for radioactivity;
- 3) Shield the contaminated area;
- 4) Provide radiological monitors and personal protective equipment recommended for use by OSHA and the Nuclear Regulatory Commission to personnel entering the contaminated area; and
- 5) Properly dispose radioactive waste using approved packaging.

Additional information can be found at:

CDC: Radiation Safety Manual
<http://www.cdc.gov/od/ohs/manual/radman.htm>

Post Reoccupation Surveillance

The healthcare facility's epidemiologist, infection control personnel, and laboratory director should agree on a period of enhanced review of clinical microbiology reports to determine whether patients who are receiving care in the reopened facility are acquiring infections attributed to *Aspergillus* spp. or other fungi, nontuberculous mycobacteria, *Legionella*, or other waterborne microorganisms above expected levels (i.e., rates similar to those identified before water damage occurred).

If the need for active investigation is identified, environmental microbial sampling may be indicated to determine if:

- 1) The water in the facility's water distribution system meets the microbial quality of the Safe Drinking Water Act (see: <http://www.epa.gov/safewater/sdwa/index.html>); and/or
- 2) Mold remediation efforts were effective in reducing microbial contamination in the affected areas of the hospital (see: http://www.epa.gov/mold/mold_remediation.html).

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