



Healthcare Water System Repair Following Disruption of Water Supply

Excerpted from the Guidelines for Environmental Infection Control in Health-Care Facilities, 2003 Recommendations of CDC and the Healthcare Infection Control Advisory Committee (HICPAC)

To see the entire document and find references go to

http://www.cdc.gov/ncidod/dhqp/gl_envirinfection.html

c. Infection Control Impact of Water System Maintenance and Repair

Corrective measures for water system failures have not been studied in well-designed experiments, but rather are based on empiric engineering and infection control principles. Healthcare facilities can occasionally sustain intentional cut-offs by the municipal water authority to permit new construction project tie-ins and unintentional breaks in service when a water main breaks due to aging infrastructure or a construction accident. Vacuum breakers or other similar devices can prevent backflow of water in the facility's distribution system during water-disruption emergencies.¹¹ To be prepared for such an emergency, all healthcare facilities need contingency plans that identify: 1) the total demand for potable water; 2) the quantity of replacement water (e.g., bottled water) required for a minimum of 24 hours when the water system is down; 3) mechanisms for emergency water distribution; and 4) procedures for correcting drops in water pressure that affect operation of essential devices and equipment that are driven or cooled by a water system.

Detailed current plans for hot and cold water piping systems should be readily available for maintenance and repair purposes in case of system problems. Opening potable water systems for repair or construction and subjecting systems to water-pressure changes can result in water discoloration and dramatic increases in the concentrations of *Legionella* spp. and other gram-negative bacteria. The maintenance of a chlorine residual at all points within the piping system also offers some protection from entry of contamination to the pipes in the event of an inadvertent cross-connection between potable and non-potable water lines. As a minimum preventive measure, ASHRAE recommends a thorough flushing of the system.⁶³⁷ High-temperature flushing or chlorination may also be appropriate strategies to decrease potentially high concentrations of waterborne organisms. The decision to pursue either of these remediation strategies, however, should be made on a case-by-case basis. If only a portion of the system is involved, high temperature flushing or chlorination may be used on only that portion of the system.⁶³⁷

When shock decontamination of hot water systems is necessary (e.g., after disruption due to construction, cross-connections), the hot water temperature should be raised to 71°C - 77°C (160°F - 170°F) and maintained at that level while progressively flushing each outlet around the system. A minimum flush time of 5 minutes has been recommended;³ the optimal flush time is not known, however, and longer flush times may be necessary.⁶⁸¹ The number of outlets that can be flushed simultaneously depends on the capacity of the water heater and the flow capability of the system. Appropriate safety procedures to prevent scalding are essential. When possible,

flushing should be performed when the fewest building occupants are present (e.g., nights and weekends).

When thermal shock treatment is not possible, shock chlorination may provide an alternative.⁶³⁷ Experience with this method of decontamination is limited, however, and high levels of free chlorine can corrode metals. Chlorine should be added, preferably overnight, to achieve a free chlorine residual of at least 2 mg/L (2 ppm) throughout the system.⁶³⁷ This may require chlorination of the water heater or tank to levels of 20 - 50 mg/L (20 - 50 ppm). The pH of the water should be maintained between 7.0 and 8.0.⁶³⁷ After completion of the decontamination, recolonization of the hot water system is likely to occur unless proper temperatures are maintained or a procedure such as continuous supplemental chlorination is continued.

Interruptions of the water supply and sewage spills are situations which require immediate recovery and remediation measures to assure the health and safety of patients and staff.⁶⁸² When delivery of potable water through the municipal distribution system has been disrupted, the public water supplier must issue a "boil water" advisory if microbial contamination presents an immediate public health risk to customers. The hospital engineer should oversee the restoration of the water system in the facility and clear it for use when appropriate to do so. Hospitals must maintain a high level of surveillance for waterborne disease among patients and staff after the advisory is lifted.⁶¹⁹

Flooding from either external (e.g., from a hurricane) or internal sources (e.g., a water system break) usually results in property damage and a temporary loss of water and sanitation.^{683 - 685} The JCAHO requires all hospitals have plans which address facility response for recovery from both internal and external disasters.⁶⁸⁶ The plans are required to address: 1) general emergency preparedness; 2) staffing; 3) regional planning among area hospitals; 4) emergency supply of potable water; 5) infection control and medical services needs; 6) climate control; and 7) remediation. The basic principles of structural recovery from flooding are similar to those for recovery from sewage contamination. Tables 21 - 23 summarize actions that will help to restore facility function and operations after water disruptions, sewage spills, and flooding. Medical records should be allowed to dry, and either photocopied or placed in plastic covers before returning them to the record. Moisture meters can be used to assess water-damaged structural materials.

Table 21. Recovery and Remediation Measures for Water-Related Emergencies^{683 - 695}

Potable Water Disruptions

Contingency plan items:

- ◆ Ensure access to plumbing network so that repairs can be made.
- ◆ Provide sufficient potable water, either from bottled sources or truck delivery.
- ◆ Post advisory notices against consuming tap water, ice, or beverages made with water.
- ◆ Rinse raw foods as needed in disinfected water.

Water treatment:

- ◆ Heat water to a rolling boil for 1 minute.

Remediation of the water system after the "boil water" advisory is rescinded:

- ◆ Flush fixtures (e.g., faucets, drinking fountains) and equipment for several minutes and restart.
- ◆ Run water softeners through a regeneration cycle.
- ◆ Drain, disinfect, and refill water storage tanks if needed.
- ◆ Change pre-treatment filters and disinfect the dialysis water system.

Sewage Spills / Malfunction

Overall strategy:

- ◆ Move patients and clean/sterile supplies out of the area.
- ◆ Redirect traffic away from the area.
- ◆ Close the doors or use plastic sheeting to isolate the area prior to clean-up.
- ◆ Restore sewage system function first, then the potable water system (if both are malfunctioning).
- ◆ Remove sewage solids, drain the area, let dry, then clean with a detergent/disinfectant.

Remediation of the structure:

- ◆ Hard surfaces - drain and dry the area, then clean with a detergent/disinfectant.
- ◆ Carpeting, loose tiles, buckled flooring - remove and allow the support surface to dry; replace the items; wet down carpeting with a low-level disinfectant prior to removal.
- ◆ Wallboard and other porous structural materials - remove and replace if they cannot be cleaned and dried within 72 hours.

Furniture:

- ◆ Hard surface furniture (i.e., metal, plastic) - clean and allow to dry.
- ◆ Wood furniture - let dry, sand the wood surface, and reapply varnish.
- ◆ Cloth furniture - replace.

Electrical equipment:

- ◆ Replace if the item cannot be easily dismantled, cleaned, and reassembled.
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An exception to these recommendations is made for hemodialysis units where water is further treated either by portable water treatment or large-scale water treatment systems usually involving reverse osmosis (RO). In the United States, greater than 98% of dialysis facilities use RO treatment for their water.⁶⁸⁷ It may be prudent, however, to change out pre-treatment filters and disinfect the system to prevent colonization of the RO membrane and microbial contamination down-stream of the pre-treatment filter.

Table 22. Contingency Planning - Flooding^{683 - 685}

General emergency preparedness:

- ◆ Ensure that emergency electrical generators are not located in flood-prone areas of the facility.
- ◆ Develop alternative strategies for moving patients, water containers,

medical records, equipment, supplies, etc. if the elevators are inoperable.

- ◆ Establish in advance a centralized base of operations with batteries, flashlights, cellular phones.
- ◆ Ensure sufficient supplies of sandbags to sandbag the entrances and the area around boilers, incinerators, and generators.
- ◆ Establish alternative strategies for bringing core employees to the facility if high water prevents travel.

Staffing patterns:

- ◆ Temporarily reassign licensed staff as needed to critical care areas to provide manual ventilation and to perform vital assessments on patients.
- ◆ Designate a core group of employees to remain on site to keep all services operational if the facility remains open.
- ◆ Train all employees in emergency preparedness procedures.

Regional planning among area facilities for disaster management:

- ◆ Incorporate community support and involvement (e.g., media alerts, news, transportation).
- ◆ Develop in advance strategies for transferring patients as needed.
- ◆ Develop strategies for sharing supplies and providing essential services among participating facilities (e.g., central sterile department services, laundry).
- ◆ Identify sources for emergency provisions (e.g., blood, emergency vehicles, bottled water).

Medical services and infection control:

- ◆ Use waterless hand sanitizers in general patient-care areas.
- ◆ Postpone elective surgeries until full services are restored, or transfer these patients to other facilities.
- ◆ Consider using portable dialysis machines (water demand is less).
- ◆ Provide an adequate supply of tetanus and hepatitis A immunizations for patients and staff.

Climate control:

- ◆ Provide adequate water for cooling towers (may need to truck in, especially if the tower uses potable water).

Table 23. Water Demand in Healthcare Facilities During Water Disruption Emergencies

Potable Water

Drinking water
Handwashing
Cafeteria services
Ice
Manual flushing of toilets
Patient baths, hygiene

Hemodialysis
Hydrotherapy
Fire prevention (e.g., sprinkler systems)
Surgery and critical care areas
Laboratory services
Laundry and central sterile departments (if these services cannot be arranged for elsewhere)
Cooling towers^a

Bottled, Sterile Water

Surgical scrub
Emergency surgical procedures
Pharmaceutical preparations
Patient-care equipment (e.g., ventilators, nebulizers) if electrical power is available

a. Some cooling towers may use a potable water source, but most units use non-potable water

Recommendations

III. Remediation Strategies for Distribution System Repair or Emergencies

A. Whenever possible, disconnect the ice machine before planned water disruptions.

Category II

B. Prepare a contingency plan to estimate water demands for the entire facility in advance of significant water disruptions (i.e., those expected to result in extensive and heavy microbial or chemical contamination of the potable water), sewage intrusion, or flooding.^{713, 719}

Category IC (JCAHO: EC 1.4)

C. When a significant water disruption or an emergency occurs, adhere to any advisory to boil water issued by the municipal water utility.⁶⁴² ***Category IB, IC*** (Municipal order)

1. Alert patients, families, staff, and visitors not to consume water from drinking fountains, ice, or drinks made from municipal tap water, while the advisory is in effect, unless the water has been disinfected (e.g., by bringing to a rolling boil for >1 minute).⁶⁴² ***Category IB, IC*** (Municipal order)
2. After the advisory is lifted, run faucets and drinking fountains at full flow for >5 minutes, or use high-temperature water flushing or chlorination.^{642, 661} ***Category IC, II*** (Municipal order; ASHRAE 12:2000)

D. Maintain a high level of surveillance for waterborne disease among patients after a boil water advisory is lifted. ***Category II***

E. Corrective decontamination of the hot water system might be necessary after a disruption in

service or a cross-connection with sewer lines has occurred.

1. Decontaminate the system when the fewest occupants are present in the building (e.g., nights or weekends).3, 661 **Category IC** (ASHRAE: 12:2000)
2. If using high-temperature decontamination, raise the hot-water temperature to 160°F– 170°F (71°C–77°C) and maintain that level while progressively flushing each outlet
3. around the system for >5 minutes.3, 661 **Category IC** (ASHRAE: 12:2000) If using chlorination, add enough chlorine, preferably overnight, to achieve a free chlorine residual of >2 mg/L (>2 ppm) throughout the system.661 **Category IC** (ASHRAE: 12:2000)
 - a. Flush each outlet until chlorine odor is detected.
 - b. Maintain the elevated chlorine concentration in the system for >2 hrs (but <24 hrs).
4. Use a very thorough flushing of the water system instead of chlorination if a highly chlorine-resistant microorganism (e.g., *Cryptosporidium* spp.) is suspected as the water contaminant. **Category II**
- 5.

F. Flush and restart equipment and fixtures according to manufacturers' instructions.

Category II

G. Change the pretreatment filter and disinfect the dialysis water system with an EPA registered

product to prevent colonization of the reverse osmosis membrane and downstream microbial contamination.721 **Category II**

H. Run water softeners through a regeneration cycle to restore their capacity and function. **Category II**

I. If the facility has a water-holding reservoir or water-storage tank, consult the facility engineer or local health department to determine whether this equipment needs to be drained, disinfected with an EPA-registered product, and refilled.

Category II

J. Implement facility management procedures to manage a sewage system failure or flooding (e.g., arranging with other health-care facilities for temporary transfer of patients or provision of services), and establish communications with the local municipal water utility and the local health department to ensure that advisories are received in a timely manner upon release.713, 719 **Category IC** (JCAHO: EC 1.4; Municipal order)

K. Implement infection-control measures during sewage intrusion, flooding, or other water related emergencies.

1. Relocate patients and clean or sterilize supplies from affected areas.
Category II
2. If hands are not visibly soiled or contaminated with proteinaceous material, include an alcohol-based hand rub in the hand hygiene process 1) before performing invasive procedures; 2) before and after each patient contact; and 3) whenever hand hygiene is indicated.1364 **Category II**
3. If hands are visibly soiled or contaminated with proteinaceous material, use soap and bottled water for handwashing.1364 **Category II**
4. If the potable water system is not affected by flooding or sewage contamination, process surgical instruments for sterilization according to standard procedures. **Category II**
5. Contact the manufacturer of the automated endoscope reprocessor (AER) for specific instructions on the use of this equipment during a water advisory. **Category II**

L. Remediate the facility after sewage intrusion, flooding, or other water-related emergencies.

1. Close off affected areas during cleanup procedures. **Category II**
2. Ensure that the sewage system is fully functional before beginning remediation so contaminated solids and standing water can be removed.
Category II
3. If hard-surface equipment, floors, and walls remain in good repair, ensure that these are dry within 72 hours; clean with detergent according to standard cleaning procedures. **Category II**
4. Clean wood furniture and materials (if still in good repair); allow them to dry thoroughly before restoring varnish or other surface coatings.
Category II
5. Contain dust and debris during remediation and repair as outlined in air recommendations (Air: II G 4, 5). **Category II**

M. Regardless of the original source of water damage (e.g., flooding versus water leaks from point-of-use fixtures or roofs), remove wet, absorbent structural items (e.g., carpeting, wallboard, and wallpaper) and cloth furnishings if they cannot be easily and thoroughly cleaned and dried within 72 hours (e.g., moisture content <20% as determined by moisture meter readings); replace with new materials as soon as the underlying structure is declared by the facility engineer to be thoroughly dry.18, 266, 278, 1026 **Category IB**