INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY FEBRUARY 2013, VOL. 34, NO. 2

REVIEW ARTICLE

Hospital Infection Prevention and Control Issues Relevant to Extensive Floods

Anucha Apisarnthanarak, MD;[1] Linda M. Mundy, MD, PhD;[2] Thana Khawcharoenporn, MD, MSc;[1] C. Glen Mayhall, MD[3]

The devastating clinical and economic implications of floods exemplify the need for effective global infection prevention and control (IPC) strategies for natural disasters. Reopening of hospitals after excessive flooding requires a balance between meeting the medical needs of the surrounding communities and restoration of a safe hospital environment. Postflood hospital preparedness plans are a key issue for infection control epidemiologists, healthcare providers, patients, and hospital administrators. We provide recent IPC experiences related to reopening of a hospital after extensive black-water floods necessitated hospital closures in Thailand and the United States. These experiences provide a foundation for the future design, execution, and analysis of black-water flood preparedness plans by IPC stakeholders.

Infect Control Hosp Epidemiol 2013;34(2):200-206

Floods are the leading cause of death and economic loss from natural disasters, and there is consistent global evidence of an increase in the incidence of floods over the past several decades.[1-6] In countries like China, extensive flooding is an annual event, whereas in countries such as Saudi Arabia and Thailand, inundation is uncommon, yet the impact is often severe. A timeline of major floods in world history from 1883 to 2009 suggests a range of vulnerability to flood hazards.[7] It is predicted that floods will increase in frequency and intensity in the years to come, and the impact of flooding on global health and economics is anticipated to increase as well.[7-9] Hospital preparedness plans are paramount in the mitigation of risk from floods, yet there is a paucity of data to support infection prevention and control (IPC) preparedness plans. We report a perspective on initial black-water flood preparedness plans, postflood IPC interventions, and adjunct surveillance measures as well as unresolved challenges on the basis of IPC experiences in the southern United States and central Thailand.

HOSPITAL IPC ISSUES RELEVANT TO CLOSURE AND REOPENING OF HOSPITALS AND HEALTHCARE SYSTEMS

Closure of a Healthcare System

The decision to close a hospital or healthcare system because of extensive or progressive flooding involves risk mitigation for patient care, patient safety, and the occupational health and safety of healthcare workers (HCWs) and other personnel. Criteria for healthcare system closure include the ability to maintain standards of patient care, the increase in surge capacity in all areas of care, a sustainable power source, and continued access to standard water supplies. When a decision to close the healthcare system has been made, it is important to triage patients to alternative sites of care, inclusive of shelters, and to initiate surveillance for key communicable diseases.

Reopening of a Healthcare System

Reopening of a hospital or healthcare system is contingent upon damage to hospital infrastructure, surge capacity for safe patient care, a triage system, hospital air quality, quality of sterilization and disinfection, and the functional capacity of the HCWs, pharmacy, and laboratories. Assurance of safe patient care includes the provision of clean water for ingestion, hand hygiene, and food preparation as well as adequate disposal of sewage, waste water, and medical waste. Effective pre- and postflood preparedness plans require interdisciplinary expertise from environmental health and safety personnel, structural engineers, public safety and security personnel, IPC personnel, housekeeping staff, nurses, physicians, pharmacists, laboratory technicians, radiology personnel, hospital administration, and the finance department. At least 4 practical IPC issues are relevant to reopening of a healthcare system: removal of flood waters, disinfection, mold remediation, and restoration of adequate air flow (Figure 1). In resource-

Affiliations: 1. Division of Infectious Diseases, Thammasat University Hospital, Pratumthani, Thailand, 12120; 2. WWEpidemiology, GlaxoSmithKline, Collegeville, Pennsylvania 19426; 3. Department of Healthcare Epidemiology, University of Texas Medical Branch, Galveston, Texas 77555.

Received August 13, 2012; accepted September 30, 2012; electronically published December 21, 2012.

© 2012 by The Society for Healthcare Epidemiology of America. All rights reserved. 0899-823X/2013/3402-0015$15.00. DOI: 10.1086/669094

https://doi.org/10.1086/669094 Published online by Cambridge University Press

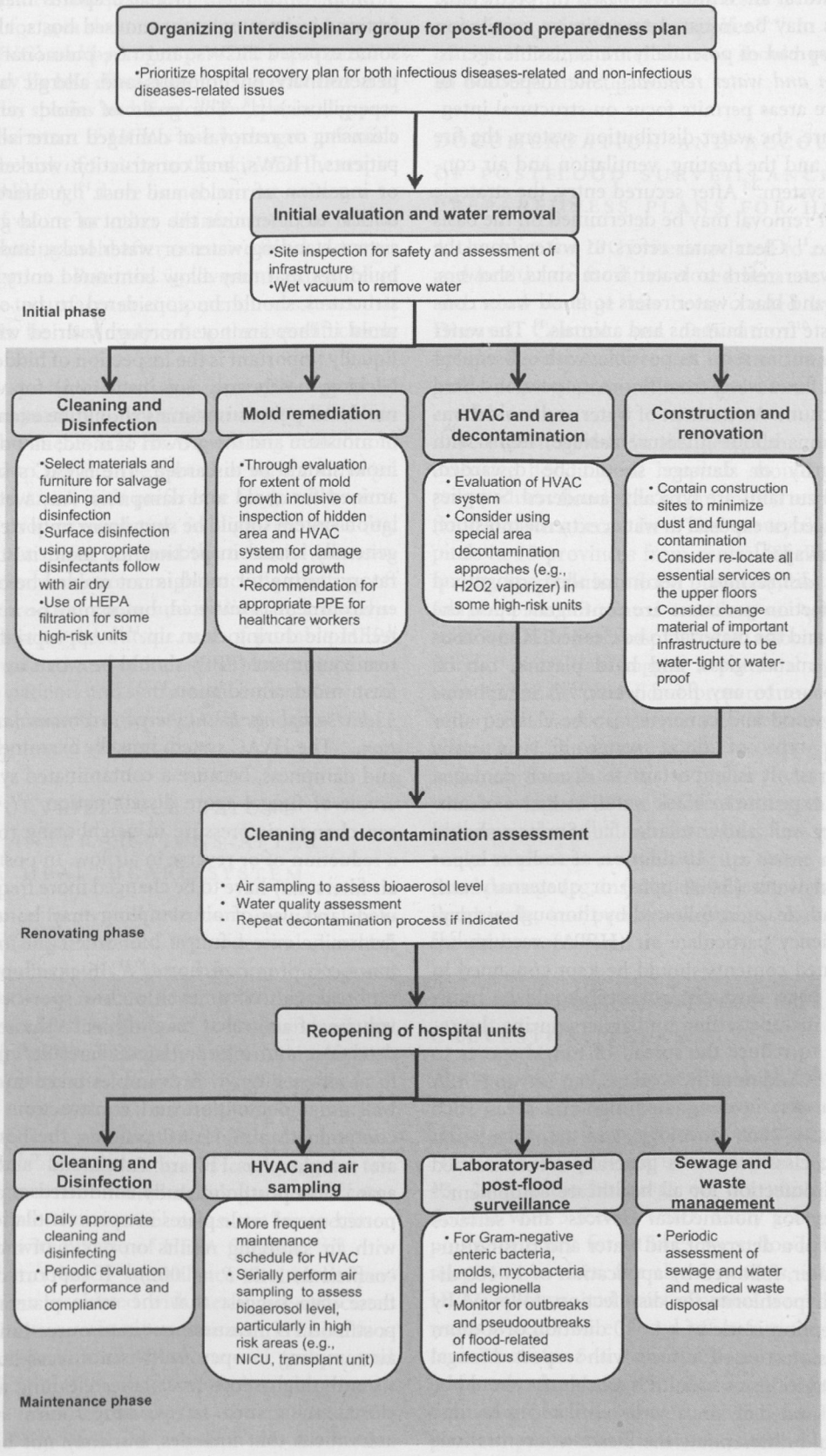


FIGURE 1. Practical infection prevention and control issues relevant to reopening of a healthcare system after extensive floods. HEPA, high-efficiency particulate air; HVAC, heating, ventilation and air conditioning; NICU, neonatal intensive care unit; PPE, personal protective equipment.

https://doi.org/10.1086/669094 Published online by Cambridge University Press

limited settings, natural air ventilation based on predictable wind flow patterns may be initiated to optimize ventilation and minimize the spread of potentially transmissible agents.

Initial evaluation and water removal. Site inspection of flooded patient care areas permits focus on structural integrity, hidden moisture, the water distribution system, the fire emergency system, and the heating, ventilation and air conditioning (HVAC) system.[10] After secured entry, the strategic plan for flood water removal may be determined on the basis of the water source.[11] Clear water refers to water from the tap or rain; gray water refers to water from sinks, showers, tubs, and washers; and black water refers to flood water contaminated with waste from humans and animals.[11] The water should be pumped out as soon as possible, with subsequent removal of residual flood water from floors, carpets, and hard surfaces via wet vacuum. Assessment of water and mold damage requires decisions about furniture salvage; items with questionable integrity or damage should be discarded, whereas linens and curtains are typically laundered. Supplies that were not damaged or exposed to water, extreme moisture, or mold may be salvaged.

Cleaning and disinfection. Recommended postflood cleaning and disinfection processes are contingent upon the type of flood water and the material to be cleaned. Nonporous materials, such as metal, glass, and hard plastics, can be cleaned after exposure to any flood water.[12-15] Semiporous materials, such as wood and concrete, can be cleaned after exposure to any type of flood water if structurally sound.[12-15] In contrast, it is important to discard damaged porous items after exposure to black water, inclusive of submerged carpets, dry wall, and insulation.[12-15] Surfaces should be disinfected with either a 1 : 10 dilution of sodium hypochlorite (bleach) in water (5,000 ppm) or quaternary ammonium compound cleansers followed by thorough air drying and high-efficiency particulate air (HEPA) vacuum.[12-15] The HEPA-vacuumed contents should be kept contained in well-sealed plastic bags; dust disturbances should be minimized, which may include setting up barriers during the remediation process to reduce the spread of fungal spores to unaffected areas.[12-15] Additionally, workers can set up HEPA filters and hard barriers in designated high-risk areas, such as neonatal intensive care, oncology, and transplantation units. A Spaulding classification is generally recommended for cleaning and disinfection for all healthcare equipment.[16] Cleaning processes for nonmedical devices and surfaces should include use of a detergent and water and rinsing surfaces with clean water, followed by application of 1 : 100 dilution of sodium hypochlorite for disinfection, followed by air drying. An exception is use of a 1 : 10 dilution of sodium hypochlorite for disinfection of surfaces with suspected fungal contamination.[16] Dilutions of sodium hypochlorite should be prepared centrally and daily in a well-ventilated area, distinctive labels should differentiate the bleach concentrations to avoid confusion, and electronic medical equipment should be cleaned according to manufacturers' instructions.

Mold remediation. Inhaled spores may cause fungal infections in immunocompromised hosts, allergic reactions in some exposed HCWs, and rare pulmonary diseases (eg, hypersensitivity pneumonitis and allergic bronchopulmonary aspergillosis).[17,18] The goals of mold remediation include cleansing or removal of damaged material and protection of patients, HCWs, and construction workers from inhalation or ingestion of molds and dust.[19] A thorough evaluation is critical to determine the extent of mold growth, detect persistent standing water or water leaks, and assess damage to buildings that may allow continued entry of water. Flooded structures should be considered to be contaminated with mold if they are not thoroughly dried within 48 hours.[19-21] Equally important is the inspection of hidden areas (eg, carpet backing, baseboard, and insulation) for water damage and mold. All porous materials should be examined for evidence of moisture and the growth of mold; all porous material with mold should be discarded. The HVAC system should be examined for mold and dampness. Any wet, moldy air ventilation system should be shut down until cleaned and repaired; generally, visual inspection for mold is sufficient.[19-21] Laboratory testing for mold is not needed before clean up of the environment is initiated, but it may be a useful surveillance technique during clean up.[14,15] Appropriate personal protective equipment (PPE) should be worn by workers who perform mold remediation.[19-21]

Air sampling, HVAC, area decontamination, and construction. The HVAC system must be examined for mold, debris, and dampness, because a contaminated system can be a reservoir of fungal spore dissemination.[20,21] Opening windows can change air pressure in neighboring rooms and result in a reduction of or reverse in airflow. In postflood surveillance, air filters may have to be changed more frequently than scheduled, and use of air sampling may be a helpful guide to determine excess fungal bioburden (FB) on units with immunocompromised hosts.[20,21] In postflood surveillance, an outbreak can occur even at low spore concentrations, the volume of air tested may influence the sensitivity of fungal detection, and interpretation of results may depend on the local air quality.[22-25] Air samples taken in postflood units as well as at demolition and construction sites may identify contamination of HVAC systems; the best culture media of air samples for FB are Sabouraud and inhibitory mold agar.[22-25] A postflood study conducted at a Thai hospital reported use of settle plates in open-ventilation units correlated with air sampling results on day 5 of incubation (adjusted coefficient, 1.49; $P = .002$).[26] If supported in future studies, these data suggest that the settle plate method may be a postflood FB measurement in resource-limited settings where air sampling in open units is not feasible. Detection of persistently high spore levels after cleaning and disinfection of closed units, such as operating rooms, requires additional assessment that includes, but may not be limited to, malfunction of air handlers, leakage around air handlers into the ceilings, overloaded intake filters with debris, insufficient air

https://doi.org/10.1086/669094 Published online by Cambridge University Press

exchange per hour, or inadequate exhaust fans. In addition, special approaches for area decontamination may include the use of UV light (UVC) and hydrogen peroxide vaporizers.[27-30] Although UVC may be less efficacious for the eradication of fungi (eg, *Aspergillus* species and *Penicillium* species), appropriate PPE must be worn if HCWs use hydrogen peroxide vaporizers, given the risk of toxicity to the skin and the respiratory system.[31,32] Although there is no current evidence to support the use of ozone or other disinfectants, the role of these agents in removing mold after extensive floods deserves additional investigation. Potential inadvertent exposure of people and damage to surfaces or equipment necessitates that chemical fumigants be used only when the benefit clearly exceeds the risk.[33]

Controlling the spread of dust and spores in a partially open hospital is important to minimize invasive mold exposure of high-risk patients and HCWs. During demolition, barriers are needed to prevent the spread of dust and fungal spores to unaffected areas, with preference for hard barriers, HEPA filters, and proper ventilation in high-risk areas (eg, the bone marrow transplant unit and the neonatal intensive care unit).[19-21] Recommendations might include shutting off ventilation in construction zones and sealing air grills, discharging air and dust to the outside, use of portable HEPA filters if air is recirculated, use of industrial blowers to direct air flow away from patients and staff areas, confirmatory tests of air flow directed away from patient areas using smoke sticks, and control of solid debris.[19-21]

POSTFLOOD SURVEILLANCE BEYOND ROUTINE IPC INTERVENTIONS AFTER REOPENING A HEALTHCARE SYSTEM

Postflood surveillance for typical infections includes leptospirosis, dengue, malaria, measles, typhoid, viral diarrheal illnesses, pinkeye, and hepatitis A virus infection.[34,35] Regional distinctions in postflood infections are important, as evidenced by flood-associated melioidosis in a nonendemic region of Thailand.[36] Postflood fungal pseudo-outbreaks have been identified months after hospitals have reopened.[37,38] Pseudo-outbreaks may occur as a result of contaminated specimens (contaminated blood culture bottle diaphragms) and a high air FB.[36-38] Pseudo-outbreaks can easily be terminated by thorough environmental cleaning and strict compliance with basic infection control measures for specimen collection with and without use of HEPA filtration.[37,38]

Active or laboratory-based surveillance should be performed for pathogens associated with healthcare-associated infections (eg, multidrug-resistant organisms), invasive fungal infections, nontuberculous *Mycobacterium* species, and *Legionella* species.[37,38,40-43] If the water supply is contaminated, measures should be taken to remove the contaminants from the point source.[37,38,40,41] Particular attention should be rendered to electronic faucets as sources of unacceptable levels of microbial growth after flooding.[44] Interval testing of initially contaminated water sources is recommended to ensure restoration of safe water supplies.[40,41] In addition, detection of contaminated water sources should prompt initiation of an outbreak investigation.

DOCUMENTATION AND ACCOUNTABILITY OF POSTFLOOD SURVEILLANCE AND PREPAREDNESS PLANS FOR HOSPITALS

A checklist for IPC criteria related to reopening hospitals and healthcare facilities closed because of extensive water and wind damage has been created by the Centers for Diseases Control and Prevention.[10] Additionally, the Sphere Project was a recent international initiative to help guide disaster preparedness and community-based recovery from disasters.[45]

Because hospitals in any geographic area can experience extensive flooding, all hospitals should develop a hospital preparedness flood plan to optimize a responsive plan should flood disasters occur. In a Thai survey that involved 72 hospitals in 15 provinces from central Thailand, 92% of participating hospitals had flood protocols, but only 52% had performed protocol-related exercises; an estimated loss of 4.8 million USD per hospital was associated with extensive floods.[46] Such data suggest a potential opportunity for national Thai hospital flood preparedness plans that include waterproof vaults; placement of electric supply lines at the ceiling level; movement of vital records, equipment, supplies, and hazardous materials to higher floors; movement of elevators to higher floors before shutting them down; and installation of manual sanitary vaults and storm sewer shutoff vaults to prevent sewage back up. Other measures to reduce flood damage (eg, installation of water-tight barriers, movable flood walls, and permanent pumps to remove flood water) should be considered.

LESSONS LEARNED FROM HURRICANE IKE, GALVESTON, TEXAS

The reopening of a hospital or healthcare system after extensive black-water flooding can occur once patient and HCW safety has been assured by standard procedures. During Hurricane Ike, which struck Galveston, Texas, on September 13, 2008, most buildings on the university campus were flooded with 3 feet of water. Many generators and building points of entry for utilities were flooded; electrical power, telephone services, fire alarm systems, information systems, HVAC systems, and most elevators were nonfunctional. The water systems were closed off before the hurricane and remained off for 5–6 days; the linear accelerators in the radiation oncology department were destroyed. The water drained off of Galveston Island in a few hours, but all hospitalized patients had been evacuated to inland hospitals before the hurricane. An international commercial disaster recovery company was hired; the water-damaged portions of

https://doi.org/10.1086/669094 Published online by Cambridge University Press

walls were removed, and all areas were cleaned, dried, and disinfected. Damaged items were discarded, and items above the flood waters were relocated for storage. *Legionella pneumophila* was detected in water cultures of each of 10 distribution systems and first remediated with chlorine dioxide followed by placement of copper-silver ionizers on each of the water distribution systems.

After Hurricane Ike, there was a high concentration of spores in the air on Galveston Island and in the hospital operating rooms.[47] Before the storm, filters at the air intakes were changed every 3 months. After the storm, the intake filters were replaced every 2 weeks. Duct work was cleaned, and the air handlers were repaired, cleaned, and serviced. Point-of-use HEPA filtration was required to provide safe air for the operating rooms, which reopened in January 2009 (Figure 2).

In addition to the loss of the linear accelerators on the first floor of the hospital, the dietary department and pharmacy were heavily damaged. To prevent serious losses due to future floods, new linear accelerators were placed in vaults with water-tight doors, all incoming utilities were raised 20 feet, and generators were moved to higher elevations. Three and a half years after the hurricane, a new bed tower is being constructed; all essential services will be located on the upper floors of the support building and new hospital. The first floors of the new hospital and support building will be 12 feet above sea level, and the second floors will be 25 feet above sea level.

The decision to reopen a healthcare system after extensive floods in a resource-limited setting, in contrast to well-resourced countries, may be contingent on the unmet needs for alternative sites of medical care in the region and other political pressures. In such situations, the healthcare epidemiologist should have feasible, strategic plans and have negotiated with the hospital administration for purchase of equipment needed to remediate contaminated environmental surfaces and air and water resources. The hospital administration should also be prepared to provide funding for surveillance of potential outbreaks or pseudo-outbreaks after the institution is reopened.[46] Additional interval monitoring of hospital air quality is essential to minimize the occupational risk to healthcare workers and to enhance patient safety.[48]

CONCLUSIONS

Postflood disasters have increased in recent decades, with consequent infectious diseases transmission in both communities and hospitals. Extensive gray- and black-water floods are likely to increase in frequency and severity in several geographic areas of the world. Hospital IPC preparedness plans will help minimize the effects of these untoward events and guide effective, expedited strategies to reopen hospitals and healthcare institutions after extensive black-water floods.

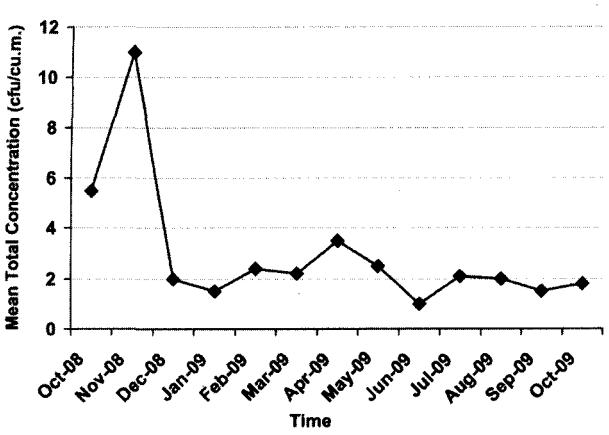


FIGURE 2. Line graph measurement of the mean air concentrations of fungal spores in the operating rooms at the University of Texas Medical Branch at Galveston, Texas, after Hurricane Ike on September 13, 2008.

ACKNOWLEDGMENTS

Financial support. This study was supported by the National Research University Project of the Thailand Office of Higher Education Commission (to A.A. and T.K.).

Potential conflicts of interest. L.M.M. is an employee of GlaxoSmithKline; her work on this study was independent of all activities related to employment at GlaxoSmithKline. All other authors report no conflicts of interest relevant to this article. All authors submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and the conflicts that the editors consider relevant to this article are disclosed here.

Address correspondence to Anucha Apisarnthanarak, MD, Division of Infectious Diseases, Faculty of Medicine, Thammasat University Hospital, Pathumthani, Thailand, 12120 (anapisarn@yahoo.com).

REFERENCES

1. Du W, FitzGerald GJ, Clark M, Hou XY. Health impacts of floods. *Prehosp Disaster Med* 2010;25:265–272.
2. Taylor J, Lai KM, Davies M, Clifton D, Ridley I, Biddulph P. Flood management: prediction of microbial contamination in large-scale floods in urban environments. *Environ Int* 2011;37:1019–1029.
3. Tapsell LC, Probst Y, Lawrence M, Friel S, Flood V, McMahon A, Butler R. Food and nutrition security in the Australia-New Zealand region: impact of climate change. *World Rev Natr Diet* 2011;102:192–200.
4. Barbeau DN, Grimsley LF, White LE, El-Dahr JM, Lichtveld M. Mold exposure and health effects following hurricanes Katrina and Rita. *Annu Rev Public Health* 2010;31:165–178.
5. Ivers LC, Ryan ET. Infectious diseases of severe weather-related and flood-related natural disasters. *Curr Opin Infect Dis* 2006;19:408–414.
6. Scholastic.com. Timeline of major flood in world history. http://www.scholastic.com/browse/article.jsp?id=3754082 Accessed April 20, 2012.
7. Euripidou E, Murray V. Public health impacts of floods and chemical contamination. *J Public Health (Oxf)* 2004;26:376–383.

https://doi.org/10.1086/669094 Published online by Cambridge University Press

8. Hunt JC. Flood in a changing climate: a review. *Philos Transanct A Math Phys Eng Sci* 2002;360:1531–1543.
9. Bubeck P, Botzen WJ, Aerts JC. A review of risk perceptions and other factors that influence flood mitigation behavior. *Risk Anal* 2012;32(9):1481–1495.
10. Centers for Disease Control and Prevention. Checklist for infection control concerns when reopening healthcare facilities closed due to extensive water and wind damage. http://emergency.cdc.gov/disasters/reopen_healthfacilities_checklist.asp. Accessed October 21, 2011.
11. Black H. Unnatural disaster: human factors in the Mississippi floods. *Environ Health Perspect* 2008;116:A390–A393.
12. Washington State Department of Health. Flood cleanup. http://www.doh.wa.gov/Topics/floods_cleanup.htm. Accessed April 20, 2012.
13. Ontario Ministry of Health and Long-term Care. Best practices for environmental cleaning for prevention and control of infections. http://www.health.gov.on.ca/english/providers/program/infectious/diseases/ic_enviro_clean.html.
14. Centers for Disease Control and Prevention. Guidelines for environmental infection control in health-care facilities. http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5210a1.htm Accessed April 20, 2012.
15. Centers for Disease Control and Prevention. Remediation and infection control considerations for reopening healthcare facilities closed due to extensive water and wind damage. http://emergency.cdc.gov/disasters/reopen_healthfacilities.asp Accessed April 20, 2012.
16. Spaulding EH. Chemical disinfection of medical and surgical materials. In: Lawrence C, Block SS, eds. *Disinfection Sterilization and Preservation.* Philadelphia: Lea and Febiger, 1968:517–531.
17. Bush RK, Portnoy JM, Saxon A, Terr AI, Wood RA. The medical effects of mold exposure. *J Clin Immunol* 2006;117:326–333.
18. Knutsen AP, Bush RK, Demain JG, et al. Fungi and allergic lower respiratory tract diseases. *J Clin Immunol* 2012;129:280–291.
19. Environmental Protection Agency. Mold remediation in schools and commercial buildings: investigating, evaluating, and remediating moisture and mold problems. http://www.epa.gov/mold/i-e-r.html. Accessed April 20, 2012.
20. Occupational Safety and Health Administration. Building assessment, restoration, demolition: mold remediation. http://www.osha.gov/SLTC/etools/hurricane/mold.html#damaged. Accessed April 20, 2012.
21. New York City Department of Health and Mental Hygiene. Guidelines on assessment and remediation of fungi in indoor environments. http://www.nyc.gov/html/doh/html/epi/moldrpt1.shtml. Accessed April 20, 2012.
22. Panagopoulou P, Filioti J, Petrikkos G, et al. Environmental surveillance of filamentous fungi in three tertiary care hospitals in Greece. *J Hosp Infect* 2002;52:185–191.
23. Hao ZF, Ao JH, Hao F, Yang RY, Zhu H, Zhang J. Environment surveillance of filamentous fungi in two tertiary care hospitals in China. *Chin Med J* 2011;124:1970–1975.
24. Yassin AF, Almouqatea S. Assessment of airborne bacteria and fungi in an indoor and outdoor environment. *Int J Environ Sci Tech* 2010;7:535–544.
25. Streifel AJ. Design and maintenance of hospital ventilation systems and the prevention of airborne healthcare-associated infections. In: Mayhall CG, ed. *Hospital Epidemiology and Infection Control.* Philadelphia: Lippincott Williams and Wilkins, 2012.
26. Khawcharoenporn T, Apisarnthanarak A, Thongphubeth K, et al. Post-flood measurement of fungal bioaerosol in a resource-limited hospital setting: can settle plate method be used? *J Hosp Infect* (in press).
27. Rutala WA, Gergen MF, Weber DJ. Room decontamination with UV radiation. *Infect Control Hosp Epidemiol* 2010;31:1025–1029.
28. Kujundzic E, Matalkah F, Howard CJ, Hernandez M, Miller SL. UV air cleaners and upper-room air ultraviolet germicidal irradiation for controlling airborne bacteria and fungal spores. *J Occup Environ Hyg* 2006;3:536–546.
29. Marty N, Cavalie L, Conil J, Roques C. Dry fog disinfection: an assessment of microbiological efficacy and practical advantages. *Revue Hygienes* 2007;15:317–320.
30. Koburger T, Below H, Dornquast T, Kramer A. Decontamination of room air and adjoining wall surfaces by nebulizing hydrogen peroxide. *GMS Krankenhhyg Interdiszip* 2011;6:Doc09.
31. Begum M, Hocking AD, Miskelly D. Inactivation of food spoilage fungi by ultra violet (UVC) irradiation. *Int J Food Microbiol* 2009;129:74–77.
32. University of Pennsylvania Environmental Health and Radiation Safety. Ultraviolet radiation hazards. http://www.ehrs.upenn.edu/programs/labsafety/chp/sop/uv_safety.html. Accessed April 20, 2012.
33. Infection Control Today. Area decontamination technology. http://www.infectioncontroltoday.com/reports/2011/11/decontamination.aspx. Accessed April 20, 2012.
34. Kouadio IK, Aljunid S, Kamigaki T, Hammad K, Oshitani H. Infectious diseases following natural disasters: prevention and control measures. *Expert Rev Anti Infect Ther* 2012;10:95–104.
35. Ivers LC, Ryan ET. Infectious diseases of severe weather-related and flood-related natural disasters. *Curr Opin Infect Dis* 2006;19:408–414.
36. Apisarnthanarak A, Khawcharoenporn T, Mundy LM. Flood-associated melioidosis in a non-endemic region of Thailand. *Int J Infect Dis* 2012;16:e409–e410.
37. Apisarnthanarak A, Khawcharoenporn T, Thongphubeth K, et al. Post-flood pseudofungemia due to *Penicillium* species. *Clin Infect Dis* 2012;55:e9–e11.
38. Apisarnthanarak A, Eimsitrakoon T, Khawcharoenporn T, Rakskul P, Mundy LM. Neurological investigation of post-flood pseudo-meningitis due to mold. *Infect Control Hosp Epidemiol* 2012;33:758–759.
39. Peláez T, Muñoz P, Guinea J, et al. Outbreak of invasive aspergillosis after major heart surgery caused by spores in the air of the intensive care unit. *Clin Infect Dis* 2012;54:e24–e31.
40. Brown-Elliott BA, Wallace RJ Jr, Tichindelean C, et al. Five-year outbreak of community- and hospital-acquired *Mycobacterium porcinum* infections related to public water supplies. *J Clin Microbiol* 2011;49:4231–4238.
41. Haupt TE, Heffernan RT, Kazmierczak JJ, et al. An outbreak of legionnaires disease associated with a decorative water wall fountain in a hospital. *Infect Control Hosp Epidemiol* 2012;33:185–191.
42. Apisarnthanarak A, Khawcharoenporn T, Mundy LM. Black-

https://doi.org/10.1086/669094 Published online by Cambridge University Press

water floods and hospital-based post-flood mold investigations. *Infect Control Hosp Epidemiol* 2012;33:1266.
43. Apisarnthanarak A, Li Yang H, Warren DK. Termination of an extreme-drug resistant *Acinetobacter baumannii* outbreak in a hospital after flooding: lessons learned. *Clin Infect Dis* 2012;55: 1589–1590.
44. Hargreaves J, Shireley L, Hansen S, et al. Bacterial contamination associated with electronic faucets: a new risk for healthcare facility. *Infect Control Hosp Epidemiol* 2001;22:202–205.
45. The Sphere Project. *The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response.* http://www.sphereproject.org/handbook/. Accessed April 20, 2012.
46. Apisarnthanarak A, Khawcharoenporn T, Woeltje K, Warren DK. Hospital flood preparedness: a survey of 15 provinces in central Thailand. *Infect Control Hosp Epidemiol* 2012;33: 953–954.
47. Hewlett AL, Tichindelean C, Falk P, Mayhall CG. Air quality evaluation and remediation of the University of Texas Medical Branch following Hurricane Ike. In: *Program and Abstracts of the Fifth Decennial International Conference on Healthcare-Associated Infections 2010*; March 18–22, 2010; Atlanta, GA. Abstract 771.
48. Apisarnthanarak A, Khawcharoenporn T, Mundy LM. Air quality of a hospital after closure for black water flood: an occupational health concern? *Infect Control Hosp Epidemiol* 2012;33: 1285–1286.

https://doi.org/10.1086/669094 Published online by Cambridge University Press