Guidelines for Environmental Infection Cont

Recommendations of CDC and the Healthcare Infection Control Pr

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The material in this report originated in the National Center for Infectious Diseases, James M. Hughes, M.D., Director; and t
Director.

Summary

The health-care facility environment is rarely implicated in disease transmission, except d inadvertent exposures to environmental pathogens (e.g.,* Aspergillus *spp. and* Legion tuberculosis *and varicella-zoster virus) can result in adverse patient outcomes and ca infection-control strategies and engineering controls can effectively prevent these infectio pseudo-outbreaks can be minimized by 1) appropriate use of cleaners and disinfectants automated endoscope reprocessors or hydrotherapy equipment); 3) adherence to wate standards for specialized care environments (e.g., airborne infection isolation rooms, pr management of water intrusion into the facility. Routine environmental sampling is not hemodialysis settings and other situations where sampling is directed by epidemiologic j control decisions.

This report reviews previous guidelines and strategies for preventing environment-a recommendations. These include 1) evidence-based recommendations supported by studie Administration, U.S. Environmental Protection Agency, U.S. Department of Labor, O Department of Justice); 3) guidelines and standards from building and equipment profes Association for the Advancement of Medical Instrumentation, and American Society of E recommendations derived from scientific theory or rationale; and 5) experienced opinio The report also suggests a series of performance measurements as a m

Introduction

Parameters of the Report

This report, which contains the complete list of recommendations with pertinent refer
***Control in Health-Care Facilities*. The full four-part guidelines will be available on C**
website. Relative to previous CDC guidelin

- **revises multiple sections (e.g., cleaning and disinfection of environmental surfa**
  regulated medical waste) from previous editions of CDC's *Guideline for I*
- **incorporates discussions of air and water environmental concerns from CDC**
- **consolidates relevant environmental infection-control meas**
- **includes two topics not addressed in previous CDC guidelines --- infection-contr**
  water quality in hemodialysis

In the full guidelines, Part I, Background Information: Environmental Infection Con
review of the relevant scientific literature. Attention is given to engineering and infe
renovation, and repair of health-care facilities. Use of an infection-control risk assessm
other activities expected to generate dust or water aerosols. Also reviewed in Part
catastrophic events (e.g., flooding, sewage spills, loss of electricity and ventilation, o
environmental surfaces, laundry, plants, animals, medical wastes, cloth furnishings
facilities. Part III and Part IV of the full guidelines provide references (for the
Part II (this report) contains recommendations for environmental infection control i
preventing infections associated with air, water, or other elements of the environment
divisions within CDC's National Center for Infectious Diseases and the Healthcare Inf
a 12-member group that advises CDC on concerns related to the surveillance, preve
primarily in U.S. health-care facilities. In 1999, HICPAC's infection-control focus wa
health care is provided (e.g., outpatient surgical centers, urgent care centers, clinics, c
nursing facilities). The topics addressed in this report are applicable to the majority o
intended for use primarily by infection-control practitioners, epidemiologists, emp
managers, information systems professionals, administrators, environmental service pr

- **infection-control impact of ventilation system and**
- **establishment of a multidisciplinary team to conduct in**
- **use of dust-control procedures and barriers during construct**
- **environmental infection-control measures for special**
- **use of airborne-particle sampling to monitor the effectiveness of**
- **procedures to prevent airborne contamination in operating rooms when in**
- **guidance regarding appropriate indications for routine culturing of water as p**
- **guidance for recovering from water-system disruptions, water le**
- **infection-control concepts for equipment using water from main lines (e.g., wat**
  equipment, dental unit water lines, and automate
- **environmental surface cleaning and disinfection strategies with res**
- **infection-control procedures for healt**
- **use of animals in health care for activit**
- **managing the presence of service animals in**
- **infection-control strategies for when animals receive treatme**

- a call to reinstate the practice of inactivating amplified cultures and stocks of

Topics outside the scope of this report include 1) noninfectious adverse events (e.g., si
home, 3) home health care, 4) terrorism, and 5) health-care

Wherever possible, the recommendations in this report are based on data from well-de
were conducted by using narrowly defined patient populations or specific health-care
making generalization of findings potentially problematic. Construction standards for
residential home-care units. Similarly, infection-control measures indicated for imm
those facilities where such patients are r

Other recommendations were derived from knowledge gained during infectious diseas
termination of the outbreak was often the result of multiple interventions, the majo
evaluated. This is especially true for construction situat

Other recommendations were derived from empiric engineering concepts and may
conclusions. Where recommendations refer to guidance from the American Institut
intended for new construction or renovation. Existing structures and engineered syste
standards in effect at the time of constructio

Also, in the absence of scientific confirmation, certain infection-control recommenda
strong theoretic rationale and suggestive evidence. Finally, certain recommenda

Performance Measurements

Infections caused by the microorganisms described in this guideline are rare events, an
a facility may not be readily measurable. Therefore, the following steps to mea
recommendations:

1. Document whether infection-control personnel are actively involved in all phas
renovation. Activities should include performing a risk assessment of the neces
and documenting of the presence of negative airflow within th
2. Monitor and document daily the negative airflow in AII rooms and positive ai
rooms.
3. Perform assays at least once a month by using standard quantitative methods fo
for heterotrophic and mesophilic bacteria in water used to prepare
4. Evaluate possible environmental sources (e.g., water, laboratory solutions, or re
mycobacteria (NTM) of unlikely clinical importance are isolated from clinical cu
the probable mechanism
5. Document policies to identify and respond to water damage. Such policies shou
porous materials within 72 hours, or removal of the wet mater

Updates to Previous Recommendati

Contributors to this report reviewed primarily English-language manuscripts identifi
Medicine's MEDLINE, bibliographies of published articles, and infection-control t
opinions of all reviewers. This report updates the following publis

CDC. Guideline for handwashing and hospital environmental control. MMWR 1998;
laundry, infective waste, and housek

Tablan OC, Anderson LJ, Arden NH, et al., Hospital Infection Control Practices Adv
pneumonia. Infect Control Hosp Epidemiol 1994;15:587--627. Updates and expa

aspergillosis and Legionnaires disease; online version incorporates Appendices B, C, a
Legionella spp.
CDC. Guidelines for preventing the transmission of *mycobacterium tuberculosis* in hea
supplemental information on engineerin
CDC. Recommendations for preventing the spread of vancomycin resistance: recom
Advisory Committee (HICPAC). MMWR 1995;44(No. RR12). Supplements enviror
Hospitals with Endemic VRE or Continued VI
Garner JS, Hospital Infection Control Practices Advisory Committee. Guideline for
Epidemiol 1996;17:53--80. Supplements and updates topics in Part II --- Recommend
laundry, routine and terminal cleaning, airbo
Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR, Hospital Infection C
prevention of surgical site infection. Infect Control Hosp Epidemiol 1999;4:250--
cleaning/disinfection recommendations from the section, Intraoperati
U.S. Public Health Service, Infectious Diseases Society of America, Prevention of O
guidelines for the prevention of opportunistic infections in persons infected with hur
2002; 10:3--64. Supplements information regarding patient interact
CDC, Infectious Diseases Society of America, American Society of Blood and Marrow
infections among hematopoietic stem cell transplant recipients. Cytotherapy 2001;3
Infection Control.

Key Terms

Airborne infection isolation (AII) refers to the isolation of patients infected with o
diameter. This isolation area receives numerous air changes per hour (ACH) (≥1
construction before 2001), and is under negative pressure, such that the direction of
corridor) into the room. The air in an AII room is preferably exhausted to the outside
filtered through a high-efficiency particulate air (HEPA) filter. The use of personal re
these rooms when caring for TB or smallpox patients and for staff who lack immunity
virus [VZV] infection).
Protective environment (PE) is a specialized patient-care area, usually in a hospital, wi
from the room to the outside adjacent space). The combination of HEPA filtration,
minimal leakage of air into the room creates an environment that can safely acc
hematopoietic stem cell transplant (
Immunocompromised patients are those patients whose immune mechanisms are d
immunodeficiency virus [HIV] infection or congenital immune deficiency syndrome)
cardiac failure), or immunosuppressive therapy (e.g., radiation, cytotoxic chem
Immunocompromised patients who are identified as high-risk patients have the grea
microorganisms. Patients in this subset include persons who are severely neutropenic
count [ANC] of ≤500 cells/mL), allogeneic HSCT patients, and those who have receive
myelogenous leukemia patients

Abbreviations

AAMI Association for the Advancement of Medi
ACH air changes per hour

AER automated endoscope reproc
AHJ authority having jurisdicti
AIA American Institute of Archi
AII airborne infection isolatio
ANSI American National Standards
ASHRAE American Society of Heating, Refrigeration, and
BMBL Biosafety in Microbiological and Biomedical Laboratories
CFR Code of Federal Regulatio
CJD Creutzfeldt-Jakob diseas
CPL compliance document (OSH
DFA direct fluorescence assay
DHHS U.S. Department of Health and Hu
DOT U.S. Department of Transpor
EC environment of care
EPA U. S. Environmental Protection
FDA U.S. Food and Drug Administ
HBV hepatitis B virus
HEPA high efficiency particulate
HIV human immunodeficiency v
HSCT hematopoietic stem cell tran
HVAC heating, ventilation, air cond
ICRA infection-control risk assess
JCAHO Joint Commission on Accreditation of Hea
NaOH sodium hydroxide
NTM nontuberculous mycobacte
OSHA Occupational Safety and Health Ac
PE protective environment
PPE personal protective equipm
TB tuberculosis
USC United States Code
USDA U.S. Department of Agricu
UV ultraviolet
UVGI ultraviolet germicidal irrad
VHF viral hemorrhagic fever
VRE vancomycin-resistant *Enteroc*
VRSA vancomycin-resistant *Staphyloco*
VZV varicella zoster virus

Recommendations for Environmental Infection Contro

Rationale for Recommendations

As in previous CDC guidelines, each recommendation is categorized on the basis of exi
possible economic effect. The recommendations are evidence-based wherever possibl

empiric infection-control or engineering principles, theoretic rationale, or from expe
(e.g., floods).
The HICPAC system for categorizing recommendations has been modified to include a
by state or federal regulations. Guidelines and standards published by the AIA, A
Conditioning Engineers (ASHRAE), and the Association for the Advancement of Me
recommendations. These standards reflect a consensus of expert opinions and extens
Health and Human Services. Compliance with these standards is usually voluntary. H
standards as regulations. For example, the standards from AIA regarding constructi
have been adopted by reference by >40 states. Certain recommendations have two cat
and IC), indicating the recommendation is evidence-based as

Rating Categories

Recommendations are rated according to the fo
Category IA. Strongly recommended for implementation and strongly supported by
studies.
Category IB. Strongly recommended for implementation and supported by certain ex
theoretic rationale.
Category IC. Required by state or federal regulation, or representing an established a
agencies and regulatory citations are listed where appropriate. Recommendations f
Recommendations from AIA guidelines cite the appropria
Category II. Suggested for implementation and supported by suggestive clinica
Unresolved issue. No recommendation is offered. No consensus or insu

Recommendations --- Air

I. Air-Handling Systems in Health-Car

A. Use AIA guidelines as minimum standards where state or local regulations ar
systems in new or renovated health-care facilities. Ensure that existing structure
construction (*1*). Category IC (AIA

B. Monitor ventilation systems in accordance with engineers' and manufacturer
optimal performance for removal of particulates, and elimination of excess mo
9.31.D, 10.31.D, 11.31.D, Environmental Protectio

1. Ensure that heating, ventilation, air conditioning (HVAC) filters are properly
overloads (*2,4,6,9*). Categor
2. Monitor areas with special ventilation requirements (e.g., AII or PE) for A
Category IB, IC (AIA: 7.2.C7,

a. Develop and implement a maintenance schedule for ACH, pressure differe
data as part of the multidisciplin
assessment. Take into account the age and
b. Document these parameters, especially th

3. Engineer humidity controls into the HVAC system and monitor the control

(AIA: 7.31.D9)

a. Locate duct humidifiers upstream fr
b. Incorporate a water-removal mechan
c. Locate all duct takeoffs sufficiently downstream from the humi

4. Incorporate steam humidifiers, if possible, to reduce potential for microbial p humidifiers. Category I
5. Ensure that air intakes and exhaust outlets are located properly in construc (*1*,*27*). Category IC (AIA: 7.31.D 9.31.D3, 10.31.D3, 11.31

a. Locate exhaust outlets >25 ft from a
b. Locate outdoor air intakes ≥6 ft above groun
c. Locate exhaust outlets from contaminated areas above roof lev

6. Maintain air intakes and inspect filters periodically to ensure proper o
7. Bag dust-filled filters immediately upon removal to prevent dispersion of du (*4*,*28*). Category IB

a. Seal or close the bag containing the
b. Discard spent filters as regular solid waste, regardless of the

8. Remove bird roosts and nests near air intakes to prevent mites and fungal Category IB
9. Prevent dust accumulation by cleaning air-duct grilles in accordance with fa are not occupied by patients (*1* Category IC, II (AIA: 7.31
10. Periodically measure output to monitor system function; clean ventilation optimum performance (*1*,*31*,*32*). Ca (AIA: 7.31.D10)

C. Use portable, industrial-grade HEPA filter units capable of filtration rates i respirable particles as needed (*33*).

1. Select portable HEPA filters that can recirculate all or nearly all of the room II
2. Portable HEPA filter units placed in construction zones can be used later i surfaces are cleaned, and the filter r performance verified by appropriate parti
3. Situate portable HEPA units with the advice of facility engineers to en

4. Ensure that fresh-air requirements for the area

D. Follow appropriate procedures for use of areas with through-the-wall ventilatio
10.31.D18, 11.31.D15)

1. Do not use such areas as PE rooms (*1*). Cat
2. Do not use a room with a through-the-wall ventilation unit as an AII roo
engineering controls are met (*1*,*34*). Ca
7.2.C3)

E. Conduct an infection-control risk assessment (ICRA) and provide an adequate n
meet the needs of the patient population (*1*,*2*,*7*,*8*,*17*,*19*, *20*,*34*,*36*
F. When ultraviolet germicidal irradiation (UVGI) is used as a supplemental eng
ceiling or suspended from the ceiling as an upper air unit; 2) in the air-return c
booths for sputum induction (*34*).
G. Seal windows in buildings with centralized HVAC systems, including l
H. Keep emergency doors and exits from PE rooms closed except during an eme
Category II
I. Develop a contingency plan for backup capacity in the event of a general p
Accreditation of Healthcare Organizations [JCAHO]:

1. Emphasize restoration of appropriate air quality and ventilation condition
departments, and intensive care u
Category IC (AIA: 1.5.A1; JCA
2. Deploy infection-control procedures to protect occupants until power and sys
5.1, 5.2; JCAHO: EC 1.

J. Do not shut down HVAC systems in patient-care areas exept for maintenanc
construction (*1*,*46*). Category IB, IC (A

1. Coordinate HVAC system maintenance with infection-control staff and re
Category IC (AIA: 5.1, 5
2. Provide backup emergency power and air-handling and pressurization syst
differentials in PE rooms, AII roo
rooms, and other critical-care areas (*1*,*37*,*47*). C
3. For areas not served by installed emergency ventilation and backup systems, u
patients in those areas (*33*). Ca
4. Coordinate system startups with infection-control staff to protect patients
Category IC (AIA: 5.1, 5
5. Allow sufficient time for ACH to clean the air once the system is opera

K. HVAC systems serving offices and administrative areas may be shut down for e alter or adversely affect pressure differentials maintained in laboratories or crit PE rooms, AII rooms, operating roon

L. Whenever possible, avoid inactivating or shutting down the entire HVAC s

M. Whenever feasible, design and install fixed backup ventilation systems for n operating rooms, and other critical-care areas identified by

II. Construction, Renovation, Remediation, Rep

A. Establish a multidisciplinary team that includes infection-control staff to coordi consider proactive preventive measures at the inception; produce and mainta *16,38,48--51*). Category IB, IC (

B. Educate both the construction team and health-care staff in immunocompro risks associated with construction projects, dispersal of fungal spores during su fungal spores (*11--16,27,50,52--56*).

C. Incorporate mandatory adherence agreements for infection control into const mechanisms to ensure timely correction of problems (*1,11,*1

D. Establish and maintain surveillance for airborne environmental disease (e. renovation, repair, and demolition activities to ensure the health and safety of

1. Using active surveillance, monitor for airborne infections in immuno

2. Periodically review the facility's microbiologic, histopathologic, and postmorte IB

3. If cases of aspergillosis or other health-care--associated airborne fungal infec biopsies and cultures as feasibl *16,27,50,57--59*). Categor

E. Implement infection-control measures relevant to construction, renovation, mai IB, IC (AIA: 5.1, 5.2)

1. Before the project gets under way, perform an ICRA to define the scope of *16,48--51,60*). Category IB, IC (

a. Determine if immunocompromised patients may be at risk for exposure to f *16,48,51*).

b. Develop a contingency plan to prevent such

2. Implement infection-control measures for external demolition and cons

a. Determine if the facility can operate temporarily on recirculate

b. If this is not possible or practical, check the low-efficiency (roughing) filter of particulates.

c. Seal windows and reduce wherever possible other sources of outside air

especially in PE areas.

3. Avoid damaging the underground water system (i.e., buried pipes) to prevent
IB, IC (AIA: 5.1)
4. Implement infection-control measures for internal construction activities (

a. Construct barriers to prevent dust from construction areas from entering p
fungal spores and in compliance w
codes (*1,45,48,49,55,64*
b. Seal off and block return air vents if rigid barriers a
c. Implement dust-control measures on surfaces and divert pedestr
d. Relocate patients whose rooms are adjacent to work zones, depending on t
for generation of dust or water ac
the methods used to control these a

5. Perform those engineering and work-site related infection-control measu
renovations (*1,48,49,51,64,66*). Catego
5.1, 5.2)

a. Ensure proper operation of the air-handling system in the affected area afte
negative pressure (*39,47,50,64*).
IB
b. Create and maintain negative air pressure in work zones adjacent to patien
are maintained (*1,48,49,51,6*
c. Monitor negative airflow inside rig
d. Monitor barriers and ensure integrity of the construction barriers; r
e. Seal windows in work zones if practical; use window chutes for disposal
negative pressure differential for
maintained (*1,13,48*
f. Direct pedestrian traffic from construction zones away from patient-care ar
g. Provide construction crews with 1) designated entrances, corridors, and ele
facilities) and convenience serv
vending machines); 3) protective clothing (e.g., coveralls, footgear, and hea
anteroom for changing clothing a
equipment (*1,11,13--16*
h. Clean work zones and their entrances daily by 1) wet-wiping tools and tool
mats with tacky surfaces inside th
and 3) covering debris and securing this covering before removi
i. In patient-care areas, for major repairs that include removal of ceiling tile
plastic sheets or prefabricated pla
contain dust; use a negative pressure system within this enclosure to remo

portable HEPA filter capable of filtr
300--800 ft^3/min., or exhaust air directly to tl
j. Upon completion of the project, clean the work zone according to facility pr
debris before removing rigid barri
***-16,48--50*).**
k. Flush the water system to clear sediment from pipes to minimize
l. Restore appropriate ACH, humidity, and pressure differential; clean or

F. Use airborne-particle sampling as a tool to evaluate bar
G. Commission the HVAC system for newly constructed health-care facilities and r
on ensuring proper ventilation for operating rooms, AII rooms, and PE areas
H. No recommendation is offered regarding routine microbiologic air sampling b
occupancy of areas housing immunocompromised patients (
I. If a case of health-care--acquired aspergillosis or other opportunistic environme
after construction, implement appropriate follow-up me

1. Review pressure-differential monitoring documentation to verify that pressu
are appropriate for their settings
Category IB, IC (AIA:
2. Implement corrective engineering measures to restore proper pressure diffe
3. Conduct a prospective search for additional cases and intensify retrospect
laboratory records (27,48,76,79,80).
4. If no epidemiologic evidence of ongoing transmission exists, continue routine
fungal disease (27,75). Categ

J. If no epidemiologic evidence exists of ongoing transmission of fungal disease, co
the source (*11,13--16,27,44,49--51,60,8*

1. Collect environmental samples from potential sources of airborne fungal spor
than settle plates (*2,4,11,1*
***16,27,44,49,50,64,65,81--86*). C**
2. If either an environmental source of airborne fungi or an engineering probl
promptly perform corrective measures
source and route of entry (*49,60*).
3. Use an EPA-registered antifungal biocide (e.g., copper-8-quinolinolate) for dec
IB
4. If an environmental source of airborne fungi is not identified, review infecti
identify potential areas for correction
(*88,89*). Category IB
5. If possible, perform molecular subtyping of *Aspergillus* spp. isolated from
identities (*90--94*). Categor

K. If air-supply systems to high-risk areas (e.g., PE rooms) are not optimal, use por
until rooms with optimal air-handling systems become av
III. Infection Control and Ventilation Requiren
A. Minimize exposures of severely immunocompromised patients (e.g., solid-organ
activities that might cause aerosolization of fungal spores (e.g., vacuuming o
B. Minimize the length of time that immunocompromised patients in PE are ou
activities (37,62). Categor
C. Provide respiratory protection for severely immunocompromised patients whe
activities; consult the most recent revision of CDC's *Guideline for Prevention*
regarding the appropriate type of respiratory pro
D. Incorporate ventilation engineering specifications and dust-controlling proce
(Figure 1). Category IB,

1. Install central or point-of-use HEPA filters for supply (incoming) air (*1,2,27,4*
7.2.D)
2. Ensure that rooms are well-sealed by 1) properly constructing windows, doo
that are smooth and free of fissures
and crevices; 3) sealing walls above and below the ceiling; and 4) monit
(*1,27,44,100,101*). Category IB, IC (
3. Ventilate the room to maintain ≥12 ACH (*1,27,37,100,*
4. Locate air supply and exhaust grilles so that clean, filtered air enters from on
from the opposite side of the
(*1,27,100,101*). Category IC (AI
5. Maintain positive room air pressure (≥2.5 Pa [0.01-inch water gauge]) in relati
Table 7.2)
6. Maintain airflow patterns and monitor these on a daily basis by using perman
renovated construction, or by using
methods (e.g., flutter strips or smoke tubes) in existing PE units. Document t
7. Install self-closing devices on all room exit doors in PE r

E. Do not use laminar air flow systems in newly constructe
F. Take measures to protect immunocompromised patients who would benefit fr
disease (e.g., acute VZV infection or

1. Ensure that the patient's room is designed to r
2. Use an anteroom to ensure appropriate air-balance relationships and provide
place a HEPA filter in the exhaus
return air must be recirculated (*1,100*) (Figure 2). Ca
3. If an anteroom is not available, place the patient in AII and use portable, indu
the room (*33*). Category

G. Maintain backup ventilation equipment (e.g., portable units for fans or filters)
areas and take immediate steps to restore the fixed ventilation
IV. Infection-Control and Ventilation Requirem
A. Incorporate certain specifications into the planning and construction or renovati
IC

1. Maintain continuous negative air pressure (2.5 Pa [0.01 inch water gauge]) i
pressure periodically, preferably
audible manometers or smoke tubes at the door (for existing AII rooms), or w
Document the results of mon
(*1,100,101*). Category IC (AIA: 7.2
2. Ensure that rooms are well-sealed by properly constructing windows, doo
indicates air leakage, locate the lea
necessary repairs (*1,99,100*). Category I
3. Install self-closing devices on all AII room exit door
4. Provide ventilation to ensure ≥12 ACH for renovated rooms and new rooms,
IB, IC (AIA: Table 7.2
5. Direct exhaust air to the outside, away from air-intake and populated ar
recirculated after passing through a HI
Category IC (AIA: Table

B. Where supplemental engineering controls for air cleaning are indicated from a
exhaust air ducts of the HVAC system to supplement HEPA filtration or instal
room air (*34*). Category
C. Implement environmental infection-control measures for persons with di

1. Use AII rooms for patients with or suspected of having an airborne infectio
enclosed booth that is engineered t
≥12 ACH; 2) air supply and exhaust rate sufficient to maintain a 2.5 Pa (0.
respect to all surrounding spaces wi
rate of ≥50 ft^3/min; and 3) air exhausted directly outside away from air intak
recirculation (*1,34,105--107*). Cate
(AIA: 7.15.E, 7.31.D23, 9.10,
2. Although airborne spread of viral hemorrhagic fever (VHF) has not been docu
a VHF patient in an AII room, p
with an anteroom, to reduce the risk of occupational exposure to aerosolize
respiratory secretions present in la
during the end stage of a patient's illness (

a. If an anteroom is not available, use portable, industrial-grade HEPA fi

equivalents for removing airborne

b. Ensure that health-care workers wear face shields or goggles with appropr
with prominent cough, vomiting, c
hemorrhage (*109*)

3. Place smallpox patients in negative pressure rooms at the onset of their illnes
(*36*). Category II

D. No recommendation is offered regarding negative pressure or isolation for pa
Unresolved issue.

E. Maintain backup ventilation equipment (e.g., portable units for fans or filters) fo
rooms, and take immediate steps to restore the fixed ventilation

V. Infection-Control and Ventilation Requirements

A. Implement environmental infection-control and ventilati

1. Maintain positive-pressure ventilation with respect to corridors and adjac
2. Maintain ≥15 ACH, of which ≥3 ACH should be fresh air (*1*
3. Filter all recirculated and fresh air through the appropriate filters, providing
Category IC (AIA: Table
4. In rooms not engineered for horizontal laminar airflow, introduce air at the c
IC (AIA: 7.31.D4)
5. Do not use ultraviolet (UV) lights to prevent surgical-site i
6. Keep operating room doors closed except for the passage of equipment, pers
(*127,128*). Category IB

B. Follow precautionary procedures for infectious TB patients who also requi

1. Use an N95 respirator approved by the National Institute for Occupational Sa
room (*129,131*). Category IC (Oc
Safety and Health Administration [OSHA]; 29 Code of Fe
2. Intubate the patient in either the AII room or the operating room; if intubatin
to open until 99% of the airborne c
are removed (Table 1) (*34,117*).
3. When anesthetizing a patient with confirmed or suspected TB, place a bact
airway to prevent contamination c
equipment or discharge of tubercle bacilli into the ar
4. Extubate and allow the patient to recover in an A
5. If the patient has to be extubated in the operating room, allow adequate time
(Table 1), because extubation is
producing procedure (*34,117*). C

C. Use portable, industrial-grade HEPA filters temporarily for supplemental air c
who require surgery (*33*,*34*,*117*). (

1. Position the units appropriately so that all room air passes through the fi
appropriate placements (*34*). Ca
2. Switch the portable unit off during the surgic
3. Provide fresh air as per ventilation standards for operating rooms; portable u
ACH (*1*,*33*,*133*). Category

D. If possible, schedule TB patients as the last surgical cases of the day to maximize
Category II
E. No recommendation is offered for performing orthopedic implant operatio
Unresolved issue
F. Maintain backup ventilation equipment (e.g., portable units for fans or filters)
immediate steps to restore the fixed ventilation system (*1*,*47*
VI. Other Potential Infectious Aerosol Hazards in
A. In settings where surgical lasers are used, wear appropriate personal protective
minimize exposure to laser plumes (*129*,*135*,*136*). Categor
B. Use central wall suction units with in-line filters to evacuate min
C. Use a mechanical smoke evacuation system with a high-efficiency filter to mana
ablating tissue infected with human papilloma virus (HPV) or performin
(*34*,*136*,*137*,*139*--*141*). Categ
Recommendations --- Water
I. Controlling the Spread of Waterborne M
A. Practice hand hygiene to prevent the hand transfer of waterborne pathogens, an
guidelines (*36*,*142*--*146*). Cate
B. Eliminate contaminated water or fluid environmental reservoirs (e.g., in equipm
C. Clean and disinfect sinks and wash basins on a regular basis by using an EPA-
D. Evaluate for possible environmental sources (e.g., potable water) of specimen
NTM) of unlikely clinical importance are isolated from clinical cultures (e.g.
postprocedural, colonization after use of tap water in pa
E. Avoid placing decorative fountains and fish tanks in patient-care areas; ensu
fountains are used in public areas of the health-ca
II. Routine Prevention of Waterborne Microbial Contaminatio
A. Maintain hot water temperature at the return at the highest temperature allo
(≥51°C), and maintain cold water temperature at <68°F (<20°C) (*27*,*1*
B. If the hot water temperature can be maintained at ≥124°F (≥51°C), explore engin
point-of-use fixtures) to help minimize the risk of
C. When state regulations or codes do not allow hot water temperatures above the
110°F (35°C--43.3°C) for nursing care facilities or when buildings cannot be retro
alternative preventive measures to minimize the growth of *Legi*

1. Periodically increase the hot water temperature to ≥150°F (≥6
2. Alternatively, chlorinate the water and then flush it throu

D. Maintain constant recirculation in hot-water distribution systems serving
III. Remediation Strategies for Distribution System
A. Whenever possible, disconnect the ice machine before plan
B. Prepare a contingency plan to estimate water demands for the entire facility expected to result in extensive and heavy microbial or chemical contaminati (*45,156*). Category IC (JCAHO
C. When a significant water disruption or an emergency occurs, adhere to any ad (*157*). Category IB, IC (Municip

1. Alert patients, families, staff, and visitors not to consume water from drinking while the advisory is in effect, unle
has been disinfected (e.g., by bringing to a rolling boil for ≥1 minu
2. After the advisory is lifted, run faucets and drinking fountains at full flow fo chlorination (*153,157*). Category IC, order; ASHRAE: 12:20

D. Maintain a high level of surveillance for waterborne disease among patie
E. Corrective decontamination of the hot water system might be necessary after a d has occurred.

1. Decontaminate the system when the fewest occupants are present in the bu (ASHRAE: 12:2000)
2. If using high-temperature decontamination, raise the hot-water temperature progressively flushing each outlet system for ≥5 minutes (*27,153*). Category I
3. If using chlorination, add enough chlorine, preferably overnight, to achieve a f system (*153*). Category IC (AS 12:2000)

a. Flush each outlet until chlorine o
b. Maintain the elevated chlorine concentration in t

4. Use a thorough flushing of the water system instead of chlorination if a highly spp.) is suspected as the water co Category II

F. Flush and restart equipment and fixtures according to man

G. Change the pretreatment filter and disinfect the dialysis water system with ar
reverse osmosis membrane and downstream microbial
H. Run water softeners through a regeneration cycle to restore t
I. If the facility has a water-holding reservoir or water-storage tank, consult the f
whether this equipment needs to be drained, disinfected with an EP
J. Implement facility procedures to manage a sewage system failure or floodin
temporary transfer of patients or provision of services), and establish communi
health department to ensure that advisories are received in a timely manner
Municipal order)
K. Implement infection-control measures during sewage intrusion, fl

1. Relocate patients and clean or sterilize supplies fr
2. If hands are not visibly soiled or contaminated with proteinaceous material,
process 1) before performing invasiv
2) before and after each patient contact; and 3) whenever ha
3. If hands are visibly soiled or contaminated with proteinaceous material, use s
4. If the potable water system is not affected by flooding or sewage contaminatio
to standard procedures. Cate
5. Contact the manufacturer of the automated endoscope reprocessor (AER) for
water advisory. Category

L. Remediate the facility after sewage intrusion, flooding, o

1. Close off affected areas during cleanup pr
2. Ensure that the sewage system is fully functional before beginning remedia
removed. Category II
3. If hard-surfaced equipment, floors, and walls remain in good repair, ensure
according to standard cleaning p
Category II
4. Clean wood furniture and materials (if still in good repair); allow them to d
coatings. Category II
5. Contain dust and debris during remediation and repair as outlined in

M. Regardless of the original source of water damage (e.g., flooding versus wate
absorbent structural items (e.g., carpeting, wallboard, and wallpaper) and cl
cleaned and dried within 72 hours (e.g., moisture content $\leq$20% as determined b
soon as the underlying structure is declared by the facility engineer to
IV. Additional Engineering Measures as Indicated by Epidemiologic Investigation
Legionnaires Disease
A. When using a pulse or one-time decontamination method, superheat the water b
170°F (71°C--77°C) or hyperchlorinate the system by flushing all outlets for $\geq$5

residual chlorine using a chlorine-based product registered by the EPA for wat
(*153,155,161--164*). Categor
B. After a pulse treatment, maintain both the heated water temperature at
recommendation (Water: II A) wherever practical and permitted by state cod
ppm) free residual chlorine at the tap by using a chlorine-based product reg
hypochlorite [bleach]) (*153,165--169*). Category IC
C. Explore engineering or educational options (e.g., install preset thermostatic mix
each outlet) to minimize the risk of scalding for patient
D. No recommendation is offered for treating water in the facility's distribution sy
or silver), monochloramines, ozone, or UV light (
V. General Infection-Control Strategies for Preventi
A. Conduct an infection-control risk assessment of the facility to determine if patie
present (*27,189,190*). Catego
B. Implement general strategies for detecting and preventing Legionnaires dis
immunocompromised patients (i.e., facilities that do not have HSCT or solid-o
Category IB

1. Establish a surveillance process to detect health-care--associated I
2. Inform health-care personnel (e.g., infection control, physicians, patient-care s
disease to occur and measures to p
control health-care--associated legionellosis
3. Establish mechanisms to provide clinicians with laboratory tests (e.g., cultu
serology) for the diagnosis of Legion
(*27,189*). Category II

C. Maintain a high index of suspicion for health-care--associated Legionnaires
legionellosis on suspected cases, especially in patients at risk who do not requir
patients aged ≥65 years; or patients with chronic underlying disease (e.g., diabet
lung disease) (*27,166,190,192--198*).
D. Periodically review the availability and clinicians' use of laboratory diagnostic
use of the tests on patients with diagnosed or suspected pneumonia is limited,
enhance clinicians' use of the test(s) (*19*)
E. If one case of laboratory-confirmed, health-care--associated Legionnaires dis
suspected, health-care-associated Legionnaires disease occur during a 6-
(*181,189,191,193,199,200*). Cat

1. Report the cases to state and local health departments w
2. If the facility does not treat severely immunocompromised patients, conduc
review of microbiologic, serologic, an
data to look for previously unidentified cases of health-care--associated I
surveillance for additional

(*27*,*181*,*189*,*191*,*193*,*199*,*200*). C

3. If no evidence of continued health-care--associated transmission exists, contir
the initiation of surveillance (
189,*191*,*193*,*199*,*200*). Cate

F. If there is evidence of continued health-care--associated transmission (i.e., a
determine the source of *Legionella* spp. (*19*

1. Collect water samples from potential aerosolized water sour
2. Save and subtype isolates of *Legionella* spp. obtained from patients an
3. If a source is identified, promptly institute water system decontamination m
Category IB
4. If *Legionella* spp. are detected in ≥1 culture (e.g., conducted at 2-week interval
them accordingly, and repe
decontamination procedures; consider intensive use of techniques used in the
and hyperchlorination (*27*,*210*,*21*
IB

G. If an environmental source is not identified during a Legionnaires disease outb
Either defer decontamination pending identification of the source of *Legionell*
water distribution system, with special attention to areas i
H. No recommendation is offered regarding routine culturing of water systems in
(i.e., PE or transplant units) for persons at high risk for *Legionella* spp. infectio
issue
I. No recommendation is offered regarding the removal of faucet aerators in a
J. Keep adequate records of all infection-control measures and environmenta

VI. Preventing Legionnaires Disease in Protective Enviro

A. When implementing strategies for preventing Legionnaires disease among sever
HSCT or solid-organ transplant programs, incorporate these specific surveilla
outlined previously (see App

1. Maintain a high index of suspicion for legionellosis in transplant patients eve
legionellae (*189*,*215*). Catego
2. If a case occurs in a severely immunocompromised patient, or if severely imm
the hospital (e.g., PE or transplan
cases are identified elsewhere in the facility, conduct a combined epidemiologi
of *Legionella* spp. (*189*,*210*). Ca

B. Implement culture strategies and potable water and fixture treatment measu
Category II

1. Depending on state regulations on potable water temperature in public bui
health-care--associated legionellosis
maintain heated water with a minimum return temperature of ≥124°F (≥51°
water to achieve 1--2 mg/L (1--2 p
residual chlorine at the tap (*153--155,165,16*
2. Periodic culturing for legionellae in potable water samples from HSCT or so
comprehensive strategy to prevent
disease in these units (*37,154,189,21*
3. No recommendation is offered regarding the optimal methodology (i.e., frequ
cultures in HSCT or solid-organ tra
Unresolved issue
4. In areas with patients at risk, when *Legionella* spp. are not detectable in unit
aerators monthly by using a chlo
EPA-registered product. If an EPA-registered chlorine disinfectant is not avai
v/v dilution]) (*153,187*). Categ

C. If *Legionella* spp. are determined to be present in the water of a transplant unit
longer detected by cultu

1. Decontaminate the water supply as outlined previously (Wat
2. Do not use water from the faucets in patient-care rooms to avoid cr
3. Restrict severely immunocompromised patients from ta
4. Use water that is not contaminated with *Legionella* spp. for HSCT
5. Provide patients with sterile water for tooth brushing, drinking, and for flu
(*37,219*). Category IB

D. Do not use large-volume room air humidifiers that create aerosols (e.g., by Ventu
subjected to high-level disinfection and filled only with steri
VII. Cooling Towers and Evaporative C
A. When planning construction of new health-care facilities, locate cooling towe
system, and design the towers to minimize the volume of aerosol drift
B. Implement infection-control procedures for operational cooling towers

1. Install drift eliminators (*153,203,222*). Catego
2. Use an effective EPA-registered biocide on a regular basis
3. Maintain towers according to manufacturers' recommendations, and kee
including environmental test results fr
outbreak investigations (*153*). Category I

C. If cooling towers or evaporative condensers are implicated in health-care--associ
(*199,203,221,223*). Categor

VIII. Dialysis Water Quality and Di

A. Adhere to current AAMI standards for quality-assurance performance of device in hemodialysis centers (both acute and maintenance [chronic] settings) and for Category IA, IC (AAMI: American National Standards Institute [AN

B. No recommendation is offered regarding whether more stringent requirements f hemodiafiltration. Unresolve

C. Conduct microbiologic testing specific to water in dialysis settings (*229,230,236* ANSI/AAMI RD47:1993, RD6

1. Perform bacteriologic assays of water and dialysis fluids at least once a mon methods (*236--238*). Category IA, ANSI/AAMI RD62:20

a. Assay for heterotrophic, mesophilic bacteri

b. Do not use nutrient-rich media (e.g., blood

2. In conjunction with microbiologic testing, perform endotoxin testing on pro (*229,230,239--242*). Category IA, ANSI/AAMI RD5:1992, ANSI/AAM

3. Ensure that water does not exceed the limits for microbial counts and endoto (AAMI: ANSI/AAMI RD5: ANSI/AAMI RD47:19

D. Disinfect water distribution systems in dialysis settings at least weekly (*226- RD62:2001)

E. Wherever practical, design and engineer water systems in dialysis settings to branches and taps that can harbor bacteria (*226-- 228,231,236*). Cate

F. When storage tanks are used in dialysis systems, they should be routinely draine with an ultrafilter or pyrogenic filter (membrane filter with a pore size sufficient in the water line distal to the storage tank (*236*). Category I

IX. Ice Machines and Ice

A. Do not handle ice directly by hand, and wash hands b

B. Use a smooth-surface ice scoop to dispense ice

1. Keep the ice scoop on a chain short enough that the scoop cannot touch the flo use (*243,244*). Category

2. Do not store the ice scoop in the ice

C. Do not store pharmaceuticals or medical solutions on ice intended for consump equipment specifically manufactured for this pur

D. Machines that dispense ice are preferred to those that require ice to be remove

E. Limit access to ice-storage chests, and keep container doors closed
F. Clean, disinfect, and maintain ice-storage chests on

1. Follow the manufacturer's instructions for
2. Use an EPA-registered disinfectant suitable for use on ice machines, dispenser
Category II
3. If instructions and EPA-registered disinfectants suitable for use on ice machi
regimen (Box 3) (*244*). Categ
4. Flush and clean ice machines and dispensers if they have not been disconnecte
II

G. Install proper air gaps where the condensate lines me
H. Conduct microbiologic sampling of ice, ice chests, and ice-making machines a
investigation (*244*,*248*,*249*). Cat
X. Hydrotherapy Tanks and Po
A. Drain and clean hydrotherapy equipment (e.g., Hubbard tanks, tubs, whirlpoo
use, and disinfect equipment surfaces and components by using an EPA-regi
instructions. Category I
B. In the absence of an EPA-registered product for water treatmer

1. Maintain a 15-ppm chlorine residual in the water of small hydrotherapy
2. Maintain a 2--5-ppm chlorine residual in the water of whirlpo
3. If the pH of the municipal water is in the basic range (e.g., when chloramine
community), consult the facility engi
the possible need to adjust the pH of the water to a more acidic level before di
(*252*). Category II

C. Clean and disinfect hydrotherapy equipment after
D. Clean and disinfect inflatable tubs unless they are sin
E. No recommendation is offered regarding the use of antiseptic chemicals (e.g., c
Unresolved issue
F. Conduct a risk assessment of patients before their use of large hydrotherapy
incontinence from pool use until their conditi
G. For large hydrotherapy pools, use pH and chlorine residual levels appropriate
agencies. Category IC (Sta
H. No recommendation is offered regarding the use in health-care settings of w
recreational use. Unresolved
XI. Miscellaneous Medical Equipment Connecte
A. Clean, disinfect, and maintain AER equipment according to the manufacturer'
inadvertent contamination of endoscopes and bronchoscopes with wate

1. To rinse disinfected endoscopes and bronchoscopes, use water of the highest
(e.g., sterile water or bacteriologic
water [water filtered through 0.1--0.2-*μ*m filters]
2. Dry the internal channels of the reprocessed endoscope or bronchoscope b
forced-air treatment) to lessen the
proliferation of waterborne microorganisms and to help preven

B. Use water that meets nationally recognized standards set by the EPA for drinki
routine dental treatment output water (*264--267*). Category I
C. Take precautions to prevent waterborne contamination of d

1. After each patient, discharge water and air for a minimum of 20--30 secon
system that enters a patient's m
handpieces, ultrasonic scalers, or air/water syri
2. Consult with dental water-line manufacturers to 1) determine suitable met
quality; and 2) determine appropria
monitoring the water to ensure quality is maint
3. Consult with the dental unit manufacturer regarding the need for periodi
Category IB

Recommendations ---Environmental

I. Cleaning and Disinfecting Strategies for Environmental S
A. Select EPA-registered disinfectants, if available, and use them in accordance wit
(EPA: 7 United States Code [USC]
B. Do not use high-level disinfectants/liquid chemical sterilants for disinfectio
environmental surfaces; such use is counter to label instructions for these to
Administration [FDA]: 21 CFR 80
C. Follow manufacturers' instructions for cleaning and maintaining
D. In the absence of a manufacturer's cleaning instructi

1. Clean noncritical medical equipment surfaces with a detergent/disinfecta
registered hospital disinfectant wit
tuberculocidal claim (depending on the nature of the surface and the degre
instructions (*274*). Categor
2. Do not use alcohol to disinfect large environment
3. Use barrier protective coverings as appropriate for noncritical surfaces that
delivery of patient care; 2) likely
contaminated with blood or body substances; or 3) difficult to clea

E. Keep housekeeping surfaces (e.g., floors, walls, tabletops) visibly clean on a reg

1. Use a one-step process and an EPA-registered hospital detergent/disinfectan

care areas where 1) uncertainty ex
nature of the soil on the surfaces (e.g., blood or body fluid contamination vers
the presence of multidrug resistant
on such surfaces (*272,274,280,281*
2. Detergent and water are adequate for cleaning surfaces in nonpatient-c
3. Clean and disinfect high-touch surfaces (e.g., doorknobs, bed rails, light switc
on a more frequent schedule than
touch housekeeping surfaces. C
4. Clean walls, blinds, and window curtains in patient-care areas when they

F. Do not perform disinfectant fogging in patient-care
G. Avoid large-surface cleaning methods that produce mists or aerosols, or dispe
H. Follow proper procedures for effective uses of mops, c

1. Prepare cleaning solutions daily or as needed, and replace with fresh solution
(*280,281*). Category II
2. Change the mop head at the beginning of each day and also as required by f
other body substances. Categ
3. Clean mops and cloths after use and allow to dry before reuse; or use singl
Category II

I. After the last surgical procedure of the day or night, wet vacuum or mop ope
registered hospital disinfectant (*114*)
J. Do not use mats with tacky surfaces at the entrances to operating room
K. Use appropriate dusting methods for patient-care areas designated for immun
Category IB

1. Wet-dust horizontal surfaces daily by moistening a cloth with a small amou
(*37,40,280*). Category II
2. Avoid dusting methods that disperse dust (e.g., feat

L. Keep vacuums in good repair and equip vacuums with HEPA filters for use a
M. Close the doors of immunocompromised patients' rooms when vacuuming, wa
airborne dust (*37,40,289*). Cate
N. When performing low- or intermediate-level disinfection of environmental sur
exposure of neonates to disinfectant residues on these surfaces by using EPA-r
instructions and safety advisories (*271,290--292*). Categor

1. Do not use phenolics or any other chemical germicide to disinfect bassinet
Category IB
2. Rinse disinfectant-treated surfaces, especially those treated with p

O. When using phenolic disinfectants in neonatal units, prepare solutions to cor
instructions, or use premixed formulations (*271,290--292*). Cat
II. Cleaning Spills of Blood and Body S
A. Promptly clean and decontaminate spills of blood or other potentially infectiou
1910.1030 § d.4.ii.A)
B. Follow proper procedures for site decontamination of spills of blood or blood-c
CFR 1910.1030 § d.4.ii.A

1. Use protective gloves and other PPE appropriate for this task (*293*). C
2. If the spill contains large amounts of blood or body fluids, clean the visible m
used cleaning materials in appropr
containers (*293,298,299,301,302*). Category IC (OSH
3. Swab the area with a cloth or paper towels moderately wetted with disinfect
(OSHA: 29 CFR 1910.1030 § d

C. Use germicides registered by the EPA for use as hospital disinfectants and lab
Lists D and E (i.e., products with specific label claims for HIV or hepatitis B
decontaminate spills of blood and other body fluids (*293,301,303*). Category I
2/28/97; compliance document [CPL] 2
D. An EPA-registered sodium hypochlorite product is preferred, but if such produc
(e.g., household chlorine bleach) m

1. Use a 1:100 dilution (500--615 ppm available chlorine) to decontaminate nor
body fluids in patient-care setting
Category IB
2. If a spill involves large amounts of blood or body fluids, or if a blood or cultur
6,150 ppm available chlorine) fo
application of germicide before cleaning (
III. Carpeting and Cloth Furnish
A. Vacuum carpeting in public areas of health-care facilities and in general patie
designed to minimize dust dispersion (2
B. Periodically perform a thorough, deep cleaning of carpeting as determined b
production of aerosols and leaves little or no r
C. Avoid use of carpeting in high-traffic zones in patient-care areas or where spi
laboratories, or intensive care units) (*44,30*)
D. Follow appropriate procedures for managi

1. Spot-clean blood or body substance spills promptly (*293,301,304,307*). Categor
2. If a spill occurs on carpet tiles, replace any tiles contaminated by blood and b
29 CFR 1910.1030 § d.4.ii interp

E. Thoroughly dry wet carpeting to prevent the growth of fungi; replace carpetin
F. No recommendation is offered regarding the routine use of fungicidal or bacteri
care facility or in general patient-care are
G. Do not use carpeting in hallways and patient rooms in areas housing immunos
H. Avoid using upholstered furniture and furnishings in high-risk patient-care area
contamination (e.g., pediatrics units) (
I. No recommendation is offered regarding whether upholstered furniture and fu
Unresolved issue

1. Maintain upholstered furniture in good
2. Maintain the surface integrity of the upholstery by rep
3. If upholstered furniture in a patient's room requires cleaning to remove visibl
a maintenance area where it can b
cleaned with a process appropriate for the type of upholst
IV. Flowers and Plants in Patient-Ca
A. Flowers and potted plants need not be restricted from areas for imm
B. Designate care and maintenance of flowers and potted plants to staff not d
C. If plant or flower care by patient-care staff is unavoidable, instruct the staff to w
hand hygiene after glove removal (*30*
D. Do not allow fresh or dried flowers, or potted plants, in patient-care areas for i
V. Pest Control
A. Develop pest-control strategies, with emphasis on kitchens, cafeterias, laundri
docks, construction activities, and other areas prone to i
B. Install screens on all windows that open to the outside; keep sc
C. Contract for routine pest control service by a credentialed pest-control speciali
care facility (*315*). Categor
D. Place laboratory specimens (e.g., fixed sputum smears) in covered conta
VI. Special Pathogens
A. Use appropriate hand hygiene, PPE (e.g., gloves), and isolation precautions duri
Category IB
B. Use standard cleaning and disinfection protocols to control environmental con
(e.g., methicillin-resistant *Staphylococcus aureus*, vancomycin intermediate se
***Enterococcus* [VRE]) (*318*,*320--322*)**

1. Pay close attention to cleaning and disinfection of high-touch surfaces in p
commodes, bed rails, doorknobs, or f
(*318*,*320--322*). Categor
2. Ensure compliance by housekeeping staff with cleaning and disinf
3. Use EPA-registered chemical germicides appropriate for the surface to be disi
as specified by the manufact

instructions (*271,322--327*). Category IB, IC (

4. When contact precautions are indicated for patient care, use disposable patie
to minimize cross-contaminati
multiple-resistant microorganisms (*3*

5. Follow these same surface-cleaning and disinfecting measures for managing th
II

C. Environmental-surface culturing can be used to verify the efficacy of hospita
disinfecting rooms that house patients with VRE

1. Obtain prior approval from infection-control staff and the clinical laborato
Category II

2. Infection-control staff, with clinical laboratory staff consultation, must

D. Thoroughly clean and disinfect environmental and medical equipment surfaces
accordance with manufacturers' instructions (*271,274,319, 334*). C

E. Advise families, visitors, and patients regarding the importance of hand hygiene
(e.g., respiratory secretions or fecal matter) to s

F. Do not use high-level disinfectants (i.e., liquid chemical sterilants) on envir
instructions because of the toxicity of the chemicals (*270,273,274,278*

G. Because no EPA-registered products are specific for inactivating *Clostridiu*
disinfection of environmental surfaces in accordance with guidance from th
surveillance and epidemiology indicate ongoing transmission

H. No recommendation is offered regarding the use of specific EPA-registered hosp
***C. difficile*. Unresolved is**

I. Apply standard cleaning and disinfection procedures to control environmenta
pediatric-care units and care areas for immunocompromised patients (2

J. Clean surfaces that have been contaminated with body substances; perform lo
with an EPA-registered disinfectant in accordance with the manufacturer's in
1910.1030 § d.4.ii.A; EPA: 7 USC §

K. Use disposable barrier coverings as appropriate to minimiz

L. Develop and maintain cleaning and disinfection procedures in patient-care area
Creutzfeldt-Jakob disease (CJD), for which no EPA-regi

1. In the absence of contamination with central nervous system tissue, extraordi
or applying full-strength sodium h
are not needed for routine cleaning or terminal disinfection of a room hou
Category II

2. After removing gross tissue from the surface, use either 1N NaOH or a sodiu
20,000 ppm available chlorine (d
1:5 to 1:3 v/v, respectively, of U.S. household chlorine bleach; contact the man

products for advice) to decont
operating room or autopsy surfaces with central nervous system or cerebral s
CJD patient (*273*,*337--342*). Ca

a. The contact time for the chemical used during this process
b. Blot up the chemical with absorbent material and rinse th
c. Discard the used, absorbent material into ap

3. Use disposable, impervious covers to minimize body substance contaminati

M. Use standard procedures for containment, cleaning, and decontamination
(Environmental Services: II) (*293*). Category IC (OSH

1. Wear PPE appropriate for a surface decontamination and cleaning task (*29*
2. Discard used PPE by using routine disposal procedures or decontaminate reu
29 CFR 1910.1030 § d.3.v

Recommendations ---Environmental S

I. General Information

A. Do not conduct random, undirected, microbiologic sampling of air, water, and
Category IB

B. When indicated, conduct microbiologic sampling as part of an epidemiolo
environmental conditions to detect contamination or verify abat

C. Limit microbiologic sampling for quality assurance purposes to 1) biologic mo
water and dialysate in hemodialysis units; and 3) short-term evaluation of the im
control protocols (*270*,*343*). Cat

II. Air, Water, and Environmental Surfa

A. When conducting any form of environmental sampling, identify existing comp
standard methods (*343--347*). C

B. Select a high-volume air sampling device if anticipated levels of microbi
(*345*,*346*,*348*,*349*). Categor

C. Do not use settle plates to quantify the concentration of airb

D. When sampling water, choose growth media and incubation conditions that
Category II

E. When using a sample/rinse method for sampling an environmental surface, deve
gauze, or sponge in a reproducible manner so that results

F. When environmental samples and patient specimens are available for compar
microorganisms down to the species level at a minimum, and beyond

Recommendations ---Laundry and I

I. Employer Responsibilities

A. Employers must launder workers' personal protective garments or uniforms
infectious materials (*293*). Category IC (OSHA: 29 C

II. Laundry Facilities and Equipr

A. Maintain the receiving area for contaminated textiles at negative pressure com with AIA construction standards in effect during the time of facility constr

B. Ensure that laundry areas have handwashing facilities and products and appr (AIA: 7.23.D4; OSHA: 29 CFR 1910

C. Use and maintain laundry equipment according to manufactu

D. Do not leave damp textiles or fabrics in machines

E. Disinfection of washing and drying machines in residential care is not needed a and proper washing and drying procedures

III. Routine Handling of Contaminated

A. Handle contaminated textiles and fabrics with minimum agitation to avoid cont Category IC (OSHA: 29 CFR 1910.

B. Bag or otherwise contain contaminated textiles and fabrics at the point of use

1. Do not sort or prerinse contaminated textiles or fabrics in patient-care areas

2. Use leak-resistant containment for textiles and fabrics contaminated with blo CFR 1910.1030 § d.4.iv

3. Identify bags or containers for contaminated textiles with labels, color co appropriate (*293*). Category IC (OS 1910.1030 § d.4.iv)

C. Covers are not needed on contaminated textile hampers

D. If laundry chutes are used, ensure that they are properly designed, maintained, from contaminated laundry (*357--361*). Category IC (A

1. Ensure that laundry bags are closed before tossing the f

2. Do not place loose items in the laundry

E. Establish a facility policy to determine when textiles or fabrics should be sort (*362,363*). Category II

IV. Laundry Process

A. If hot-water laundry cycles are used, wash with detergent in water ≥160°F (≥71

B. No recommendation is offered regarding a hot-water temperature setting and cy care facilities. Unresolved i

C. Follow fabric-care instructions and special laundering requirements

D. Choose chemicals suitable for low-temperature washing at proper use concentr are used (*365--370*). Catego

E. Package, transport, and store clean textiles and fabrics by methods that will ens during interfacility loading, transport, and unl

V. Microbiologic Sampling of Tex

A. Do not conduct routine microbiologic sampling of clea

B. Use microbiologic sampling during outbreak investigations if epidemiologic evi
in disease transmission (*371*). Ca
VI. Special Laundry Situation
A. Use sterilized textiles, surgical drapes, and gowns for situations requi
B. Use hygienically clean textiles (i.e., laundered, but not sterilized) in neo
C. Follow manufacturers' recommendations for cleaning fabric products, includi
D. Do not use dry cleaning for routine laundering in health-c
E. Use caution when considering use of antimicrobial mattresses, textiles, and cloth
items; EPA has not approved public health claims asserting protection against h
F. No recommendation is offered regarding using disposable fabrics and
VII. Mattresses and Pillows
A. Keep mattresses dry; discard them if they remain wet or stained, par
B. Clean and disinfect mattress covers by using EPA-registered disinfectants t
development of tears, cracks, or holes in the cove
C. Maintain the integrity of mattress and pillo

1. Replace mattress and pillow covers if they become torn or c
2. Do not stick needles into a mattress through

D. Clean and disinfect moisture-resistant mattress covers between patient use by u
E. If using a mattress cover completely made of fabric, change these covers and
F. Launder pillow covers and washable pillows in the hot-water cycle between p
substances (*382*). Category
VIII. Air-Fluidized Beds
A. Follow manufacturers' instructions for air-fluidized bed mainte
B. Change the polyester filter sheet at least weekly or as indicated by
C. Clean and disinfect the polyester filter sheet thoroughly, especially between
Category IB
D. Consult the facility engineer to determine the proper placement of air-fluidiz
Recommendations --- Animals in Health-C
I. General Infection-Control Measures for An
A. Minimize contact with animal saliva, dander, urine, a
B. Practice hand hygiene after any animal contac

1. Wash hands with soap and water, especially if hands are visibly soiled or con
2. Use either soap and water or alcohol-based hand rubs when hands are n
II. Animal-Assisted Activities and Resident A
A. Avoid selection of nonhuman primates and reptiles in animal-assisted activitie
(*391--393*). Category II
B. Enroll animals that are fully vaccinated for zoonotic diseases and that are health
or otherwise have completed recent anthelmintic treatment under the re

C. Enroll animals that are trained with the assistance or under the direction of pe
D. Ensure that animals are controlled by persons trained in providing activities or
and behavior traits (*391*,*394*). C
E. Take prompt action when an incident of biting or scratching by an animal

1. Remove the animal permanently from these pr
2. Report the incident promptly to appropriate authorities (e.g., infection-con
control personnel) (*391*). Cate
3. Promptly clean and treat scratches, bites, or other

F. Perform an ICRA and work actively with the animal handler before conduct
whether the session should be held in a public area of the facility or in
G. Take precautions to mitigate allergic response

1. Minimize shedding of animal dander by bathing animals <2
2. Groom animals to remove loose hair before a visit, or use a

H. Use routine cleaning protocols for housekeeping surfaces
I. Restrict resident animals, including fish in tanks, from access to patient-care are
sterile supply areas, sterile and clean supply storage areas, medication preparat
Category II
J. Establish a facility policy for regular cleaning of fish tanks, rodent cages, and b
cleaning task to a nonpatient-care staff member; avoid splashing tank water
bedding. Category II
III. Protective Measures for Immunocompr
A. Advise patients to avoid contact with animal feces, saliva, urine, o
B. Promptly clean and treat scratches, bites, or other wounds
C. Advise patients to avoid direct or indirect contact w
D. Conduct a case-by-case assessment to determine if animal-assisted activities o
immunocompromised patients (*394*)
E. No recommendation is offered regarding permitting pet visits to terminally il
Unresolved issue.
IV. Service Animals
A. Avoid providing facility access to nonhuman primates and reptile
B. Allow service animals access to the facility in accordance with the Americans
animal creates a direct threat to other persons or a fundamental alteration
Department of Justice: 28 CFR
C. When a decision must be made regarding a service animal's access to any parti
animal, patient, and health-care situation on a case-by-case basis to determi
reasonable modifications in policies and procedures will mitigate this risk (*39*
36.208)

D. If a patient must be separated from his or her service animal while in the h
arrangements have been made for supervision or care of the animal during
arrangements to address the patient's needs in the absenc
V. Animals as Patients in Human Health-C
A. Develop health-care facility policies to address the treatment of

1. Use the multidisciplinary team approach to policy development, including pu
activities. Category II
2. Exhaust all veterinary facility, equipment, and instrument options
3. Ensure that the care of the animal is supervised by a l

B. When animals are treated in human health-care facilities, avoid treating anima
invasive procedures are performed (e.g., cardiac catheterization laborator
C. Schedule the animal procedure for the last procedure of the day in the area, at a
vicinity. Category II
D. Adhere strictly to standard precautio
E. Clean and disinfect environmental surfaces thoroughly by using an EPA-reg
removed. Category II
F. Allow sufficient ACH to clean the air and help remove airborne dander, m
G. Clean and disinfect using EPA-registered products or sterilize equipment tha
equipment. Category I
H. If reusable medical or surgical instruments are used in an animal procedure,
Category II
VI. Research Animals in Health-Care
A. Use animals obtained from quality stock, or quarantine incoming an
B. Treat sick animals or remove them from th
C. Provide prophylactic vaccinations, as available, to animal handl
D. Ensure proper ventilation through appropriate facility design and location (*399*
USC 2131)

1. Keep animal rooms at negative pressure relative to corridors
2. Prevent air in animal rooms from recirculating elsewhere in the health-c

E. Keep doors to animal research rooms cl
F. Restrict access to animal facilities to essential
G. Establish employee occupational health programs specific to the animal resear
procedures specific to zoonoses with occupational health clinics in the health-c
Health and Human Services [DHHS]: Biosafety in Microbiological and Biomedi
139)
H. Document standard operating procedures for the unit (*4*
I. Conduct routine employee training on worker safety concerns relevant to the a

animal handling) (*400,401*). Category IC (DHHS: BMBL;

J. Use precautions to prevent development of animal-induced asthma in an

Recommendations --- Regulated Medic

I. Categories of Regulated Medical

A. Designate the following as major categories of medical waste that require spe laboratory wastes [e.g., cultures and stocks of microorganisms]; 2) bulk blood, b pathology and anatomy waste; and 4) sharps [e.g., needl

B. Consult federal, state, and local regulations to determine if other waste items Category IC (States; OSHA: 29 CFR 1910.1030 § g.2.1; Department of Trans CO23.8)

II. Disposal Plan for Regulated Medic

A. Develop a plan for the collection, handling, predisposal treatment, and terminal IC (States; OSHA: 29 CFR 1910.1

B. Designate a person or persons as responsible for establishing, monitoring,

III. Handling, Transporting, and Storing Regula

A. Inform personnel involved in handling and disposal of potentially infective was are trained in appropriate handling and disposal methods (*293*). Ca

B. Manage the handling and disposal of regulated medical wastes generated in isol medical wastes from other patient-care are

C. Use proper sharps disposal strategies (*293*). Category IC (C

1. Use a sharps container capable of maintaining its impermeability after waste final disposal (*293*). Category IC (O 1910.1030 § d.4.iii.A

2. Place disposable syringes with needles, including sterile sharps that are bei puncture-resistant containers locat practical to the point of use (*293*). Category IC (OSH

3. Do not bend, recap, or break used syringe needles before discarding them int 1910.1030 § d.2.vii and § d.2

D. Store regulated medical wastes awaiting treatment in a properly ventilated area prevent development of noxious odors. C

E. If treatment options are not available at the site where the medical waste is g impervious containers to the on-site treatment location or to another facilit

IV. Treatment and Disposal of Regulated M

A. Treat regulated medical wastes by using a method (e.g., steam sterilization technology) approved by the appropriate authority having jurisdiction (A Administration) before disposal in a sanitary landfi

B. Follow precautions for treating microbiologic wastes (e.g., amplified cultures an BMBL)

1. Biosafety level 4 laboratories must inactivate microbiologic wastes in the lab
autoclaving) before transport to and
sanitary landfill (*400*). Category IC
2. Biosafety level 3 laboratories must inactivate microbiologic wastes in the lab
autoclaving) or incinerate them at
before transport to and disposal in a sanitary landfill (

C. Biosafety levels 1 and 2 laboratories should develop strategies to inactivate an
approved inactivation method (e.g., autoclaving) instead of packaging and ship
and disposal (*400,406--408*). Ca
D. Laboratories that isolate select agents from clinical specimens must comply wit
and appropriate disposal of these agents (*409*). Category
E. Sanitary sewers may be used for safe disposal of blood, suctioned fluids, groun
sewage discharge requirements are met and that the state has declared this to

V. Special Precautions for Wastes Generated During Care

A. When discarding items contaminated with blood and body fluids from VHF pati
agitation during handling (*36,109*).
B. Manage properly contained wastes from areas providing care to VHF patients
areas (Regulated Medical Waste: III B) (*36,*
C. Decontaminate bulk blood and body fluids from VHF patients by using appro
treatment) before disposal (*36,109*). Cate
D. When discarding regulated medical waste generated during the routine (i.e., no
decontaminate them by using approved inactivation methods (e.g., autoclaving o
(e.g., blood, sharps, or pathological waste) (*36,270,27*
E. Incinerate medical wastes (e.g., central nervous system tissues or contaminat
procedures of diagnosed or suspected CJD patie

References

1. The American Institute of Architects and The Facilities Guidelines Institute. Gu
care facilities, 2001. Washington, DC: American Inst
2. Arnow PM, Sadigh M, Costas C, Weil D, Chudy R. Endemic and epidemic
Aspergillus organisms. J Infect Dis 199
3. Streifel AJ. Design and maintenance of hospital ventilation systems and the prev
Mayhall, CG, ed. Hospital epidemiology and infection control. 2nd ed. Phila
4. Pittet D, Huguenin T, Dharan S, et al. Unusual cause of lethal pulmonary aspe
disease. Am J Respir Crit Care Med 1996
5. US Environmental Protection Agency, Office of Air and Radiation, and US Depa
of Occupational Safety and Health. Building air quality: a guide for building own
publication (NIOSH)91-114 and EPA/400/1--91/033. Available
6. Rao CY, Burge HA, Chang JC. Review of quantitative standards and guidelin
1996;46:899--908.
7. Beck-Sagué CM, Dooley SW, Hutton MD, et al. Hospital outbreak of multidrug-

transmission to staff and HIV-infected patients.
8. Dooley SW, Villarino ME, Lawrence M, et al. Nosocomial transmission of tuber
1992;267:2632--4.
9. Sarubbi FA Jr, Kopf HB, Wilson MB, McGinnis MR, Rutala WA. Increased r
during hospital construction. Am Rev Resp
10. Streifel AJ, Stevens PP, Rhame FS. In-hospital source of airborne *Penici*
11. Hansen W. The need for an integrated indoor air quality program. In: Hansen
care organizations. Oakbrook Terrace, IL: Joint Commission on Accredit
12. Bartley J. Ventilation. In: Pfeiffer J, ed. APIC text of infection control and epid
in Infection Control and Epidemiology, Inc (A
13. Bartley J. Construction and renovation. In: Pfeiffer J, ed. APIC text of infectio
for Professionals in Infection Control and Epidemiolo
14. Harvey MA. Critical-care--unit bedside design and furnishing: impact on n
1998;19:597--601.
15. Infection Control Focus Group. Patient care focus groups 1998: assessing orga
construction, renovation, and physical plant projects. National Associatio
16. Carter CD, Barr BA. Infection control issues in construction and renovati
17. Coronado VG, Beck-Sagué CM, Hutton MD, et al. Transmission of multidrug-r
human immunodeficiency virus infection in an urban hospital: epidemiologic a
Infect Dis 1993;168:1052-
18. Coronado VG, Valway S, Finelli L, et al. Nosocomial transmission of multidrug
drug users with human immunodeficiency virus infection [Abstract S50]. In: A
Hospital Epidemiology of America. Chicago, IL. Infect Co
19. Edlin BR, Tokars JI, Grieco MH, et al. An outbreak of multidrug-resistant tub
immunodeficiency syndrome. N Engl J Me
20. Fischl MA, Uttamchandani RB, Daikos GL, et al. An outbreak of tuberculosis a
patients with HIV infection. Ann Intern M
21. Ikeda RM, Birkhead GS, DeFerdinando Jr GT, et al. Nosocomial tuberculosis
Control Hosp Epidemiol 1995;1
22. Jarvis WR. Nosocomial transmission of multidrug-resistant *Mycobacter*
23. Jarvis WR. Nosocomial transmission of multidrug-resistant *Mycobacteriu*
24. Jereb JA, Klevens RM, Privett TD, et al. Tuberculosis in health care worker
Mycobacterium tuberculosis. Arch Intern M
25. Moran GJ, McCabe F, Morgan MT, Talan DA. Delayed recognition and infe
department. Ann Emerg Med 199
26. Pearson ML, Jereb JA, Frieden TR, et al. Nosocomial transmission of multidru
and health care workers. Ann Intern Me
27. CDC. Guidelines for prevention of nosocomial pneumonia
28. Ko G, Burge HA, Muilenberg M, Rudnick S, First M. Survival of mycobact
1998;3:65--78.
29. Gage AA, Dean DC, Schimert G, Minsley N. *Aspergillus* infection aft

30. Vargo JA, Ginsberg MM, Mizrahi M. Human infestation by the pigeon mi
31. National Air Duct Cleaners Association. NADCA general specifications for the c
-06. Washington, DC: National Air Duct Cleaners Association, 2002. Availab
32. US Environmental Protection Agency, Office of Pesticide Progams. Use of c
conditioning, and refrigeration systems [Letter]. March 14, 2002. Avai
33. Rutala WA, Jones SM, Worthington JM, Reist PC, Weber DJ. Efficacy of porta
size range of *Mycobacterium tuberculosis*. Infect Contro
34. CDC. Guidelines for preventing the transmission of *Mycobacterium tuberculos*
35. American Society of Heating, Refrigerating and Air-Conditioning Engineers, I
GA, 1999; ASHRAE Standard
36. Garner JS, Hospital Infection Control Practices Advisory Committee. Guideline
Epidemiol 1996;17:53--8
37. CDC. Guidelines for preventing opportunistic infections among hematopoietic
10).
38. Flynn PM, Williams BG, Hethrington SV, Williams BF, Giannini MA, Pearson T
Infect Control Hosp Epidemiol 19
39. Tabbara KF, Al Jabarti A. Hospital construction-associated outbreak of ocul
1998;105:522--6.
40. Rhame FS, Streifel AJ, Kersey JH Jr, McGlave PB. Extrinsic risk factors for pn
1984;76:42--52.
41. Wells WF. Aerodynamics of droplet nuclei [Chapter 3]. In: Wells WF. Airbor
University Press, 1955:13
42. CDC. Epidemiologic notes and reports: nosocomial transmission of multidru
Florida and New York, 1988--1991. MMW
43. CDC. Outbreak of multidrug-resistant tuberculosis at a hospital --- N
44. Gerson SL, Parker P, Jacobs MR, Creger R, Lazarus HM. Aspergillosis due
Epidemiol 1994;15:221--
45. Joint Commission on Accreditation of Healthcare Organizations. 2001 hospital
Press, 2001:193--220.
46. Fridkin SK, Kremer FB, Bland LA, Padhye A, McNeil MM, Jarvis WR. *Acremo*
extraction in an ambulatory surgical center and was traced to an enviro
47. Streifel AJ. Maintenance and engineering. In: Pfeiffer J, ed. APIC text of i
Association for Professionals in Infection Control and E
48. Weems JJ Jr, Davis BJ, Tablan OC, Kaufman L, Martone WJ. Construction act
and zygomycosis in patients with hematologic malignan
49. Krasinski K, Holzman RS, Hanna B, Greco MA, Graff M, Bhogal M. Nosoco
Control 1985;6:278--82
50. Bartley JM. APIC state-of-the-art report: the role of infection control during c
2000;28:156--69.
51. Walsh TJ, Dixon DM. Nosocomial aspergillosis: environmental microbiology
Epidemiol 1989;5:131--4

52.Johnson MW, Mitch WE, Heller AH, Spector R. The impact of an educational
Med 1982;73:9--14.
53.Soumerai SB, Salem-Schatz S, Avorn J, Casteris CS, Ross-Degnan D, Popovsky
blood transfusion practice. JAMA 19
54.Eisenberg JM. An educational program to modify laboratory use
55.Rello J, Quintana E, Ausina V, Puzo V, Puzo C, Net A, Prats G. Risk factors for
ill patients. Am Rev Respir Dis 199(
56.McWhinney PHM, Kibbler CC, Hamon MD, et al. Progress in the diagnos
transplantation: 13 years' experience. Clin Infe
57.Pannuti CS, Gingrich RD, Pfaller MA, Wenzel RP. Nosocomial pneumonia in a
9-year study. J Clin Oncol 1991
58.Wingard JR, Beals SU, Santos GW, Mertz WG, Saral R. *Aspergillus* infectior
Transplant 1987;2:175--8
59.Gerson SL, Talbot GH, Hurwitz S, Strom BL, Lusk EJ, Cassileth PA. Prolong
pulmonary aspergillosis in patients with acute leukemia.
60.Lentino JR, Rosenkranz MA, Michaels JA, Kurup VP, Rose HD, Rytel MW. No
disease secondary to road construction and contaminated air cond
61.Streifel AJ, Lauer JL, Vesley D, Juni B, Rhame FS. *Aspergillus fumigatus* and o
demolition. Appl Environ Microbiol
62.Thio CL, Smith D, Merz WG, et al. Refinements of environmental assessment du
a leukemia and bone marrow transplant unit. Infect Cont
63.Mermel LA, Josephson SL, Giorgio CH, Dempsey J, Parenteau S. Association of
potable water? Infect Control Hosp Epider
64.Arnow PM, Anderson RL, Mainous PD, Smith EJ. Pulmonary aspergillosis dur
53.
65.Kuehn TH, Gacek B, Yang CH, et al. Identification of contaminants, exposures
activities (RP-804). ASHRAE Transactior
66.Opal SM, Asp AA, Cannady PB Jr, Morse PL, Burton LJ, Hammer PG II. Eff
outbreak of disseminated aspergillosis associated with hospital c
67.Association for Professionals in Infection Control and Epidemiology, Educatior
construction and renovation. Bartley J, ed. Washington DC: Association for Pr
68.Ottney TC. Particle management for HVAC system
69.Finkelstein LE, Mendelson MH. Infection control challenges during he
70.Overberger PA, Wadowsky RM, Schaper MM. Evaluation of airborne particu
Assoc J 1995;56:706--12
71.Streifel AJ, Marshall JW. Parameters for ventilation controlled environments
healthy buildings (IAQ/1997). Atlanta, GA:
72.American Society of Heating, Refrigerating, and Air-Conditioning Engineers (A
Guideline 1-1996. Atlanta, GA: ASHR
73.Morey R, Williams C. Porous insulation in buildings: a potential source of r
International Conference. Toronto, Canada: International Societ

74. Aisner J, Murillo J, Schimpff SC, Steere AC. Invasive aspergillosis in acute leu
Ann Intern Med 1979;90:4
75. McCarty JM, Flam MS, Pullen G, Jones R, Kassel SH. Outbreak of primary cu
Pediatr 1986;108(Pt.1):72
76. Klimowski LL, Rotstein C, Cummings KM. Incidence of nosocomial aspergillo
Infect Control Hosp Epidemiol 198
77. Pfundstein J. *Aspergillus* infection among solid organ transplant recipie
78. Rhame FS, Streifel A, Stevens P, et al. Endemic *Aspergillus* airborne spore level
transplant (BMT) patients [Abstract]. In: Program and abstracts of the 25th
Chemotherapy. Minneapolis, MN: American Soci
79. Walmsley S, Devi S, King S, Schneider R, Richardson S, Ford-Jones L. Invasiv
review. Pediatr Infect Dis J 1993;
80. Kyriakides GK, Zinneman HH, Hall WH, et al. Immunologic monitoring an
1976;131:246--52.
81. Abzug MJ, Gardner S, Glode MP, Cymanski M, Roe MH, Odom LF. Helipor
Control Hosp Epidemiol 1992;1
82. Sherertz RJ, Belani A, Kramer BS, et al. Impact of air filtration on nosocom
transplant recipients. Am J Med 198
83. Aisner J, Schimpff SC, Bennett JE, Young VM, Wiernik PH. *Aspergillus* infe
materials in a new hospital. JAMA 19
84. Fox BC, Chamberlin L, Kulich P, Rae EJ, Webster LR. Heavy contamination o
of the source and attempts at decontamination. Am J
85. Barnes RA, Rogers TR. Control of an outbreak of nosocomial aspergillosis by
86. Leenders A, VanBelkum A, Janssen S, et al. Molecular epidemiology of apparen
J Clin Microbiol 1996;34:34
87. Yeager CC. Copper and zinc preservatives [Chapter 21]. In: Block SS, ed. Disinf
PA: Lea and Febiger, 19
88. Allo MD, Miller J, Townsend T, Tan C. Primary cutaneous aspergillosis associ
1987;317:1105--8.
89. Schleupner CJ, Hamilton JR. A pseudoepidemic of pulmonary fungal infecti
1980;1:38--42.
90. Denning DW, Clemons KV, Hanson LH, Stevens DA. Restriction endonucleas
isolates of geographically and epidemiologically diverse or
91. James MJ, Lasker BA, McNeil MM, Shelton M, Warnock DW, Reiss E. Use of a
isolates of *Aspergillus flavus* from a cluster of cutaneous infections in a neonat
92. Skladny H, Buchheidt D, Baust C, et al. Specific detection of *Aspergillus* sp
immunocompromised patients by two-step PCR. J Cl
93. Symoens F, Bouchara JP, Heinemann S, Nolard N. Molecular typing of *As*
polymorphic DNA. J Hosp Infect 20
94. Diaz-Guerra TM, Mellado E, Cuenca-Estrella M, Gaztelurrutia L, Navarro JI, T
strain isolated from a patient who underwent heart surgery and two environn

Microbiol 2000;38:2419--
95. Siegler L, Kennedy MJ. *Aspergillus, Fusarium*, and other opportunistic moni
Tenover FC, Yolken RH, eds. Manual of clinical microbiology. 7th ed. Washi
1999:1212--41.
96. Breton P, Germaud P, Morin O, Audouin AF, Milpied N, Harousseau JL. Un
disease [French]. Rev Pneumol Clin 1
97. Guarro J, Nucci M, Akiti T, Gené J, Barreiro MD, Gonçalves RT. Fungemia du
Clin Microbiol 2000;38:419
98. Burton JR, Zachery JB, Bessin R, et al. Aspergillosis in four renal transpl
amphotericin B. Ann Intern Med 19
99. Buckner CD, Clift RA, Sanders JE, et al. Protective environment for marrow tr
1978;89:893--901.
100. Murray WA, Streifel AJ, O'Dea TJ, Rhame FS. Ventilation for protection
1988;94:1185--91.
101. Streifel AJ, Vesley D, Rhame FS, Murray B. Control of airborne fungal s
1989;15: 221--7.
102. Rhame FS. Endemic nosocomial filamentous fungal disease: a prop
environmental hazard. Infect Control 198
103. American Society of Heating, Refrigerating, and Air-Conditioning Engin
and air-conditioning applications. Health care facilities [Chapter 7]. Atlanta G
Conditioning Engineers, Inc.
104. Mahoney DH Jr, Steuber CP, Starling KA, Barrett FF, Goldberg J, Fer
acute leukemia. J Pediatr 1979;
105. Ehrenkranz NJ, Kicklighter JL. Tuberculosis outbreak in a general hospi
Med 1972;77:377--82.
106. Calder RA, Duclos P, Wilder MH, Pryor VL, Scheel, WJ. *Mycobacterium*
Tuberc Lung Dis 1991;66:1
107. Jereb JA, Burwen DR, Dooley SW, et al. Nosocomial outbreak of tube
technique for restriction fragment length polymorphism analysis of *Mycobacte*
108. Monath TP. Yellow fever: Victor, Victoria? Conqueror, conquest? Epide
the future. Am J Trop Med Hyg 19
109. CDC. Update: Management of patients with suspected viral hemorrh
110. Weber DJ, Rutala WA. Risks and prevention of nosocomial transmission
111. Gerberding JL. Nosocomial transmission of opportunistic infectio
112. Vargas SL, Ponce CA, Gigliotti F, et al. Transmission of *Pneumocystis c*
immunocompetent contact health care workers. J Cl
113. Walzer PD. *Pneumocystis carinii* [Chapter 260]. In: Mandell GL, Benne
diseases. 5th ed. Philadelphia, PA: Churchill Liv
114. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR, Hospital In
for prevention of surgical site infection, 1999. Infect Contr
115. Lidwell OM. Clean air at operation and subsequent sepsis

116. Nichols RL. The operating room [Chapter 22]. In: Bennett JV, Brachma
Brown and Company, 1992:4
117. Clark RP, Reed PJ, Seal DV, Stephenson ML. Ventilation conditions an
proposed safe economies. J Hyg (Lond)
118. Babb JR, Lynam P, Ayliffe GAJ. Risk of airborne transmission in an ope
Infect 1995;31:159--68
119. Laufman H. The operating room [Chapter 20]. In: Bennett JV, Brachma
Brown and Company,1986:3
120. Ad Hoc Committee of the Committee on Trauma, Division of Medical Scie
Council. Postoperative wound infections: the influence of ultraviolet irradiation
Surg 1964;160(suppl):1--1
121. Charnley J. A clean-air operating enclosure
122. Lidwell OM, Lowbury EJ, Whyte W, Blowers R, Stanley SJ, Lowe D. Eff
the joint after total hip or knee replacement: a randomise
123. Hill C, Flamant R, Mazas F, Evrard J. Prophylactic cefazolin versus pl
double-blind randomised trial. Lance
124. Ha'eri GB, Wiley AM. Total hip replacement in a laminar flow environm
1980;148:163--8.
125. Collins DK, Steinhaus K. Total hip replacement without deep infection
1976;58:446--50.
126. Taylor GJ, Bannister GC, Leeming JP. Wound disinfection with u
127. Ayliffe GA. Role of the environment of the operating suite in surgical wo
128. Choux M, Genitori L, Lang D, Lena G. Shunt implantation: reducing the
129. Occupational Safety and Health Administration. 29 CFR 1910.139. Resp
130. Langevin PB, Rand KH, Layton AJ. The potential for dissemination of *My*
circuit. Chest 1999;115:110
131. Occupational Safety and Health Administration. 29 CFR 1910. Occupa
Register 1997;62:54159--2
132. Aranha-Creado H, Prince D, Greene K, Brandwein H. Removal of *Mycobe*
Hosp Epidemiol 1997;18:25
133. Burroughs HE. Sick building syndrome: fact, fiction, or facility? In: Ha
health care organizations. Oakbrook Terrace, IL: Joint Commission on Acc
134. Anderson K, Morris G, Kennedy H, et al. Aspergillosis in immunocomp
hygiene, design, and indoor air. Thorax
135. National Institute for Occupational Safety and Health. Control of smok
publication no. (NIOSH) 96--128. Available at http://
136. Association of Perioperative Registered Nurses. Recommended practices f
4, 267--9.
137. Hughes PS, Hughes AP. Absence of human papillomavirus DNA in the
Dermatol 1998;38:426--
138. Capizzi PJ, Clay RP, Battey MJ. Microbiologic activity in laser resurfac

139. Emergency Care Research Institute (ECRI). Surgical smoke eva
140. ECRI. Update evaluation: surgical smoke evacuation sy
141. ECRI. Stationary surgical smoke evacuation syste
142. Villarino ME, Stevens LE, Schable B, et al. Risk factors for epidemic *Xa*
care unit patients. Infect Control Hosp Epid
143. Seifert H, Strate A, Pulverer G. Nosocomial bacteremia due to *Acineto*
predictors of mortality. Medicine (Baltim
144. Yu VL. *Serratia marcescens*: historical perspective and clini
145. Go ES, Urban C, Burns J, et al. Clinical and molecular epidemiology of *A*
sulbactam. Lancet 1994;344:1
146. Boyce JM, Pittet D. Guideline for hand hygiene in health-care settings:
Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hyg
(suppl):S3--40.
147. Burdge DR, Nakielna EM, Noble MA. Case-control and vector studies of
patients with cystic fibrosis. Infect Control Hosp
148. Cox R, deBorja K, Bach MC. A pseudo-outbreak of *Mycobacterium che*
Hosp Epidemiol 1997;18:13
149. Hoy J, Rolston K, Hopfer RL. Pseudoepidemic of *Mycobacterium fort*
1987;15:268--71.
150. Stine TM, Harris AA, Levin S, Rivera N, Kaplan, RL. A pseudoepidemic
JAMA 1987;258:809--1
151. Bennett SN, Peterson DE, Johnson DR, Hall WN, Robinson-Dunn B, Die
pseudoinfections. Am J Respir Crit Care M
152. Hlady WG, Mullen RC, Mintz CS, Shelton BG, Hopkins RS, Daikos GL.
fountain by molecular epidemiology. Am J Epi
153. American Society of Heating, Refrigerating, and Air-Conditioning Engi
risk of legionellosis associated with building water systems. A
154. Snyder MB, Siwicki M, Wireman J, et al. Reduction of *Legionella pneu*
supplemental chlorination of hospital hot water. J
155. Ezzeddine H, Van Ossel C, Delmée M, Wauters G. *Legionella* spp. in a hos
Infect 1989;13:121--31
156. Joint Commission on Accreditation of Healthcare Organizations. Compr
handbook. Oakbrook Terrace, IL: JCA
157. Juranek DD, Addiss DG, Bartlett ME, et al. Crytosporidiosis and public
Works Association 1995;87:
158. Tokars JI, Miller ER, Alter MJ, Arduino MJ. National surveillance of dia
Dial 2000;13:75-85.
159. Vujanovic V, Smoragiewicz W, Krzysztyniak K. Airborne fungal ecolo
indirect mycotoxin risk assessment in indoor air. E
160. Vesper S, Dearborn DG, Yike I, et al. Evaluation of *Stachybotrys chartaru*
quantitative assessment before, during, and after remediat

161. Best M, Yu VL, Stout J, Goetz A, Muder RR, Taylor F. Legionellaceae in and evaluation of a method for control of nosocomial Legionnaires' disease
162. Meenhorst PL, Reingold AL, Groothuis DG, et al. Water-related nosc serogroups 1 and 10. J Infect Dis 198
163. Johnston JM, Latham RH, Meier FA, et al. Nosocomial outbreak of Leg control measures. Infect Control 1
164. Muraca PW, Yu VL, Goetz A. Disinfection of water distribution system methodologies. Infect Control Hosp Epide
165. Johnson JT, Yu VL, Best MG, et al. Nosocomial legionellosis in surgica epidemiological reservoir and mode of transmissi
166. Marrie TJ, MacDonald S, Clarke K, Haldane D. Nosocomial legionnaires' Infect Control 1991;19:79-
167. Marrie TJ, Haldane D, Bezanson G, Peppard R. Each water outlet is Epidemiol Infect 1992;108:2
168. Department of Health and Social Security and the Welsh Office. The c practice. London: Her Majesty's Statio
169. Helms CM, Massanari RM, Wenzel RP, et al. Legionnaires' disease asso report on continuous hyperchlorination. JA
170. Edelstein PH, Whittaker RE, Kreiling RL, Howell, CL. Efficacy of ozon plumbing fixtures. Appl Environ Microbi
171. Muraca P, Stout JE, Yu VL. Comparative assessment of chlorine, heat, within a model plumbing system. Appl Environ
172. Domingue EL, Tyndall RL, Mayberry WR, Pancorbo OC. Effects of thre 1. Appl Environ Microbiol 1988;
173. Landeen LK, Yahya MT, Gerba CP. Efficacy of copper and silver ion *Legionella pneumophila.* Appl Environ Micro
174. Matulonis U, Rosenfeld CS, Shadduck RK. Prevention of *Legionella* in approach to decontamination of a water system. Infect Con
175. Liu Z, Stout JE, Tedesco L, et al. Controlled evaluation of copper-silver hospital water distribution system. J Infect
176. Margolin AB. Control of microorganisms in source water and drinking w MJ, Stetzenback LD, Walter MV, eds. Manual of environmental microbiology Press, 1997:195--202.
177. Freije MR. *Legionella* control in health care facilities: a guide for minim Inc., 1996:65--75.
178. Lin YE, Vidic RD, Stout JE, Yu VL. *Legionella* in water distribution syste key to successful disinfection. Journal of the American Wate
179. Biurrun A, Caballero L, Pelaz C, León E, Gago A. Treatment of a *Legio* using copper-silver ionization and continuous chlorination. Infec
180. Goetz A, Yu VL. Copper-silver ionization: Cautious optimism for *Legi* culturing. Am J Infect Control 1997

181. Stout JE, Lin EY, Goetz AM, Muder RR. Controlling *Legionella* in hospit
method and copper-silver ionization. Infect Control H
182. Walker JT, Mackerness CW, Mallon D, Makin T, Williets T, Keevil CW
system by chlorine dioxide. J Ind Microbi
183. Hambidge A. Reviewing efficacy of alternative water treatment t
184. Rohr U, Senger M, Selenka F, Turley R, Wilhelm M. Four years of experi
in a German university hospital hot water plumbing syste
185. Cunliffe DA. Inactivation of *Legionella pneumophila* by monc
186. Kirmeyer GJ, Foust GW, Pierson GL, Simmler JJ, LeChevalier MW. O
Water Works Research Foundat
187. Kool JL, Carpenter JC, Fields BS. Effect of monochloramine disinfect
Legionnaires' disease. Lancet 1999
188. Kool JL, Bergmire-Sweat D, Butler JC, et al. Hospital characteristics ass
and risk of nosocomial Legionnaires' disease: a cohort study of 15 hospital
189. Kool JL, Fiore AE, Kioski CM, et al. More than 10 years of unrecognized
transplant patients. Infect Control Hosp Epid
190. Le Saux NM, Sekla L, McLeod J, et al. Epidemic of nosocomial Legionna
and environmental study. CMAJ 198
191. Kugler JW, Armitage JO, Helms CM, et al. Nosocomial Legionnaires' dise
Am J Med 1983;74:281--
192. Marston BJ, Lipman HB, Breiman RF. Surveillance for Legionnaires' dise
Med 1994;154:2417--22
193. Haley CE, Cohen ML, Halter J, Meyer RD. Nosocomial Legionnaires' dise
Medical Center. Ann Intern Med 19
194. Jimènez ML, Aspa J, Padilla B, et al. Fiberoptic bronchoscopic diagnosis
pneumonitis. Eur J Clin Microbiol Infect
195. Bock BV, Kirby BD, Edelstein PH, et al. Legionnaires' disease in
196. Kirby BD, Snyder KM, Meyer RD, Finegold SM. Legionnaires' disease: r
of the literature. Medicine (Baltimore) 1
197. Brady MT. Nosocomial legionnaires disease in a childre
198. Muder RR, Yu VL, McClure JK, Kroboth FJ, Kominos SD, Lumish I
prospective pneumonia study: implications for underdia
199. Garbe PL, Davis BJ, Weisfeld JS, et al. Nosocomial Legionnaires' disea
source. JAMA 1985;254:52
200. Hanrahan JP, Morse DL, Scharf VB, et al. A community hospital outbreal
Epidemiol 1987;125:639--
201. Arnow PM, Chou T, Weil D, Shapiro EN, Kretzschmar C. Nosocomial Le
respiratory devices. J Infect Dis 198
202. Mastro TD, Fields BS, Breiman RF, Campbell J, Plikaytis BD, Spika JS.
nebulizers. J Infect Dis 1991;163
203. Dondero TJ Jr, Rendtorff RC, Mallison GF, et al. An outbreak of Leg

conditioning cooling tower. N Engl J Mec
204. O'Mahony MC, Stanwell-Smith RE, Tillett HE, et al. The Stafford
1990;104:361--80.
205. Breiman RF, Fields BS, Sanden G, Volmer L, Meier A, Spika JS. Associat
of amoebae. JAMA 1990;263:
206. Breiman RF, VanLoock FL, Sion JP, et al. Association of "sink bathing"
abstracts of the 91st General Meeting of the American Society for Microbiolog
207. Struelens MJ, Maes N, Rost F, et al. Genotypic and phenotypic metl
pneumophila outbreak and efficacy of control measur
208. Barbaree JM, Gorman GW, Martin WT, Fields BS, Morrill WE. Protoc
Environ Microbiol 1987;53:1
209. Schoonmaker D, Heimberger T, Birkhead G. Comparison of ribotypin
electrophoresis for distinguishing *Legionella pneumophila* isolates obtained duri
8.
210. Knirsch CA, Jakob K, Schoonmaker D, et al. An outbreak of *Legionella*
molecular epidemiology, and control. Am J
211. CDC. Sustained transmission of nosocomial Legionnaires Disease
212. Alary M, Joly JR. Factors contributing to the contamination of hospital
1992;165:565--9.
213. Yu VL, Beam TR Jr, Lumish RM, et al. Routine culturing for *Legionella*
hospital prospective study. Am J Med S
214. Tobin JO, Swann RA, Bartlett CL. Isolation of *Legionella pneumophila* f
Med J 1981;282:515--7
215. Chow JW, Yu VL. Legionella: a major opportunistic pathogen in tran
216. Mandel AS, Sprauer MA, Sniadack DH, Ostroff SM. State regulation of h
1993;14:642--5.
217. Hirani NA, Macfarlane JT. Impact of management guidelines on the out
1997;52:17--21.
218. Patterson WJ, Hay J, Seal DV, McLuckie JC. Colonization of transpl
precautions required to reduce the risk of legionellos
219. Marrie TJ, Haldane D, MacDonald S, et al. Control of endemic nosocomi
high risk patients. Epidemiol Infect 19
220. Zuravleff JJ, Yu VL, Shonnard JW, Rihs JD, Best M. *Legionella p*
demonstration of aerosol transmission and subsequent subclinical infection in e
221. World Health Organization, Regional Office for Europe. Environmental a
Ver Wasser Boden Lufthyg 1993;
222. Bhopal RS, Barr G. Maintenance of cooling towers following two outbr
1990;104:29--38.
223. World Health Organization. Epidemiology, prevention, and control of
World Health Organ 1990;68:
224. Bolan G, Reingold AL, Carson LA, et al. Infections with *Mycobacterium c*

hemodialyzers. J Infect Dis 1985;1
225. Lowry PW, Beck-Saguè CM, Bland LA, et al. *Mycobacterium chelonae* i
hemodialysis clinic in California. J Infect I
226. Favero MS, Petersen NJ, Boyer KM, Carson LA, Bond WW. Microbial
health risks. Trans Am Soc Artif Intern Or
227. Favero MS, Petersen NJ, Carson LA, Bond WW, Hindman SH. Gram-ne
Sci 1975;12:321--34.
228. Favero MS, Petersen NJ. Microbiologic guidelines for hemodia
229. Association for the Advancement of Medical Instrumentation and Ameri
ANSI/AAMI RD5-1992. Arlingtor
230. Association for the Advancement of Medical Instrumentation, America
ANSI/AAMI RD47-1993. Arlingto
231. Petersen NJ, Boyer KM, Carson LA, Favero MS. Pyrogenic reactions fr
system. Dialysis Transpl 1978;
232. Dawids SG, Vejlsgaard R. Bacteriological and clinical evaluation of
1976;199:151--5.
233. Kidd EE. Bacterial contamination of dialyzing fluid of a
234. Klein E, Pass T, Harding GB, Wright R, Million C. Microbial and endot
United States. Artif Organs 1990
235. Man NK, Degremont A, Darbord JC, Collet M, Vaillant P. Evidence of
hemodialysis system. Artif Organs 19
236. Association for the Advancement of Medical Instrumentation. Wate
ANSI/AAMI RD62--2001. American National Standards
237. Bland LA. Microbiological and endotoxin assays of hemodialys
238. Arduino MJ, Bland LA, Aguero SM, Carson LA, Ridgeway M, Favero
hemodialysis fluids. J Clin Microbiol
239. Bland LA, Ridgeway MR, Aguero SM, Carson LA, Favero MS. Potential
bicarbonate concentrate. ASAIO Trans
240. Raij L, Shapiro FL, Michael AF. Endotoxemia in febrile reaction
241. Bommer J, Becker KP, Urbaschek R. Potential transfer of endotoxin acr
1996;7:883--8.
242. Arduino MJ, Favero MS. Microbiologic aspects of hemodialysis. Arlin
Instrumentation, 1998. AAMI monogra
243. Koepke GH, Christopher RP. Contamination of whirlpool baths during
1965;46:261--3.
244. CDC. Epidemiologic notes and reports: outbreak of viral gastroenteritis -
245. Crow HE, Corpe RF, Smith CE. Is serious pulmonary disease caused by n
communicable? Dis Chest 1961;3
246. Stout JE, Yu VL, Muraca P. Isolation of *Legionella pneumophila* from t
origin and transmission of the organism. Infec
247. Manangan LP, Anderson RL, Arduino MJ, Bond WW. Sanitary care

machines in health care facilities. Am J Infect
248. Cannon RO, Poliner JR, Hirschhorn RB, et al. A multistate outbreak of N
of commercial ice. J Infect Dis 199
249. Khan AS, Moe CL, Glass RI, et al. Norwalk virus-associated gastroent
Hawaii: comparison and application of molecular method-based
250. Schmidt OW, Cooney MK, Foy HM. Adeno-associated virus in adenovir
251. McCandlish R, Renfrew M. Immersion in water during labor and l
252. White CG. Chemistry of chlorination [Chapter 4]. In: Handbook of Chlo
NY: Van Nostrand Reinhold, 199
253. Muscarella LF. Automatic flexible endoscope reprocessors. Ga
254. Muscarella LF. Anticipated reliability of liquid chemical sterilan
255. Muscarella LF. Déjà vu . . . all over again? The importance of instru
2000;21:628--9.
256. Gubler JG, Salfinger M, von Graevenitz A. Pseudoepidemic of nontuberc
cleaning machine: report of an outbreak and review of the
257. Fraser VJ, Jones M, Murray PR, Medoff G, Zhang Y, Wallace RJ Jr. C
Mycobacterium chelonae linked to an automated bronchoscope disinfect
258. Muscarella LF. Application of environmental sampling to flexible endosc
water. Infect Control Hosp Epidemiol
259. Cooke RP, Whymant-Morris A, Umasankar RS, Goddard SV. Bacteria-fr
dream? J Hosp Infect 1998;3
260. Allen JJ, Allen MO, Olsen MM, et al. *Pseudomonas* infection of the bi
endoscope. Gastroenterology 1987
261. Michele TM, Cronin WA, Graham NM, et al. Transmission of *Myco*
identification by DNA fingerprinting. JAM
262. US Food and Drug Administration, CDC. Public health advisory: infec
automated endoscope reprocessing system. September 10, 1999. Available a
263. Alvarado CJ, Reichelderfer M. APIC guideline for infection prevention
2000;28:138--55.
264. CDC. Statement from CDC regarding biofilm and dental unit water qua
Services, Public Health Service, C
265. CDC. Recommended infection-control practices for dentistr
266. Office of Safety and Asepsis Procedures Research Foundation. Dental uni
Available at http://www.osap.org/issues/pa
267. US Environmental Protection Agency. National Primary Drinking Wa
Available at http://www.epa.gov/safev
268. Bagga BS, Murphy RA, Anderson AW, Punwani I. Contamination of de
prevention. JADA 1984;109:
269. Shearer BG. Biofilm and the dental office
270. Garner JS, Favero MS. CDC guideline for handwashing and hospital
271. US Environmental Protection Agency. Federal Insecticide, Fungicide, and

http://www4.law.cornell.edu/uscode/7
272. Mallison GF. Hospital disinfectants for housekeeping: flo
273. Favero MS, Bond WW. Chemical disinfection of medical and surgical
sterilization, and preservation. 5th ed. Philadelphia, PA: Li
274. Rutala WA. APIC guideline for selection and use of disinfec
275. Stingeni L, Lapomarda V, Lisi P. Occupational hand dermatitis in hos
276. Ashdown BC, Stricof DD, May ML, Sherman SJ, Carmody RF. Hy
neuroimaging findings. AM J Roentgeno
277. Busch A, Werner E. Animal tolerance to peracetic acid: experimental resu
the skin of pigs [German]. Monatshefte für Veteri
278. US Food and Drug Administration. Medical devices: adequate d
279. Favero MS, Bond WW. Sterilization, disinfection, and antisepsis in th
Herrmann KL, Isenberg HD, Shadomy HJ, eds. Manual of clinical microb
Microbiology, 1991:183--2
280. Chou T. Environmental Services. In: Pfeiffer J, ed. APIC text of infection
for Professionals in Infection Control and Epider
281. Rutala WA, Weber DJ. Cleaning, disinfection, and sterilization. In
Epidemiology. Washington, DC: Association for Professionals in Infecti
282. Ayliffe GA, Collins BJ, Lowbury EJ, Babb JR, Lilly HA. Ward floors an
(Lond) 1967;65:515--37
283. Dancer SJ. Mopping up hospital infection. J
284. Schmidt EA, Coleman DL, Mallison GF. Improved system for floor cle
1984;47:942--6.
285. Mallison GF. Decontamination, disinfection, and sterilizat
286. Walter CW, Kundsin RB. The floor as a reservoir of hospital in
287. Scott E, Bloomfield SF. The survival and transfer of microbial contam
1990;68:271--8.
288. Scott E, Bloomfield SF. Investigations of the effectiveness of detergent wa
of cleaning cloths. J Appl Bacteriol 19
289. Brown DG, Schatzle K, Gable T. The hospital vacuum cleaner: mechani
Health 1980;42:192--6
290. Wysowski DK, Flynt JW, Goldfield M, Altman R, Davis AT. Epidem
disinfectant detergent. Pediatrics 19
291. Doan HM, Keith L, Shennan AT. Phenol and neonata
292. American Academy of Pediatrics, American College of Obstetricians a
perinatal care. 4th ed. Washington, DC
293. US Department of Labor, Occupational Safety and Health Administ
bloodborne pathogens; final rule. Federal Regi
294. Spire B, Montagnier L, Barré-Sinoussi F, Chermann JC. Inactivatio
disinfectants. Lancet 1984;2:8
295. Martin LS, McDougal JS, Loskoski SL. Disinfection and inactiv

III/lymphadenopathy-associated virus. J Infe
296. Hanson PJ, Gor D, Jeffries DJ, Collins JV. Chemical inactivatio
297. Bloomfield SF, Smith-Burchnell CA, Dalgleish AG. Evaluation of hy
immunodeficiency virus (HIV). J Hosp In
298. Druce JD, Jardine D, Locarnini SA, Birch CJ. Susceptibility of HIV to i
Infect 1995;30:167--80
299. Van Bueren J, Simpson RA, Salman H, Farrelly HD, Cookson BD. Ina
hypochlorite. Epidemiol Infect 1995
300. Prince DL, Prince HN, Thraehart O, et al. Methodological approaches to
1993;31:3296--3304.
301. CDC. Recommendations for prevention of HIV transmission in he
302. Sattar SA, Springthorpe VS. Survival and disinfectant inactivation of th
Infect Dis 1991;13:430--4
303. US Department of Labor, Occupational Safety and Health Adminis
Memorandum. Washington, D.C.: 19
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERI
304. Weber DJ, Barbee SL, Sobsey MD, Rutala WA. The effect of blood on the
a quaternary ammonium compound. Infect Control I
305. Suzuki A, Namba Y, Matsuura M, Horisawa A. Bacterial contamination o
survey. J Hyg (Lond) 1984;93:
306. Richet H, McNeil M, Peters W, et al. *Aspergillus flavus* in a bone marro
hallway carpeting [Abstract F-23]. In: Abstracts of the 89th Annual Meeting of t
American Society for Microbiolog
307. US Department of Labor, Occupational Safety and Health Administratio
Standard interpretations, 1994. A
http://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=INTERPR
308. Taplin D, Mertz PM. Flower vases in hospitals as reservoi
309. Kates SG, McGinley KJ, Larson EL, Leyden JJ. Indigenous multiresis
environments. Am J Infect Control 1
310. Bartzokas CA, Holley MP, Sharp CA. Bacteria in flower vase water: incid
1975;62:295--7.
311. Siegman-Igra Y, Shalem A, Berger SA, Livio S, Michaeli D. Should potte
1986;7:82--5.
312. Lass-Flörl C, Rath P, Niederwieser D, et al. *Aspergillus terreus* infections
suggests association with in-hospital plants. J H
313. Burgess NR. Hospital design and cockroach control. Tra
314. Lukin LG. Human cutaneous myiasis in Brisbane: a prosp
315. Bruesch J. Institutional pest management: current trend
316. Allen BW. Excretion of viable tubercle bacilli by *Blatta orientalis* (the ori
smears: a laboratory investigation. Trans R Soc T
317. Laszlo A. Technical guide: sputum examination for tuberculosis by direct

International Union Against Tuberculosis and Lun
http://www.iuatld.org/pdf/en/guides_publicatio
318. CDC. Recommendations for preventing the spread of vancomycin resista
Practices Advisory Committee (HICPAC). MM
319. Gerding DN, Johnson S, Peterson LR, Mulligan ME, Silva J Jr. *Clostridiu*
Hosp Epidemiol 1995;16:45
320. Weber DJ, Rutala WA. Role of environmental contamination in the tr
Control Hosp Epidemiol 1997;1
321. Lai KK, Kelley AL, Melvin ZS, Belliveau PP, Fontecchio SA. Failure to
hospital and the cost of barrier precautions. Infect Contr
322. Byers KE, Durbin LJ, Simonton BM, Anglim AM, Adal KA, Farr B
vancomycin-resistant *Enterococcus faecium*. Infect Contr
323. Bradley CR, Fraise AP. Heat and chemical resistance of e
324. Anderson RL, Carr JH, Bond WW, Favero MS. Susceptibility of vancom
Infect Control Hosp Epidemiol 19
325. Saurina G, Landman D, Quale JM. Activity of disinfectants against van
Hosp Epidemiol 1997;18:34
326. Rutala WA, Stiegel MM, Sarubbi FA, Weber DJ. Susceptibility of antibio
disinfectants. Infect Control Hosp Epidem
327. Sehulster LM, Anderson RL. Susceptibility of glycopeptide-intermedi
disinfectants, hand washing chemicals, and a skin antiseptic [Abstract Y-3]. In:
for Microbiology. Atlanta, GA: American Societ
328. Layton MC, Perez M, Heald P, Patterson JE. An outbreak of mupirocin
associated with an environmental reservoir. Infect Contr
329. Karanfil LV, Murphy M, Josephson A, et al. A cluster of vancomycin-resis
Control Hosp Epidemiol 1992;13
330. Boyce JM, Opal SM, Chow JW, et al. Outbreak of multidrug-resistan
vancomycin resistance. J Clin Microbiol
331. Rhinehart E, Smith NE, Wennersten C, et al. Rapid dissemination of
Enterococcus faecalis among patients and staff on an infant-toddler s
332. Livornese LL Jr, Dias S, Samel C, et al. Hospital-acquired infection with v
electronic thermometers. Ann Intern Me
333. Zervos MJ, Kauffman CA, Therasse PM, Bergman AG, Mikesell TS, Sch
Streptococcus faecalis: an epidemiologic study. Ann
334. Worsley MA. Infection control and prevention of *Clostridium difficile* infe
66.
335. Lloyd-Evans N, Springthorpe VS, Sattar SA. Chemical disinfection of hu
(Lond) 1986;97:163--73
336. Rutala WA, Weber DJ. Creutzfeldt-Jakob disease: recommendations for d
-56.
337. Kimberlin RH, Walker CA, Millson GC, et al. Disinfection studies with tv

Creutzfeldt-Jakob and related agents. J Neur
338. Rosenberg RN, White CL, Brown P, et al. Precautions in handling tissue
with documented or suspected Creutzfeldt-Jakob dise
339. Taylor DM. Inactivation of the unconventional agents of scrapie, bovine sp
J Hosp Infect 1991; 18(suppl A
340. Budka H, Aguzzi A, Brown P, et al. Tissue handling in suspected Creutz
encephalopathies (prion diseases). Brain Pa
341. Ironside JW, Bell JE. The `high-risk' neuropathological autopsy in AIDS
Neuropathol Appl Neurobiol 1996
342. World Health Organization. WHO infection control guidelines for trans
consultation. Geneva, Switzerland: World Health Organization, 1
documents/tse/whocdscsraph20
343. Bond WW, Sehulster LM. Microbiological assay of environmental and n
Clinical microbiology procedures.Washington, DC: American Soc
344. Clesceri LS, Greenberg AE, Eaton AD, eds. Standard methods for the ex
DC: American Public Health Association, American Water Works Associat
345. Buttner MP, Willeke K, Grinshpun SA. Sampling and analysis of ai
environmental microbiology. Hurst CJ, Knudsen GR, McInerney MJ, Stetzen
Society for Microbiology Press, 19
346. Jensen PA, Schafer MP. Sampling and characterization of bioaerosols. In
US Department of Health and Human Services, National Institute for Occu
http://www.cdc.gov/niosh/nmam/pdfs
347. International Organization for Standardization. Sterilization of medical
International Organization for Standardization, 1
348. Streifel AJ. Air cultures for fungi. In: Isenberg HD, ed. Clinical microbio
Society for Microbiology Press, 19
349. Wolf HW, Skaliy P, Hall LB, et al. Sampling microbiological aerosols. W
Welfare, Public Health Service, 1964. Public Health Service p
350. Wagner RA. Partitioned laundry improves bacteria co
351. Hambraeus A, Malmborg AS. Is a bed centre in a hospital a h
352. McDonald LL, Pugliese G. Textile processing service [Chapter 66]. In
control. 2nd ed. Philadelphia, PA: Lippincott Willian
353. Barrie D, Hoffman PN, Wilson JA, Kramer JM. Contamination of hospita
306.
354. Legnani PP, Leoni E. Factors affecting the bacteriological contamination
1997;200:319--33.
355. Joint Committee on Healthcare Laundry Guidelines. Guidelines for healt
Association of America, 19
356. Greene VW. Microbiological contamination control in hospitals: part 6 ---
1970;44:98--103.
357. Association for the Advancement of Medical Instrumentation. Processing

ANSI/AAMI Recommended Practice ST65:2000; Arlington, VA: Association fo
358. Hughes HG. Chutes in hospitals. Can
359. Michaelsen GS. Designing linen chutes to reduce spread of infect
360. Hoch KW. Laundry chute cleaning recommendation
361. Whyte W, Baird G, Annand R. Bacterial contamination on the surface
362. Taylor LJ. Segregation, collection, and disposal of hospital laundry
363. Walter WG, Schillinger JE. Bacterial survival in launderec
364. Belkin NL. Aseptics and aesthetics of chlorine bleach: can its use in la
1998;26:149--51.
365. Blaser MJ, Smith PE, Cody HJ, Wang WL, LaForce FM. Killing of f
temperature washing. J Infect Dis 19
366. Jaska JM, Fredell DL. Impact of detergent systems on bacterial sur
1980;39:743--8.
367. Battles DR, Vesley D. Wash water temperature and sanitation in the
368. Christian RR, Manchester JT, Mellor MT. Bacteriological quality of fa
hospital laundry facility. Appl Environ Mic
369. Smith JA, Neil KR, Davidson CG, Davidson RW. Effect of water temp
1987;8:204--9.
370. Tompkins DS, Johnson P, Fittall BR. Low-temperature washing of patie
tunnel drier on bacterial survival. J Hosp
371. Ayliffe GA, Collins BJ, Taylor LJ. Laundering [Chapter 11]. In: Hospit
UK: John Wright and Sons,198
372. Meyer CL, Eitzen HE, Schreiner RL, Gfell MA, Moye L, Kleiman MB. Sh
Pediatrics 1981;67:362--
373. Wagg RE. Disinfection of textiles in laundering and dry clean
374. Bates CJ, Wilcox MH, Smith TL, Spencer RC. The efficacy of a hospital
with bacteria and viruses. J Hosp Infect
375. Oehnel E. Drycleaning in the hospital laund
376. US Environmental Protection Agency. Consumer Products Treated wit
http://www.epa.gov/pesticides/fa
377. Fujita K, Lilly HA, Kidson A, Ayliffe GA. Gentamicin-resistant *Pseudom*
Br Med J 1981;283:219--
378. Grubb DJ, Watson KC. *Pseudomonas* septicaemia from pla
379. Sherertz RJ, Sullivan ML. An outbreak of infections with *Acinetobacter*
mattresses. J Infect Dis 1985;15
380. Ndawula EM, Brown L. Mattresses as reservoirs of epidemic methic
1991;337:488.
381. O'Donoghue MA, Allen KD. Costs of an outbreak of wound infections
382. Weernink A, Severin WP, Tjernberg I, Dijkshoorn L. Pillows, an unexpect
383. Scheidt A, Drusin LM. Bacteriologic contamination in an a
384. Freeman R, Gould FK, Ryan DW, Chamberlain J, Sisson PR. Nosocom

microsphere bed. The value of pyrolysis mass spectromet
385. Clancy MJ. Nosocomial infection and microsphere b
386. Clancy MJ. Nosocomial infection due to *Enterococci* attributed to a fluidiz
5.
387. Jacobsen E, Gurevich I, Cunha BA. Air-fluidized beds and negative-p
1993;21:217--8.
388. American Academy of Allergy, Asthma, and Immunology. Tips to remembl
of Allergy, Asthma, and Immunology. Available at http://www.aaaai.or
389. Duncan SL, APIC Guideline Committee. APIC state-of-the-art report: the
J Infect Control 2000;28:17
390. Murray AB, Ferguson AC, Morrison BJ. The frequency and severity of ca
Immunol 1983;72:145--
391. Delta Society. Standards of practice for animal-assisted activities and an
392. Fox JG. Transmissible drug resistance in *Shigella* and *Salmonella* isolat
1975;4:165--71.
393. Ostrowski SR, Leslie MJ, Parrott T, Abelt S, Piercy PE. B-virus from p
States? Emerg Infect Dis 1998;4
394. Saylor K. Pet visitation program. J Gero
395. Draper RJ, Gerber GJ, Layng EM. Defining the role of pet animals in ps
396. CDC. USPHS/IDSA guidelines for the prevention of opportunistic infec
virus. MMWR 1999;48(No. R
397. CDC. Reptile-associated salmonellosis --- selected states
398. US Department of Justice. Americans With Disabilities Act. Nondiscrimin
and in commercial facilities. Public Law 101-336. Title III, Public accomodatio
discrimination by public accomodations, 42 U
399. US Department of Agriculture. Public Law 99-198. Food Security Act of
Code, Chapter 54, Section
400. CDC, National Institutes of Health. Biosafety in microbiological and
Department of Health and Human Services, Public Health Service,
401. US Department of Labor, Occupational Safety and Health Administrati
final rule. 29 CFR 1910 § 1910.132, 1910.138. Federa
402. US Department of Transportation. Hazardous Materials Regulations
materials: revision to standards for infectious substances and genetically-mod
1998;63:46843--59.
403. US Postal Service. C 023.8.0 Hazardous materials: infectious substanc
Government Printing Office. Available at http://pe.
404. Greene R, Miele DJ, Slavik NS. Technical assistance manual: state regulat
ed. State and Territorial Association on Alternative
405. National Institute for Occupational Safety and Health. NIOSH alert:
Cincinnati, OH: US Department of Health and Human Services, National Ins
(NIOSH) publication no. 200

406. Weber AM, Boudreau Y, Mortimer VD. Health hazard evaluation report
Institute for Occupational Safety and Health, Hazard Evaluations and Tech
407. Johnson KR, Braden CR, Cairns KL, et al. Transmission of *Mycobacteriu*
8.
408. Emery R, Sprau D, Lao YJ, Pryor W. Release of bacterial aerosols during
for healthcare workers. Am Ind Hyg Asso
409. US Department of Health and Human Services, CDC. Additional require
final rule. 42 CFR Part 72. Federal Register 1
410. CDC, Office of Biosafety, Hospital Infections Program. Recommendation
and Human Services, CDC, 19

Table 1

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Box 1

Morbidity and Mortality Weekly Report
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