Guidelines for Preventing Health-Care--Associated Pneumonia, 2003

Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee

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Summary

This report updates, expands, and replaces the previously published CDC "Guideline for Prevention of Nosocomial Pneumonia". The new guidelines are designed to reduce the incidence of pneumonia and other severe, acute lower respiratory tract infections in acute-care hospitals and in other health-care settings (e.g., ambulatory and long-term care institutions) and other facilities where health care is provided.

Among the changes in the recommendations to prevent bacterial pneumonia, especially ventilator-associated pneumonia, are the preferential use of oro-tracheal rather than naso-tracheal tubes in patients who receive mechanically assisted ventilation, the use of noninvasive ventilation to reduce the need for and duration of endotracheal intubation, changing the breathing circuits of ventilators when they malfunction or are visibly contaminated, and (when feasible) the use of an endotracheal tube with a dorsal lumen to allow drainage of respiratory secretions; no recommendations were made about the use of sucralfate, histamine-2 receptor antagonists, or antacids for stress-bleeding prophylaxis. For prevention of health-care--associated Legionnaires disease, the changes include maintaining potable hot water at temperatures not suitable for amplification of Legionella *spp., considering routine culturing of water samples from the potable water system of a facility's organ-transplant unit when it is done as part of the facility's comprehensive program to prevent and control health-care--associated Legionnaires disease, and initiating an investigation for the source of* Legionella *spp. when one definite or one possible case of laboratory-confirmed health-care--associated Legionnaires disease is identified in an*

inpatient hemopoietic stem-cell transplant (HSCT) recipient or in two or more HSCT recipients who had visited an outpatient HSCT unit during all or part of the 2--10 day period before illness onset. In the section on aspergillosis, the revised recommendations include the use of a room with high-efficiency particulate air filters rather than laminar airflow as the protective environment for allogeneic HSCT recipients and the use of high-efficiency respiratory-protection devices (e.g., N95 respirators) by severely immunocompromised patients when they leave their rooms when dust-generating activities are ongoing in the facility. In the respiratory syncytial virus (RSV) section, the new recommendation is to determine, on a case-by-case basis, whether to administer monoclonal antibody (palivizumab) to certain infants and children aged <24 months who were born prematurely and are at high risk for RSV infection. In the section on influenza, the new recommendations include the addition of oseltamivir (to amantadine and rimantadine) for prophylaxis of all patients without influenza illness and oseltamivir and zanamivir (to amantadine and rimantadine) as treatment for patients who are acutely ill with influenza in a unit where an influenza outbreak is recognized.

In addition to the revised recommendations, the guideline contains new sections on pertussis and lower respiratory tract infections caused by adenovirus and human parainfluenza viruses and refers readers to the source of updated information about prevention and control of severe acute respiratory syndrome.

Introduction

Because of the high morbidity and mortality associated with health-care--associated pneumonia, several guidelines for its prevention and control have been published. The first CDC Guideline for Prevention of Nosocomial Pneumonia was published in 1981 and addressed the main infection-control problems related to hospital-acquired pneumonia at the time: the use of large-volume nebulizers that were attached to mechanical ventilators and improper reprocessing (i.e., cleaning and disinfection or sterilization) of respiratory-care equipment. The document also covered the prevention and control of hospital-acquired influenza and respiratory syncytial virus (RSV) infection.

In 1994, the Healthcare Infection Control Practices Advisory Committee (HICPAC) (then known as the Hospital Infection Control Practices Advisory Committee) revised and expanded the CDC Guideline for Prevention of Nosocomial Pneumonia to include Legionnaires disease and pulmonary aspergillosis (*1*). HICPAC advises the secretary of Health and Human Services and the directors of CDC about the prevention and control of health-care--associated infections and related adverse events. The 1994 guideline addressed concerns related to preventing ventilator-associated pneumonia (VAP) (e.g., the role of stress-ulcer prophylaxis in the causation of pneumonia and the contentious roles of selective gastrointestinal decontamination and periodic changes of ventilator tubings in the prevention of the infection). The report also presented major changes in the recommendations to prevent and control hospital-acquired pneumonia caused by *Legionnella* spp. and aspergilli.

In recent years, demand has increased for guidance on preventing and controlling pneumonia and other lower respiratory tract infections in health-care settings other than the acute-care hospital, probably resulting in part from the progressive shift in the burden and focus of health care in the United States away from inpatient care in the acute-care hospital and towards outpatient and long-term care in other health-care settings. In response to this demand, HICPAC revised the guideline to cover these other settings. However, infection-control data about the acute-care hospital setting are more abundant and well-analyzed; in comparison, data are limited from long-term care, ambulatory, and psychiatric facilities and other health-care settings.

This report consists of Parts II and III of a three-part document (*2*) and contains the consensus HICPAC recommendations for the prevention of the following infections: bacterial pneumonia, Legionnaires disease, pertussis, invasive pulmonary aspergillosis (IPA), lower respiratory tract infections caused by RSV, parainfluenza and adenoviruses, and influenza. Part III provides suggested performance indicators to assist infection-control personnel in monitoring the implementation of the guideline recommendations in their facilities.

Part I of the guideline provides the background for the recommendations and includes a discussion of the epidemiology, diagnosis, pathogenesis, modes of transmission, and prevention and control of the infections (*3*). Part I can be an important resource for educating health-care personnel. Because education of health-care personnel is the cornerstone of an effective infection-control program, health-care agencies should give high priority to continuing infection-control education programs for their staff members.

HICPAC recommendations address such issues as education of health-care personnel about the prevention and control of health-care--associated pneumonia and other lower respiratory tract infections, surveillance and reporting of diagnosed cases of infections, prevention of person-to-person transmission of each disease, and reduction of host risk for infection.

Lower respiratory tract infection caused by *Mycobacterium tuberculosis* is not addressed in this document; however, it is covered in a separate publication (*3*).

The document was prepared by CDC; reviewed by experts in infection control, intensive-care medicine, pulmonology, respiratory therapy, anesthesiology, internal medicine, and pediatrics; and approved by HICPAC. The recommendations are endorsed by the American College of Chest Physicians, American Healthcare Association, Association for Professionals of Infection Control and Epidemiology, Infectious Diseases Society of America, Society for Healthcare Epidemiology of America, and Society of Critical Care Medicine.

Key Terms Used In the Guideline

Protective environment (PE) is a specialized patient-care area, usually in a hospital, with a positive air flow relative to the corridor (i.e., air flows from the room to the outside adjacent space). The combination of high-efficiency particulate air (HEPA) filtration, high numbers ($\geq$12) of air changes per hour (ACH), and minimal leakage of air into the room creates an environment that can safely accommodate patients who have received allogeneic hemopoietic stem-cell transplant (HSCT).

Immunocompromised patients are those patients whose immune mechanisms are deficient because of immunologic disorders (e.g., human immunodeficiency virus [HIV] infection, congenital immune deficiency syndrome, and chronic diseases [(diabetes mellitus, cancer, emphysema, or cardiac failure]), or immunosuppressive therapy (e.g., radiation, cytotoxic chemotherapy, anti-rejection medication, and steroids). Immunocompromised patients who are identified as patients at high risk have the greatest risk for infection and include persons with severe neutropenia (i.e., an absolute neutrophil count [ANC] of $\leq$500 cells/mL) for prolonged periods of time, recipients of allogeneic HSCT, and those who receive the most intensive chemotherapy (e.g., patients with childhood acute myelogenous leukemia).

Abbreviations Used In the Guideline

ACIP	Advisory Committee on Immunization Practices

ANC	absolute neutrophil count
COPD	chronic obstructive pulmonary disease
CSF	cerebrospinal fluid
DTAP	diphtheria, tetanus, and acellular pertussis
DTP	diphtheria, tetanus, and pertussis
FDA	Food and Drug Administration
GCSF	granulocyte colony stimulating factor
HEPA	high-efficiency particulate air
HICPAC	Healthcare Infection Control Practices Advisory Committee
HIV	human immunodeficiency virus
HME	heat-moisture exchanger
HSCT	hemopoietic stem-cell transplant
ICU	intensive-care unit
IPA	invasive pulmonary aspergillosis
LAF	laminar airflow
NIV	noninvasive ventilation
NNIS	National Nosocomial Infection Surveillance
PE	protective environment
RSV	respiratory syncytial virus
SARS	severe acute respiratory syndrome
SDD	selective decontamination of the digestive tract
SOP	standing orders program
VAP	ventilator-associated pneumonia

Categorization of Recommendations

In this document, each recommendation is categorized on the basis of existing scientific evidence, theoretical rationale, applicability, and potential economic impact. In addition, a new category accommodates recommendations that are made on the basis of existing national or state health regulations. The following categorization scheme is applied in this guideline:

> **Category IA.** Strongly recommended for implementation and strongly supported by well-designed experimental, clinical, or epidemiologic studies.
> **Category IB.** Strongly recommended for implementation and supported by certain clinical or epidemiologic studies and by strong theoretical rationale.
> **Category IC.** Required for implementation, as mandated by federal or state regulation or standard.
> **Category II.** Suggested for implementation and supported by suggestive clinical or epidemiologic studies or by strong theoretical rationale.

No recommendation; unresolved issue. Practices for which insufficient evidence or no consensus exists about efficacy.

Prevention of Health-Care--Associated Bacterial Pneumonia

I. Staff Education and Involvement in Infection Prevention

Educate health-care workers about the epidemiology of, and infection-control procedures for, preventing health-care--associated bacterial pneumonia to ensure worker competency according to the worker's level of responsibility in the health-care setting, and involve the workers in the implementation of interventions to prevent health-care--associated pneumonia

by using performance-improvement tools and techniques (IA) (*4--11*).

II. Infection and Microbiologic Surveillance

A. Conduct surveillance for bacterial pneumonia in intensive care unit (ICU) patients who are at high risk for health-care--related bacterial pneumonia (e.g., patients with mechanically assisted ventilation or selected postoperative patients) to determine trends and help identify outbreaks and other potential infection-control problems (*12,13*). The use of the new National Nosocomial Infection Surveillance (NNIS) system's surveillance definition of pneumonia is recommended (*14*). Include data on the causative microorganisms and their antimicrobial susceptibility patterns (*15*). Express data as rates (e.g., number of infected patients or infections per 100 ICU days or per 1,000 ventilator days) to facilitate intrahospital comparisons and trend determination (*12,16,17*). Link monitored rates and prevention efforts and return data to appropriate health-care personnel (IB) (*18*).

B. In the absence of specific clinical, epidemiologic, or infection-control objectives, do not routinely perform surveillance cultures of patients or of equipment or devices used for respiratory therapy, pulmonary-function testing, or delivery of inhalation anesthesia (II) (*19--22*).

III. Prevention of Transmission of Microorganisms

A. Sterilization or Disinfection and Maintenance of Equipment and Devices

1. General measures

a. Thoroughly clean all equipment and devices to be sterilized or disinfected (IA) (*23,24*).

b. Whenever possible, use steam sterilization (by autoclaving) or high-level disinfection by wet heat pasteurization at >158 F (>70°C) for 30 minutes for reprocessing semicritical equipment or devices (i.e., items that come into direct or indirect contact with mucous membranes of the lower respiratory tract) that are not sensitive to heat and moisture (Box. Use low-temperature sterilization methods (as approved by the Office of Device Evaluation, Center for Devices and Radiologic Health, Food and Drug Administration [FDA]) for equipment or devices that are heat- or moisture-sensitive (*24--28*). After disinfection, proceed with appropriate rinsing, drying, and packaging, taking care not to contaminate the disinfected items in the process (IA) (*23,24*).

c. Preferentially use sterile water for rinsing reusable semicritical respiratory equipment and devices when rinsing is needed after they have been chemically disinfected. If this is not feasible, rinse the device with filtered water (i.e., water that has been through a 0.2μ filter) or tap water, and then rinse with isopropyl alcohol and dry with forced air or in a drying cabinet

(IB) (*24*).

d. Adhere to provisions in FDA's enforcement document for single-use devices that are reprocessed by third parties (IC) (*24*,*29*).

2. Mechanical ventilators

Do not routinely sterilize or disinfect the internal machinery of mechanical ventilators (II).

3. Breathing circuits, humidifiers, and heat-and-moisture exchangers (HMEs)

a. Breathing circuits with humidifiers

1) Do not change routinely, on the basis of duration of use, the breathing circuit (i.e., ventilator tubing and exhalation valve and the attached humidifier) that is in use on an individual patient. Change the circuit when it is visibly soiled or mechanically malfunctioning (IA) (*30*--*35*).

2) Breathing-circuit--tubing condensate

a) Periodically drain and discard any condensate that collects in the tubing of a mechanical ventilator, taking precautions not to allow condensate to drain toward the patient (IB) (*36*).

b) Wear gloves to perform the previous procedure and/or when handling the fluid (IB) (*37*,*38*).

c) Decontaminate hands with soap and water (if hands are visibly soiled) or with an alcohol-based hand rub after performing the procedure or handling the fluid (IA) (*38*,*39*).

3) No recommendation can be made for placing a filter or trap at the distal end of the expiratory-phase tubing of the breathing circuit to collect condensate (Unresolved issue).

4) Humidifier fluids

a) Use sterile (not distilled, nonsterile) water to fill bubbling humidifiers (II) (*36,40--43*).

b) No recommendation can be made for the preferential use of a closed, continuous-feed humidification system (Unresolved issue).

b. Ventilator breathing circuits with HMEs

1) No recommendation can be made for the preferential use of either HMEs or heated humidifiers to prevent pneumonia in patients receiving mechanically assisted ventilation (Unresolved issue) (IB) (*44--49*).

2) Changing HME

a) Change an HME that is in use on a patient when it malfunctions mechanically or becomes visibly soiled (II).

b) Do not routinely change more frequently than every 48 hours an HME that is in use on a patient (II) *(50--52*).

3) Do not change routinely (in the absence of gross contamination or malfunction) the breathing circuit attached to an HME while it is in use on a patient (II) (*53*).

4. Oxygen humidifiers

a. Follow manufacturers' instructions for use of oxygen humidifiers (II,C) (*29;54--56*).

b. Change the humidifier-tubing (including any nasal prongs or mask) that is in use on one patient when it malfunctions or becomes visibly contaminated (II).

5. Small-volume medication nebulizers: in-line and hand-held nebulizers

a. Between treatments on the same patient clean, disinfect, rinse with sterile water (if rinsing is needed), and dry small-volume in-line or hand-held medication nebulizers (IB) (*57--59*).

b. Use only sterile fluid for nebulization, and dispense the fluid into the nebulizer aseptically (IA) (*40--42,58,60--62*).

c. Whenever possible, use aerosolized medications in single-dose vials. If multidose medication vials are used, follow manufacturers' instructions for handling, storing, and dispensing the medications (IB) (*60,62--67*).

6. Mist tents

a. Between uses on different patients, replace mist tents and their nebulizers, reservoirs, and tubings with those that have been subjected to sterilization or high-level disinfection (II) (*68*).

b. No recommendation can be made about the frequency of routinely changing mist-tent nebulizers, reservoirs, and tubings while in use on one patient (Unresolved issue).

c. Subject mist-tent nebulizers, reservoirs, and tubings that are used on the same patient to daily low-level disinfection (e.g., with 2% acetic acid) or pasteurization followed by air-drying (II) (*69*).

7. Other devices used in association with respiratory therapy

a. Respirometer and ventilator thermometer: between their uses on different patients, sterilize or subject to high-level disinfection portable respirometers and ventilator thermometers (IB) (*70--74*).

b. Resuscitation bags

1) Between their uses on different patients, sterilize or subject to high-level disinfection reusable hand-powered resuscitation bags (IB) (*75--79*).

2) No recommendation can be made about the frequency of changing hydrophobic filters placed on the connection port of resuscitation bags (Unresolved issue).

8. Anesthesia machines and breathing systems or patient circuits

a. Do not routinely sterilize or disinfect the internal machinery of anesthesia equipment (IB) (*80*).

b. Between uses on different patients, clean reusable components of the breathing system or patient circuit (e.g., tracheal tube or face mask) inspiratory and

expiratory breathing tubing, y-piece, reservoir bag, humidifier, and tubing, and then sterilize or subject them to high-level liquid chemical disinfection or pasteurization in accordance with the device manufacturers' instructions for their reprocessing (IB) (*24,26*).

c. No recommendation can be made about the frequency of routinely cleaning and disinfecting unidirectional valves and carbon dioxide absorber chambers (Unresolved issue) (*81*).

d. Follow published guidelines or manufacturers' instructions about in-use maintenance, cleaning, and disinfection or sterilization of other components or attachments of the breathing system or patient circuit of anesthesia equipment (IB) (*82,83*).

e. No recommendation can be made for placing a bacterial filter in the breathing system or patient circuit of anesthesia equipment (Unresolved issue) (*4,84--89*).

9. Pulmonary-function testing equipment

a. Do not routinely sterilize or disinfect the internal machinery of pulmonary-function testing machines between uses on different patients (II) (*90,91*).

b. Change the mouthpiece of a peak flow meter or the mouthpiece and filter of a spirometer between uses on different patients (II) (*24,92*).

10. Room-air "humidifiers" and faucet aerators

a. Do not use large-volume room-air humidifiers that create aerosols (e.g., by venturi principle, ultrasound, or spinning disk, and thus actually are nebulizers) unless they can be sterilized or subjected to high-level disinfection at least daily and filled only with sterile water (II) (*40,93,94*).

b. Faucet aerators

1) No recommendation can be made about the removal of faucet aerators from areas for immunocompetent patients (see also section on Legionnaires Disease, Part II, Section I-C-1-d) (Unresolved issue).

2) If *Legionella* spp. are detected in the water of a transplant unit and until *Legionella* spp. are no longer detected by culture, remove faucet aerators in the unit (see also section on Legionnaires Disease,

Part II, Section I-C-1-d) (II) (*95*).

B. Prevention of Person-to-Person Transmission of Bacteria

1. Standard Precautions

a. Hand hygiene: Decontaminate hands by washing them with either antimicrobial soap and water or with nonantimicrobial soap and water (if hands are visibly dirty or contaminated with proteinaceous material or are soiled with blood or body fluids) or by using an alcohol-based waterless antiseptic agent (e.g., hand rub) if hands are not visibly soiled after contact with mucous membranes, respiratory secretions, or objects contaminated with respiratory secretions, whether or not gloves are worn. Decontaminate hands as described previously before and after contact with a patient who has an endotracheal or tracheostomy tube in place, and before and after contact with any respiratory device that is used on the patient, whether or not gloves are worn (IA) (*37*,*39*).

b. Gloving

1) Wear gloves for handling respiratory secretions or objects contaminated with respiratory secretions of any patient (IB) (*37*).

2) Change gloves and decontaminate hands as described previously between contacts with different patients; after handling respiratory secretions or objects contaminated with secretions from one patient and before contact with another patient, object, or environmental surface; and between contacts with a contaminated body site and the respiratory tract of, or respiratory device on, the same patient (IA) (*37*,*39*,*96--98*).

c. When soiling with respiratory secretions from a patient is anticipated, wear a gown and change it after soiling occurs and before providing care to another patient (IB) (*37*,*97*).

2. Care of patients with tracheostomy

a. Perform tracheostomy under aseptic conditions (II).

b. When changing a tracheostomy tube, wear a gown, use aseptic technique, and replace the tube with one that has undergone sterilization or high-level disinfection (IB) (*23*,*24*,*37*).

c. No recommendation can be made for the daily application of topical antimicrobial agent(s) at the tracheostoma (Unresolved issue) (*99*).

3. Suctioning of respiratory tract secretions
(See also Section IV-B-1-d)

a. No recommendation can be made for the preferential use of either the multiuse closed-system suction catheter or the single-use open-system suction catheter for prevention of pneumonia (Unresolved issue) (*44,100-102*).

b. No recommendation can be made about wearing sterile rather than clean gloves when performing endotracheal suctioning (Unresolved issue).

c. No recommendation can be made about the frequency of routinely changing the in-line suction catheter of a closed-suction system in use on one patient (Unresolved issue) (*103*).

d. If the open-system suction is employed, use a sterile, single-use catheter (II).

e. Use only sterile fluid to remove secretions from the suction catheter if the catheter is to be used for re-entry into the patient's lower respiratory tract (II).

IV. Modifying Host Risk for Infection

A. Increasing Host Defense Against Infection: Administration of immune modulators

1. Pneumococcal vaccination. Vaccinate patients at high risk for severe pneumococcal infections

a. Administer the 23-valent pneumococcal polysaccharide vaccine to persons aged ≥65 years; persons aged 5--64 years who have chronic cardiovascular disease (e.g., congestive heart failure or cardiomyopathy), chronic pulmonary disease (e.g., chronic obstructive pulmonary disease [COPD] or ermphysema, but not asthma), diabetes mellitus, alcoholism, chronic liver disease (e.g., cirrhosis), or cerebrospinal fluid (CSF) leaks; persons aged 5--64 years who have functional or anatomic asplenia; persons aged 5--64 years who are living in special environments or social settings; immunocompromised persons aged ≥5 years with HIV infection, leukemia, lymphoma, Hodgkin's disease, multiple myeloma, generalized malignancy, chronic renal failure, nephrotic syndrome, or other conditions associated with immunosuppression (e.g., receipt of HSCT, solid-

organ transplant, or immunosuppressive chemotherapy, including long-term systemic corticosteroids); and persons in long-term--care facilities (IA) (*104--109*).

b. Administer the 7-valent pneumococcal polysaccharide protein-conjugate vaccine to all children aged <2 years and to children aged 24--59 months who are at increased risk for pneumococcal disease (e.g., children with sickle-cell disease or other hemoglobinopathies, or children who are functionally or anatomically asplenic; children with HIV infection; children who have chronic disease, including chronic cardiac or pulmonary disease [except asthma], diabetes mellitus, or CSF leak; and children with immunocompromising conditions including malignancies, chronic renal failure or nephrotic syndrome, receipt of immunosuppressive chemotherapy, including long-term corticosteroids, and receipt of solid-organ transplant). Consider administering the vaccine to children aged 24--59 months, with priority to children aged 24--35 months, children who are American Indians/Alaska Natives or black, and children who attend group child care centers (IB) (*104*).

c. In nursing homes and other long-term--care facilities, establish a standing order program (SOP) for the administration of 23-valent vaccine to persons at high risk for acquiring severe pneumococcal infections, including pneumococcal pneumonia (IA) (*105,110,111*).

2. No recommendation can be made for the routine administration of preparations of granulocyte-colony stimulating factor (GCSF) or intravenous gamma globulin for prophylaxis against health-care--associated pneumonia (Unresolved issue) (*112--117*).

3. No recommendation can be made for the routine enteral administration of glutamine for prevention of health-care--associated pneumonia (Unresolved issue) (*118,119*).

B. Precautions for prevention of aspiration

As soon as the clinical indications for their use are resolved, remove devices such as endotracheal, tracheostomy, and/or enteral (i.e., oro- or nasogastric or jejunal) tubes from patients (IB) (*120--125*).

1. Prevention of aspiration associated with endotracheal intubation

a. Use of noninvasive ventilation (NIV) to reduce the need for and duration of endotracheal intubation

1) When feasible and not medically contraindicated, use noninvasive positive-pressure ventilation delivered continuously

by face or nose mask, instead of performing endotracheal intubation in patients who are in respiratory failure and are not needing immediate intubation (e.g., those who are in hypercapneic respiratory failure secondary to acute exacerbation of COPD or cardiogenic pulmonary edema) (II) (*126--9*).

2) When feasible and not medically contraindicated, use NIV as part of the weaning process (from mechanically assisted ventilation) to shorten the period of endotracheal intubation (II) (*130*).

b. As much as possible, avoid repeat endotracheal intubation in patients who have received mechanically assisted ventilation (II) (*131*).

c. Unless contraindicated by the patient's condition, perform orotracheal rather than nasotracheal intubation on patients (IB) (*44,132,133*).

d. If feasible, use an endotracheal tube with a dorsal lumen above the endotracheal cuff to allow drainage (by continuous or frequent intermittent suctioning) of tracheal secretions that accumulate in the patient's subglottic area (II) (*44,134--137*).

e. Before deflating the cuff of an endotracheal tube in preparation for tube removal, or before moving the tube, ensure that secretions are cleared from above the tube cuff (II).

2. Prevention of aspiration associated with enteral feeding

a. In the absence of medical contraindication(s), elevate at an angle of 30--45 degrees of the head of the bed of a patient at high risk for aspiration (e.g., a person receiving mechanically assisted ventilation and/or who has an enteral tube in place) (II) (*138--140*).

b. Routinely verify appropriate placement of the feeding tube (IB) (*141--143*).

c. No recommendation can be made for the preferential use of small-bore tubes for enteral feeding (Unresolved issue) (*144*).

d. No recommendation can be made for preferentially administering enteral feedings continuously or intermittently (Unresolved issue) (*145--148*).

e. No recommendation can be made for preferentially

placing the feeding tubes, (e.g., jejunal tubes) distal to the pylorus (Unresolved issue) (*149--155*).

3. Prevention or modulation of oropharyngeal colonization

a. Oropharyngeal cleaning and decontamination with an antiseptic agent: develop and implement a comprehensive oral-hygiene program (that might include the use of an antiseptic agent) for patients in acute-care settings or residents in long-term--care facilities who are at high risk for health-care--associated pneumonia (II) (*156,157*).

b. Chlorhexidine oral rinse

1) No recommendation can be made for the routine use of an oral chlorhexidine rinse for the prevention of health-care--associated pneumonia in all postoperative or critically ill patients and/or other patients at high risk for pneumonia (Unresolved issue) (II) (*158*).

2) Use an oral chlorhexidine gluconate (0.12%) rinse during the perioperative period on adult patients who undergo cardiac survery (II) (*158*).

c. Oral decontamination with topical antimicrobial agents.

1) No recommendation can be made for the routine use of topical antimicrobial agents for oral decontamination to prevent VAP (Unresolved issue) (*159*).

4. Prevention of gastric colonization

a. No recommendation can be made for the preferential use of sucralfate, H2-antagonists, and/or antacids for stress-bleeding prophylaxis in patients receiving mechanically assisted ventilation (Unresolved issue) (*160--167*).

b. No recommendation can be made for the routine selective decontamination of the digestive tract (SDD) of all critically ill, mechanically ventilated, or ICU patients (Unresolved issue) (*168--200*).

c. No recommendation can be made for routinely acidifying gastric feeding (Unresolved issue) (*201,202*).

C. Prevention of Postoperative Pneumonia

1. Instruct preoperative patients, especially those at high risk for contracting pneumonia, about taking deep breaths and ambulating as soon as medically indicated in the postoperative period. Patients at high risk include those who will have abdominal aortic aneurysm repair, thoracic surgery, or emergency surgery; those who will receive general anesthesia; those who are aged ≥60 years; those with totally dependent functional status; those who have had a weight loss >10%; those using steroids for chronic conditions; those with recent history of alcohol use, history of COPD, or smoking during the preceding year; those with impaired sensorium, a history of cerebrovascular accident with residual neurologic deficit, or low (<8mg/dL) or high (>22 mg/dL) blood urea nitrogen level; and those who will have received >4 units of blood before surgery (IB) (*203--206*).

2. Encourage all postoperative patients to take deep breaths, move about the bed, and ambulate unless medically contraindicated (IB) (*205--207*).

3. Use incentive spirometry on postoperative patients at high risk for pneumonia (IB) (*205--207*).

4. No recommendation can be made about the routine use of chest physiotherapy on all postoperative patients at high risk for pneumonia (Unresolved issue) (*205--207*).

D. Other Prophylactic Procedures for Pneumonia

1. Administration of antimicrobial agents other than in SDD

a. Systemic antimicrobial prophylaxis.
No recommendation can be made about the routine administration of systemic antimicrobial agent(s) to prevent pneumonia in critically ill patients or in those receiving mechanically-assisted ventilation (Unresolved issue) (*200*, *208*).

b. Scheduled changes in the class of antimicrobial agents used for empiric therapy
No recommendation can be made for scheduled changes in the class of antimicrobial agents used routinely for empiric treatment of suspected infections in a particular group of patients (Unresolved issue) (*209*,*210*).

2. Turning or rotational therapy
No recommendation can be made for the routine use of turning or rotational therapy, either by "kinetic" therapy or by continuous lateral rotational therapy (i.e., placing patients on beds that turn on their longitudinal axes intermittently or continuously) for prevention of health-care--associated pneumonia in critically ill and immobilized patients (Unresolved issue) (*44*,*211--216*).

Prevention and Control of Health-Care--Associated Legionnaires Disease

I. Primary Prevention (Preventing health-care--associated Legionnaires disease when no cases have been documented)

A. Staff Education

1. Educate physicians to heighten their suspicion for cases of health-care--associated Legionnaires disease and to use appropriate methods for its diagnosis (II).

2. Educate patient-care, infection-control, and engineering personnel about measures to prevent and control health-care--associated legionellosis (II).

B. Infection and Environmental Surveillance

1. Maintain a high index of suspicion for the diagnosis of health-care--associated Legionnaires disease and perform laboratory diagnostic tests (both culture of appropriate respiratory specimen and the urine antigen test) for legionellosis on suspected cases, especially in patients who are at high risk for acquiring the disease (e.g., patients who are immunosuppressed, including HSCT or solid-organ--transplant recipients; patients receiving systemic steroids; patients aged ≥65 years; or patients who have chronic underlying disease such as diabetes mellitus, congestive heart failure, and COPD) (IA) (*217--226*).

2. Periodically review the availability and clinicians' use of laboratory diagnostic tests for Legionnaires disease in the facility, and if clinicians do not routinely use the tests on patients with diagnosed or suspected pneumonia, implement measures to enhance clinicians' use of the tests (e.g., by conducting educational programs) (II) (*227,228*).

3. Routine culturing of water systems for *Legionella* spp.

a. No recommendation can be made about routinely culturing water systems for *Legionella* spp. in health-care facilities that do not have patient-care areas (i.e., transplant units) for persons at high risk for *Legionella* infection (Unresolved issue) (*95,229--238*).

b. In facilities with hemopoietic stem-cell- and/or solid-organ--transplantation programs, periodic culturing for legionellae in water samples from the transplant unit(s) can be performed as part of a comprehensive strategy to prevent Legionnaires disease in transplant recipients (II) (*95,239--241*).

c. If such culturing (as in b) is undertaken:

1) No recommendation can be made about the optimal methods (i.e., frequency or

number of sites) for environmental surveillance cultures in transplant units (Unresolved issue).

2) Perform corrective measures aimed at maintaining undetectable levels of *Legionella* spp. in the unit's water system (II).

3) Maintain a high index of suspicion for legionellosis in transplant patients with health-care--associated pneumonia even when environmental surveillance cultures do not yield legionellae (IB) (*224,227*).

C. Use and Care of Medical Devices, Equipment, and Environment

1. Nebulizers and other devices

a. Preferentially use sterile water for rinsing nebulization devices and other semicritical respiratory-care equipment after they have been cleaned or disinfected (*58,242*). If this is not feasible, rinse the device with filtered water (i.e., water that has been through a 0.2μ filter) or tap water and then rinse with isopropyl alcohol and dry with forced air or in a drying cabinet (IB) (*24*).

b. Use only sterile (not distilled, nonsterile) water to fill reservoirs of devices used for nebulization (IA) (*40,58,229,242,243*).

c. Do not use large-volume room-air humidifiers that create aerosols (e.g., by venturi principle, ultrasound, or spinning disk and thus are really nebulizers) unless they can be sterilized or subjected to high-level disinfection at least daily and filled only with sterile water (II) (*242,243*)

d. Faucet aerators

1) No recommendation can be made for the removal of faucet aerators from areas for immunocompetent patients (see also Bacterial Pneumonia, Part II, section III-A-10-b) (Unresolved issue).

2) If *Legionella* spp. are detected in the water of a transplant unit and until *Legionella* spp. are no longer detected by culture, remove faucet aerators in areas for severely immunocompromised patients (II) (*95*).

2. Cooling towers

a. When a new building is constructed, place cooling towers in such a way that the tower drift is directed away from the facility's air-intake system, and design the cooling towers such that the volume of aerosol drift is minimized (IB) (*95,244--5*).

b. For cooling towers, install drift eliminators, regularly use an effective biocide, maintain the tower according to manufacturers' recommendations, and keep adequate maintenance records (IB) (*95,244--5*).

3. Water-distribution system

a. Where practical and allowed by state law, maintain potable water at the outlet at ≥51°C (≥124°F) or <20°C (<68°F), especially in facilities housing organ-transplant recipients or other patients at high-risk (*244--248*). If water is maintained at ≥51°C (≥124°F), use thermostatic mixing valves to prevent scalding (II) (*249*).

b. No recommendation can be made about the treatment of water with chlorine dioxide, heavy-metal ions, ozone, or ultraviolet light *(250--266*). Hospitals served by municipalities with monochloramine-treated water have had success in controlling legionella (Unresolved issue) (*267--8*).

4. Health-care facilities with hemopoietic stem-cell or solid-organ transplantation programs
If legionellae are detected in the potable water supply of a transplant unit, and until legionellae are no longer detected by culture:

a. Decontaminate the water supply as per section II-B-2-b-3)-a)-*i* to *v* (IB).

b. Restrict severely immunocompromised patients from taking showers (IB) (*239,269*).

c. Use water that is not contaminated with *Legionella* spp. for HSCT patients' sponge baths (IB) (*270,271*).

d. Provide HSCT patients with sterile water for tooth brushing or drinking or for flushing nasogastric tubes (IB) (*239,271*).

e. Do not use water from faucets with *Legionella*-contaminated water in patients' rooms to avoid creating infectious aerosols (II) (*269*).

II. Secondary Prevention (Response to identification of laboratory-confirmed health-

care--associated Legionellosis)

A. In Facilities with HSCT or Solid-Organ Transplant Recipients:
When one inpatient of an HSCT or solid-organ transplant unit develops a case of laboratory-confirmed definite (i.e., after ≥10 days of continuous inpatient stay) or possible (i.e., within 2--9 days of inpatient stay) health-care--associated Legionnaires disease, or when two or more patients develop laboratory-confirmed Legionnaires disease within 6 months of each other and after having visited an outpatient transplant unit during part of the 2--10 day period before illness onset:

1. Contact the local or state health department or CDC if the disease is reportable in the state or if assistance is needed (II, IC).

2. In consultation with the facility's infection-control team, conduct a combined epidemiologic and environmental investigation (as outlined from II-B-2-b-1) through II-B-2-b-5)) to determine the source(s) of *Legionella* spp. (*95,239*). Include but do not limit the investigation to such potential sources as showers, water faucets, cooling towers, hot-water tanks, and carpet-cleaner water tanks (*226,228,272*). On its identification, decontaminate or remove the source of *Legionella* spp (II).

3. If the health-care facility's potable water system is found to be the source of *Legionella* spp., observe the measures outlined in Section I-C-4-b to e, about the nonuse of the facility's potable water by recipients of HSCT or solid-organ transplants and decontaminate the water supply as per Section II-B-2-b-3)-a)-*i* to *v* (IB).

4. Do not conduct an extensive facility investigation when an isolated case of possible health-care--associated Legionnaires disease occurs in a patient who has had little contact with the inpatient transplant unit during most of the incubation period of the disease (II).

B. In Facilities That Do Not House Severely Immunocompromised Patients (e.g., HSCT or Solid-Organ Transplant Recipients):

When a single case of laboratory-confirmed definite health-care--associated Legionnaires disease is identified, or when two or more cases of laboratory-confirmed, possible health-care--associated Legionnaires' disease occur within 6 months of each other:

1. Contact the local or state health department or CDC if the disease is reportable in the state or if assistance is needed (II, IC).

2. Conduct an epidemiologic investigation through a retrospective review of microbiologic, serologic, and postmortem data to identify previous cases, and begin an intensive prospective surveillance for additional cases of health-care--associated Legionnaires disease (II).

a. If no evidence of continued nosocomial transmission exists, continue the intensive prospective surveillance for cases for ≥2 months after surveillance is begun (II).

b. If evidence of continued transmission exists:

1) Conduct an environmental investigation to determine the source(s) of *Legionella* spp. by collecting water samples from potential sources of aerosolized water and saving and subtyping isolates of *Legionella* spp. obtained from patients and the environment (IB) (*40,58,270,273--282*).

2) If a source is not identified, continue surveillance for new cases for ≥2 months and, depending on the scope of the outbreak, decide to either defer decontamination pending identification of the source(s) of *Legionella* spp. or proceed with decontamination of the hospital's water distribution system, with special attention to the specific hospital areas involved in the outbreak (II).

3) If a source of infection is identified by the epidemiologic and environmental investigations, promptly decontaminate the source (IB).

a) If the heated water system is implicated:

i. Decontaminate the heated water system either by superheating or by hyperchlorination. To superheat, raise the hot water temperature to 71°C--77°C (160° F--170°F) and maintain at that level while progressively flushing each outlet around the system. A minimum flush time of 5 minutes has been recommended; however, the optimal flush time is not known and longer flush times

might be required. Post warning signs at each outlet being flushed to prevent scald injury to patients, staff, or visitors. If possible, perform flushing when the building has the fewest occupants (e.g., nights and weekends). For systems on which thermal shock treatment is not possible, use shock chlorination as an alternative. Add chlorine, preferably overnight, to achieve a free chlorine residual of ≥2 mg/L (≥2 ppm) throughout the system. This might require chlorination of the water heater or tank to levels of 20--50 mg/L (20--50 ppm). Maintain the water pH between 7.0 and 8.0 (IB) (230,244, 246,248,277,283--285).

ii. Depending on local and state regulations about potable water temperature in public buildings (*247*), circulate potable water at temperatures not conducive to amplification of *Legionella;* store

and distribute cold water at <20°C (<68°F); and store hot water at >60°C (>140°F) and circulate it at a minimum return temperature of 51°C (124°F) (II) (*95*,*245--248*).

iii. If the methods described in 3a-i and 3a-ii are not successful in decontaminating the hospital's water, seek expert consultation for review of decontamination procedures and assistance with further efforts (II).

iv. No recommendation can be made for the treatment of water with chlorine dioxide, heavy-metal ions, ozone, or ultraviolet light (*250--266*). Hospitals have reported successful decontamination using each of these methods (Unresolved issue).

v. Clean hot-water storage tanks and water heaters to remove accumulated scale and sediment (IB) (*95*).

b) If cooling towers or evaporative condensers are implicated, decontaminate the cooling-tower system (IB) (*95*,*244*).

4) Assess the efficacy of implemented measures in reducing or eliminating *Legionella* spp. by collecting specimens for culture at 2-week intervals for 3 months (II).

a) If *Legionella* spp. are not detected in cultures during 3 months of monitoring at 2-week intervals, collect cultures monthly for another 3 months (II).

b) If *Legionella* spp. are detected in one or more cultures, reassess the implemented control measures, modify them accordingly, and repeat decontamination procedures. Options for repeat decontamination include the intensive use of the same technique used for the initial decontamination or a combination of superheating and hyperchlorination (II) (*284*).

5) Keep adequate records of all infection-control measures, including maintenance procedures, and of environmental test results for cooling towers and potable-water systems (II).

Prevention and Control of Health-Care--Associated Pertussis

I. Staff Education

Educate appropriate personnel in accordance with their level of responsibility in the health-care setting about the epidemiology, modes of transmission, and means of preventing the spread of pertussis (IB) (*286*,*287*).

II. Case-Reporting, Disease Surveillance, and Case-Contact Notification

A. Report to the local and/or state health department all confirmed and suspected cases of pertussis (II, IC) (*286*).

B. Conduct active surveillance for cases of pertussis until 42 days

after the onset of the last pertussis case (II) (*288*).

C. Notify persons who have had close contact with a case of pertussis in the health-care setting so that they can be monitored for symptoms of pertussis and/or administered appropriate chemoprophylaxis. Close contact includes face-to-face contact with a patient who is symptomatic (e.g., in the catarrhal or paroxysmal period of illness); sharing a confined space in close proximity for a prolonged period of time (e.g., ≥1 hour) with a symptomatic patient; or direct contact with respiratory, oral, or nasal secretions from a symptomatic patient (e.g., an explosive cough or sneeze on the face, sharing food, sharing eating utensils during a meal, kissing, mouth-to-mouth resuscitation, or performing a full medical examination of the nose and throat) (II) (*288*).

III. Prevention of Pertussis Transmission

A. Vaccination for Primary Prevention

1. No recommendation can be made for routinely vaccinating adults, including health-care workers, with the acellular pertussis vaccine at regular intervals (e.g., every 10 years) (Unresolved issue) (*288--292*).

2. In long-term--care facilities for children and for children with prolonged stay in acute-care facilities, follow the recommendations of the Advisory Committee on Immunization Practices (ACIP) for vaccinating children according to their chronologic age (IB) (*288,293*).

B. Vaccination for Secondary Prevention

1. No recommendation can be made for vaccinating adults, including health-care workers, during an institutional outbreak of pertussis (Unresolved issue) (*288,294*).

2. During an institutional outbreak of pertussis, accelerate scheduled vaccinations to infants and children aged <7 years who have not completed their primary vaccinations, as follows:

a. Infants aged <2 months who are receiving their initial vaccination: Administer the first dose of the diphtheria, tetanus, and acellular pertussis (DTaP) vaccine as early as age 6 weeks and the second and third doses at a minimum of 4-week intervals between doses. Give the fourth dose on or after age 1 year and at least 6 months after the third dose (II) (*288,295,296*).

b. Other children aged <7 years:
Administer DTaP vaccine to all patients who are aged <7 years and are not up-to-date with their pertussis vaccinations, as follows: administer a fourth dose of DTaP if the child has had 3 doses of DTaP or diphtheria, pertussis and tetanus (DPT) vaccine, is ≥12 months old, and >6 months have passed since the third dose of DTaP or DTP; administer a fifth dose of DTaP if the child has had four doses of DTaP or DTP, is aged 4--6 years, and received the fourth vaccine dose before the fourth birthday (IB) (*287,288,293,295*).

3. Vaccination of children with a history of well-documented pertussis disease
No recommendation can be made for administering additional dose(s) of pertussis vaccine to children who have a history of well-documented pertussis disease (i.e., pertussis illness with either a *B. pertussis*-positive culture or epidemiologic linkage to a culture-positive case) (Unresolved issue) (*288,293*).

C. Patient Placement and Management

1. Patients with confirmed pertussis
Place a patient with diagnosed pertussis in a private room, or if known not to have any other respiratory infection, in a room with other patient(s) with pertussis until after the first 5 days of a full course of antimicrobial treatment or 21 days after the onset of cough if unable to take antimicrobial treatment for pertussis (IB) (*37,288*).

2. Patients with suspected pertussis

a. Place a patient with suspected pertussis in a private room. After pertussis and no other infection is confirmed, the patient can be placed in a room with other patient (s) who have pertussis until after the first 5 days of a full course of antimicrobial treatment or 21 days after the onset of cough if unable to take antimicrobial treatment for pertussis (IB) (*37,288*).

b. Perform diagnostic laboratory tests (for confirmation or exclusion of pertussis) on patients who are admitted with or who develop signs and symptoms of pertussis to allow for the earliest possible downgrading of infection-control precautions to the minimum required for

each patient's specific infection(s) (IB) (*286,297--300*).

D. Management of Symptomatic Health-Care Personnel

1. In conjunction with employee-health personnel, perform diagnostic laboratory tests for pertussis in health-care personnel with illness suggestive of pertussis (i.e., unexplained cough illness of >1 week duration and paroxysmal cough) (IB) (*286,287,297--300*).

2. In conjunction with employee-health personnel, treat symptomatic health-care personnel who are proven to have pertussis or personnel who are highly suspected of having pertussis with the same antimicrobial regimen, as detailed for chemoprophylaxis of case-contacts, in F-1 to F-2 (IB) (*286,301*).

3. Restrict symptomatic pertussis-infected health-care workers from work during the first 5 days of their receipt of antimicrobial therapy (IB) (*287,288,301*).

E. Masking

In addition to observing standard precautions, wear a surgical mask when within 3 feet of a patient with confirmed or suspected pertussis, when performing procedures or patient-care activities that are likely to generate sprays of respiratory secretions, or on entering the room of a patient with confirmed or suspected pertussis (IB) (*37*).

F. Use of a Prophylactic Antibiotic Regimen for Contacts of Persons with Pertussis

1. Administer a macrolide to any person who has had close contact with persons with pertussis and who does not have hypersensitivity or intolerance to macrolides (IB) (*287,302*).

a. Except in infants aged ≤2 weeks, use erythromycin (i.e., erythromycin estolate, 500 mg four times daily or erythromycin delayed-release tablets, 333 mg three times daily for adults, and 40--50 mg/kg day for children) for 14 days (IB) (*287,303--306*).

b. For patients who are intolerant to erythromycin or for infants aged ≤2 weeks, use any of the following regimens: azithromycin for 5--7 days (at 10--12 mg/kg/day) or for 5 days (at 10 mg/kg on day one followed by 4 days at 5 mg/kg/day) for infants and young children (*307*); or clarithromycin for 10--14 days (at 500 mg twice a day for adults or 15--20 mg/kg/day in two divided doses for children) (II) (*287,308,309*).

2. For chemoprophylaxis of persons who have hypersensitivity or intolerance to macrolides, use (except in the case of a pregnant woman at term, a nursing mother, or an infant aged <2 months) trimethoprim-sulfamethoxazole for 14 days (at one double-strength

tablet twice a day for adults and 8 mg/kg/day TMP, 40 mg/kg/day SXT a day in 2 divided doses for children) (II) (*303*,*310*).

G. Work Exclusion of Asymptomatic Health-Care Workers Exposed to Pertussis

1. Do not exclude from patient care a health-care worker who remains asymptomatic and is receiving chemoprophylaxis after an exposure to a case of pertussis (i.e., by direct contact of one's nasal or buccal mucosa with the respiratory secretions of an untreated person who is in the catarrhal or paroxysmal stage of pertussis) (II) (*287*).

2. If mandated by state law or where feasible, exclude an exposed, asymptomatic health-care worker who is unable to receive chemoprophylaxis from providing care to a child aged <4 years during the period starting 7 days after the worker's first possible exposure until 14 days after his last possible exposure to a case of pertussis (II, IC) (*287*).

H. Other measures

1. Limiting patient movement or transport
Limit the movement and transport of a patient with diagnosed or suspected pertussis from his room to those for essential purposes only. If the patient is transported out of the room, ensure that precautions are maintained to minimize the risk for disease transmission to other patients and contamination of environmental surfaces or equipment (IB) (*37*).

2. Limiting visitors
Do not allow persons who have symptoms of respiratory infection to visit pediatric, immunosuppressed, or cardiac patients (IB) (*37*,*286*,*311*).

Prevention and Control of Health-Care--Associated Pulmonary Aspergillosis

I. Staff Education and Infection Surveillance

A. Staff Education
Educate health-care personnel according to their level of responsibility about infection-control procedures to decrease the occurrence of health-care--associated pulmonary aspergillosis (II).

B. Surveillance

1. Maintain a high index of suspicion for health-care--associated pulmonary aspergillosis in severely immunocompromised patients (i.e., patients with severe, prolonged neutropenia [ANC <500/mm^3 for 2 weeks or <100/mm^3 for 1 week], most notably HSCT recipients, and including recipients of solid-organ transplants or patients with hematologic malignancies who are receiving chemotherapy, when they are severely neutropenic as defined previously) and persons receiving prolonged high-dose steroids (IA) (*312*--*319*).

2. Maintain surveillance for cases of health-care--associated pulmonary aspergillosis by establishing a system by which the facility's infection-control personnel are promptly informed when *Aspergillus* sp. is isolated from cultures of specimens from patient's respiratory tract and by periodically reviewing the hospital's microbiologic, histopathologic, and postmortem data (II).

3. Surveillance cultures

a. Do not perform routine, periodic cultures of the nasopharynx of asymptomatic patients at high risk (IB) (*320*,*321*).

b. Do not perform routine, periodic cultures of equipment or devices used for respiratory therapy, pulmonary function testing, or delivery of inhalation anesthesia in the HSCT unit, nor of dust in rooms of HSCT recipients (IB) (*321*).

c. No recommendation can be made about routine microbiologic air sampling before, during, or after facility construction or renovation or before or during occupancy of areas housing immunocompromised patients (Unresolved issue) (*95*,*322*).

4. In facilities with PEs, perform surveillance of the ventilation status of these areas either by continuous monitoring or periodic analysis of the following parameters: room air exchanges, pressure relations, and filtration efficacy to ensure that appropriate levels are maintained (IB) (*95*,*323*).

II. Prevention of Transmission of *Aspergillus* spp. Spores

A. Planning New Specialized-Care Units for High-Risk Patients

1. PE for allogeneic HSCT recipients

a. When constructing new specialized-care units with PE for HSCT recipients, ensure that patient rooms have adequate capacity to minimize accumulation of fungal spores via

1) HEPA filtration of incoming air (*324*),

2) directed room airflow,

3) positive air pressure in patient's room in relation to the corridor,

4) well-sealed room, and

5) high (≥12) air changes per hour (IB, IC) *(95;325-327*).

b. Do not use LAF routinely in PE (IB) (*95; 328-331*).

2. Units for autologous HSCT and solid-organ transplant recipients
No recommendation can be made for constructing PE for recipients of autologous HSCTs or solid-organ-transplants (e.g., heart, liver, lung, kidney) (Unresolved issue) (*95;331*).

B. In Existing Facilities with HSCT Units, and No Cases of Health-Care--Associated Aspergillosis

1. Placement of patients in PE

a. Place an allogeneic HSCT recipient in a PE that meets the conditions outlined in Section II-A-1 (IB).

b. No recommendation can be made for routinely placing a recipient of autologous HSCT or solid-organ transplant in a PE. (Unresolved issue)

2. Maintain air-handling systems in PE and other high-risk patient-care areas according to previously published CDC recommendations (IB,IC) (*95,325,327*)

3. Develop a water-damage response plan for immediate execution when water leaks, spills, and moisture accumulation occur to prevent fungal growth in the involved areas (IB) (*95,332*).

4. Use proper dusting methods for patient-care areas designated for severely immunocompromised patients (e.g., HSCT recipients) (IB) (*95,325,327, 328,333*).

a. Wet-dust horizontal surfaces daily using cloth that has been moistened with an EPA-registered hospital disinfectant (IB) (334).

b. Avoid dusting methods that disperse dust (e.g., feather dusting) (IB) (*334*).

c. Keep vacuums in good repair and equip them with HEPA filters for use in areas with patients at high risk (IB) (*333,334*).

d. Use vacuum cleaners that are equipped with HEPA filters in patient-care areas for the severely immunocompromised (IB) (*333,334*).

5. Do not use carpeting in hallways and rooms occupied by severely immunocompromised patients (IB) (*95,239,335*)

6. Avoid using upholstered furniture or furnishings in rooms occupied by severely immunocompromised patients (II).

7. Minimize the length of time that immunocompromised patients in PEs are outside their rooms for diagnostic procedures and other

activities (II).

a. Instruct severely immunocompromised patients to wear a high-efficiency respiratory-protection device (e.g., an N95 respirator) when they leave the PE during periods when construction, renovation, or other dust-generating activities are ongoing in and around the health-care facility (II) (*336*).

b. No recommendation can be made about the specific type of respiratory-protection device (e.g., surgical mask, N95 respirator) for use by a severely immunocompromised patient who leaves the PE during periods when there is no construction, renovation, or other dust-generating activity in progress in or around the health-care facility (Unresolved issue).

8. Systematically review and coordinate infection-control strategies with personnel in charge of the facility's engineering, maintenance, central supply and distribution, and catering services (IB) (*95,239,337,338*).

9. When planning construction, demolition, and renovation activities in and around the facility, assess whether patients at high-risk for aspergillosis are likely to be exposed to high ambient-air spore counts of *Aspergillus* spp. from construction, demolition, and renovation sites, and if so, develop a plan to prevent such exposures (IA) (*95,239,338*).

10. During construction, demolition, or renovation activities, construct impermeable barriers between patient-care and construction areas to prevent dust from entering the patient-care areas (IB) (*95, 326,339*).

11. Direct pedestrian traffic that come from construction areas away from patient-care areas to limit the opening and closing of doors or other barriers that might cause dust dispersion, entry of contaminated air, or tracking of dust into patient-care areas (IB) (*95,239,338--340*).

12. Do not allow fresh or dried flowers or potted plants in patient-care areas for severely immunocompromised patients (II) (*341*).

C. When a Case of Aspergillosis Occurs

1. Assess whether the infection is health-care--related or community-acquired.

a. Obtain and use the following information to help in the investigation: background rate of disease at the facility; presence of concurrent or recent cases, as determined by a review of the facility's microbiologic, histopathologic, and postmortem records; length of patient's stay in the facility before onset of

aspergillosis; patient's stay at, visit of, or transfer from, other health-care facilities or other locations within the facility; and the period the patient was exposed outside the health-care facility after the onset of immunosuppression and before onset of aspergillosis (II).

b. Determine if any ventilation deficiency exists in PEs (IB) (*95*).

2. If no evidence exists that the patient's aspergillosis is facility-acquired, continue routine maintenance procedures to prevent health-care-- associated aspergillosis, as in Section II-B-1 through II-B-12 (IB).

3. If evidence of possible facility-acquired infection with *Aspergillus* spp. exists, conduct an epidemiologic investigation and an environmental assessment to determine and eliminate the source of *Aspergillus* spp. (*95*) (IB). If assistance is needed, contact the local or state health department (IB).

4. Use an antifungal biocide (e.g., copper-8-quinolinolate) that is registered with the Environmental Protection Agency for decontamination of structural materials (IB) (*95*,*329*,*342--344*).

III. Chemoprophylaxis

A. No recommendation can be made for the routine administration of antifungal agents such as itraconazole oral solution (5 mg/kg/day) or capsules (500 mg twice a day), low-dose parenteral amphotericin B (0.1 mg/kg/day), lipid-based formulations of amphotericin B (1 mg/kg/day), or nebulized amphotericin B administered by inhalation as prophylaxis for pulmonary aspergillosis in patients at high-risk for this infection (Unresolved issue) (*239*,*345--356*).

B. No recommendation can be made for any specific strategy (e.g., deferral of hematopoietic stem-cell transplantation for a particular length of time or routine prophylaxis with absorbable or intravenous antifungal medications) to prevent recurrence of pulmonary aspergillosis in patients undergoing hematopoietic stem-cell transplantation who have a history of pulmonary aspergillosis (Unresolved issue) (*357--363*).

Prevention and Control of Health-Care--Associated Respiratory Syncytial Virus, Parainfluenza Virus, and Adenovirus Infections

I. Staff Education and Monitoring and Infection Surveillance

A. Staff Education and Monitoring

1. Staff education

a. Educate personnel in accordance with their level of responsibility in the health-care setting about the epidemiology, modes of transmission, and means of preventing the transmission of respiratory syncytial

virus (RSV) within health-care facilities (IB) (*364*).

b. Educate personnel in accordance with their level of responsibility in the health-care setting about the epidemiology, modes of transmission, and means of preventing the spread of parainfluenza virus and adenovirus within health-care facilities (II).

2. In acute-care facilities, establish mechanisms by which the infection-control staff can monitor personnel compliance with the facility's infection-control policies about these viruses (II) (*364*).

B. Surveillance

1. Establish mechanisms by which the appropriate health-care personnel are promptly alerted to any increase in the activity of RSV, parainfluenza virus, adenovirus, or other respiratory viruses in the local community. Establish mechanisms by which the appropriate health-care personnel can promptly inform the local and state health departments of any increase in the activity of the above-named viruses or of influenza-like illness in their facility (IB).

2. In acute-care facilities during periods of increased prevalence of symptoms of viral respiratory illness in the community or health-care facility and during the RSV and influenza season (i.e., December--March), attempt prompt diagnosis of respiratory infections caused by RSV, influenza, parainfliuenza, or other respiratory viruses. Use rapid diagnostic techniques as clinically indicated in patients who are admitted to the health-care facility with respiratory illness and are at high risk for serious complications from viral respiratory infections (e.g., pediatric patients, especially infants, and those with compromised cardiac, pulmonary, or immune function) (IA) (*364--368*).

3. No recommendation can be made for routinely conducting surveillance cultures for RSV or other respiratory viruses in respiratory secretions of patients (including immunocompromised patients, such as recipients of HSCT) (Unresolved issue) (*239*).

4. In long-term--care facilities, establish mechanism(s) for continuing surveillance to allow rapid identification of a potential outbreak in the facility (II).

II. Prevention of Transmission of RSV, Parainfluenza Virus, or Adenovirus

A. Prevention of Person-to-Person Transmission

1. Standard and contact precautions for RSV and parainfluenza virus and standard, contact, and droplet precautions for adenovirus

a. Hand hygiene

1) Decontaminate hands after contact with a patient or after touching respiratory

secretions or fomites potentially contaminated with respiratory secretions, whether or not gloves are worn. Use soap and water when hands are visibly dirty or contaminated with proteinaceous material or are visibly soiled with blood or other body fluids, and use an alcohol-based hand rub if hands are not visibly soiled (IA) (*37,364,369--375*).

b. Gloving

1) Wear gloves when entering the room of patients with confirmed or suspected RSV, parainfluenza, or adenovirus infection, or before handling the patients or their respiratory secretions or fomites potentially contaminated with the patients' secretions (IA) (*37,97,364,368,371--373,376,377*).

2) Change gloves between patients or after handling respiratory secretions or fomites contaminated with secretions from one patient before contact with another patient (*37,96,97,364*). Decontanimate hands after removing gloves (see II-A-1-a). (IA)

3) After glove removal and hand decontamination, do not touch potentially contaminated environmental surfaces or items in the patient's room (IB) (*37*).

c. Gowning

1) Wear a gown when entering the room of a patient suspected or proven to have RSV, parainfluenza virus, or adenovirus infection and when soiling with respiratory secretions from a patient is anticipated (e.g., when handling infants with suspected or proven RSV, parainfluenza, or adenovirus infection). Change the gown after such contact and before giving care to another patient or when leaving the patient's room. After gown removal, ensure that clothing does not come into contact with potentially contaminated environmental surfaces (IB) (*37,97*).

d. Masking and wearing eye protection

1) Wear a surgical mask and eye protection or a face shield when performing

procedures or patient-care activities that might generate sprays of respiratory secretions from any patient whether or not the patient has confirmed or suspected viral respiratory tract infection (IB) (*37*).

2) Wear a surgical mask and eye protection or a face shield when within 3 feet of a patient with suspected or confirmed adenovirus infection (IB) (*37*).

e. Patient placement in acute-care facilities

1) Place a patient with diagnosed RSV, parainfluenza, adenovirus, or other viral respiratory tract infection in a private room when possible or in a room with other patients with the same infection and no other infection (IB) (*37*,*367*--*369*, *376*,*377*).

2) Place a patient with suspected RSV, parainfluenza, adenovirus, or other viral respiratory tract infection in a private room (II).

a) Promptly perform rapid diagnostic laboratory tests on patients who are admitted with or who have symptoms of RSV infection after admission to the health-care facility to facilitate early downgrading of infection-control precautions to the minimum required for each patient's specific viral infection (IB) (*364*,*376*).

b) Promptly perform rapid diagnostic laboratory tests on patients who are admitted with or who have symptoms of parainfluenza or adenovirus infection after admission to the health-care facility to facilitate early downgrading of infection-control precautions to the minimum required for each patient's specific viral infection and early initiation of treatment when indicated (II).

f. Limiting patient movement or transport in acute-care

facilities

1) Limit to essential purposes only the movement or transport of patients from their rooms when they are diagnosed or suspected to be infected with RSV, parainfluenza virus, or adenovirus (IB) (*37*).

2) If transport or movement from the room is necessary

a) For a patient with diagnosed or suspected RSV or parainfluenza virus infection, ensure that precautions are maintained to minimize the risk for transmission of the virus to other patients and contamination of environmental surfaces or equipment by ensuring that the patient does not touch other persons' hands or environmental surfaces with hands that have been contaminated with his/her respiratory secretions (IB) (*37*).

b) For a patient with diagnosed or suspected adenovirus infection, minimize patient dispersal of droplets by having the patient wear a surgical mask, and ensure that contact precautions are maintained to minimize the risk for transmission of the virus to other patients and contamination of environmental surfaces or equipment (IB) (*37*).

2. Other measures in acute-care facilities

a. Staffing

1) Restrict health-care personnel in the acute stages of an upper respiratory tract infection from caring for infants and other patients at high risk for complications from viral respiratory tract infections (e.g.,

children with severe underlying cardio-pulmonary conditions, children receiving chemotherapy for malignancy, premature infants, and patients who are otherwise immunocompromised) (II) (*37,239,364, 368,369*).

2) When feasible, perform rapid diagnostic testing on health-care personnel with symptoms of respiratory tract infection, especially those who provide care to patients at high-risk for acquiring or developing severe complications from RSV, parainfluenza, or adenovirus infection, so that their work status can be determined promptly (II).

b. Limiting visitors
Do not allow persons who have symptoms of respiratory infection to visit pediatric, immunosuppressed, or cardiac patients (IB) (*37,239,364,376,377*).

c. Use of monoclonal antibody (palivizumab) for attenuation of RSV infection
Follow the recommendation of the American Academy of Pediatrics to consider monthly administration of palivizumab, an RSV monoclonal-antibody preparation, to the following infants and children aged <24 months:

1) those born prematurely at ≤32 weeks of gestational age that have bronchopulmonary dysplasia and those born prematurely at <32 weeks gestation without chronic lung disease who will be aged <6 months at the beginning of the RSV season.

2) those born at 32--35 weeks gestation if two or more of the following risk factors are present: child-care attendance, school-aged siblings, exposure to environmental pollutants, congenital abnormalities of the airways, or severe neuromuscular disease (II) (*378--381*).

3. Control of outbreaks in acute-care facilities

a. Perform rapid screening diagnostic tests for the particular virus(es) known or suspected to be causing the outbreak on patients who are admitted with symptoms of viral respiratory illness. Promptly cohort the patients (according to their specific infections) as

soon as the results of the screening tests are available (*364,365,367--369,376,377*). In the interim, when possible, admit patients with symptoms of viral respiratory infections to private rooms (IB).

b. Personnel cohorting

1) During an outbreak of health-care--associated RSV infection, cohort personnel as much as practical (e.g., restrict personnel who give care to infected patients from giving care to uninfected patients) (II) (*368,369,377*).

2) No recommendation can be made for routinely cohorting personnel during an outbreak of health-care--associated adenovirus or parainfluenza virus infection (Unresolved issue).

c. Use of RSV immune globulin or monoclonal antibody

1) No recommendation can be made for the use of RSV immune globulin or monoclonal antibody to control outbreaks of RSV infection in the health-care setting (Unresolved issue) (*378--386*).

Prevention and Control of Health-Care--Associated Influenza

I. Staff Education

Provide health-care personnel continuing education or access to continuing education about the epidemiology, modes of transmission, diagnosis, and means of preventing the spread of influenza, in accordance with their level of responsibility in preventing health-care--associated influenza (II) (*109,387--389*).

II. Surveillance

A. Establish mechanisms by which facility personnel are promptly alerted about increased influenza activity in the community (II).

B. Establish protocols for intensifying efforts to promptly diagnose cases of facility-acquired influenza

1. Determine the threshold incidence or prevalence of influenza or influenza-like illness in the facility at which laboratory testing of patients with influenza-like illness is to be undertaken and outbreak control measures are to be initiated (II) (*390*).

2. Arrange for laboratory tests to be available to clinicians for prompt diagnosis of influenza, especially during November--April (II) (*391--394*).

III. Modifying Host Risk for Infection

A. **Vaccination**

1. In acute-care settings (including acute-care hospitals, emergency rooms, and walk-in clinics) or ongoing-care facilities (including physicians' offices, public health clinics, employee health clinics, hemodialysis centers, hospital specialty-care clinics, outpatient rehabilitation programs, and mobile clinics), offer vaccine to inpatients and outpatients at high risk for complications from influenza beginning in September and throughout the influenza season (*108,395--397*). Groups at high risk for influenza-related complications include those aged ≥65 years; residents of nursing homes and other chronic-care facilities that house persons of any age who have chronic medical conditions; adults and children aged >6 months who have chronic disorders of the pulmonary or cardiovascular system, including asthma; adults and children who have required regular medical follow-up or hospitalization during the preceding year because of chronic metabolic diseases (including diabetes mellitus), renal dysfunction, or hemoglobinopathies, or immunosuppression (including immunosuppresssion caused by medications or HIV); children and adolescents (aged 6 months--18 years) who are receiving long-term aspirin therapy; and women who will be in the second or third trimester of pregnancy during the influenza season (*395,398--403*). In addition, offer annual influenza vaccination to all persons aged 50--64 years, close contacts of children aged <24 months, and healthy children aged 6--23 months (IA) (*395*).

2. In nursing homes and other long-term--care facilities, establish an SOP for timely administration of the inactivated influenza vaccine to persons at high risk as identified in Section III-A-1 (IA) (*109--111,395*).

a. Obtain consent for influenza vaccination (if such is required by local or state law) from every resident (or his/her guardian) at the time the resident is admitted to the facility or anytime afterwards before the next influenza season (IB) (*109,395,404*).

b. Routinely vaccinate all residents, except those with medical contraindication(s) to receipt of influenza vaccine (under an SOP or with the concurrence of the residents' respective attending physicians) at one time, annually, before the influenza season. To residents who are admitted during the winter months after completion of the facility's vaccination program, offer the vaccine at the time of their admission (IA) (*395,402,404,405*).

c. In settings not included in sections II-A-1 and -2, where health care is given (e.g., in homes visited by personnel from home health-care agencies), vaccinate patients for whom vaccination is indicated, as listed in section III-A-1, and refer patient's household members

and care givers for vaccination, before the influenza season (IA) (*395*).

3. Personnel

a. Beginning in October each year, provide inactivated influenza vaccine for all personnel including night and weekend staff (*395,406--10*). Throughout the influenza season, continue to make the vaccine available to newly hired personnel and to those who initially refuse vaccination. If vaccine supply is limited, give highest priority to staff caring for patients at greatest risk for severe complications from influenza infection, as listed in section III-A-1 (IA) (*395*).

b. Educate health-care personnel about the benefits of vaccination and the potential health consequences of influenza illness for themselves and their patients (IB) (*395*).

c. Take measures to provide all health-care personnel convenient access to inactivated influenza vaccine at the work site, free of charge, as part of employee health program (IB) (*395*).

B. Use of Antiviral Agents (See Section V-C)

IV. Prevention of Person-to-Person Transmission

A. Droplet Precautions

1. Place a patient who is diagnosed with influenza in a private room or in a room with other patients with confirmed influenza, unless medical contraindications exist (IB) (*37*).

2. Place a patient who is suspected to have influenza in a private room, and promptly perform rapid diagnostic laboratory tests to facilitate early downgrading of infection-control precautions to the minimum required for the patient's infection (II) (*37*).

3. Wear a surgical mask upon entering the patient's room or when working within 3 feet of the patient (IB) (*37*).

4. Limit the movement and transport of the patient from the room to those for essential purposes only. If patient movement or transport is necessary, have the patient wear a surgical mask, if possible, to minimize droplet dispersal by the patient (II) (*37*).

B. Eye Protection

No recommendation can be made for wearing an eye-protective device upon entering the room of a patient with confirmed or suspected influenza or when working within 3 feet of the patient (Unresolved issue).

C. Contact Precautions

No recommendation can be made for the observance of contact precautions (in addition to droplet precautions) for patients with confirmed or suspected influenza (Unresolved issue) (*37,411*).

D. Standard Precautions

1. Decontaminate hands before and after giving care to or touching a patient or after touching a patient's respiratory secretions, whether or not gloves are worn. If hands are visibly dirty or contaminated with proteinaceous material or are visibly soiled with blood or body fluids, wash them with either a nonantimicrobial soap and water or an antimicrobial soap and water. If hands are not visibly soiled, use an alcohol-based hand rub for their decontamination (IA) (*39*).

2. Wear gloves if hand contact with patient's respiratory secretions is expected (II) (*37,411*).

3. Wear a gown if soiling of clothes with patient's respiratory secretions is expected (II) (*37*).

E. Air Handling

No recommendation can be made for maintaining negative air pressure in rooms of patients in whom influenza is suspected or diagnosed, or in placing together persons with influenza-like illness in a hospital area with an independent air-supply and exhaust system (Unresolved issue) (*412--414*).

F. Personnel Restrictions

In acute-care facilities, use the facility's employee health service or its equivalent to evaluate personnel with influenza-like illness and determine whether they should be removed from duties that involve direct patient contact. Use more stringent criteria for personnel who work in certain patient-care areas (e.g., intensive care units, nurseries, and organ-transplant [especially HSCT]) where patients who are most susceptible to influenza-related complications are located (IB) (*415--417*).

V. Control of Influenza Outbreaks

A. Determining the Outbreak Strain

Early in the outbreak, perform rapid influenza virus testing on nasopharyngeal swab or nasal-wash specimens from patients with recent onset of symptoms suggestive of influenza. In addition, obtain viral cultures from a subset of patients to determine the infecting virus type and subtype (IB) (*391--394*).

B. Vaccination of Patients and Personnel

Administer current inactivated influenza vaccine to unvaccinated patients and health-care personnel (IA) (*395,402,406,408*).

C. Antiviral Agent Administration

1. When a facility outbreak of influenza is suspected or recognized:

a. Administer amantadine, rimantadine, or oseltamivir as prophylaxis to all patients without influenza illness in the involved unit for whom the antiviral agent is not

contraindicated (regardless of whether they received influenza vaccinations during the previous fall) for a minimum of 2 weeks or until approximately 1 week after the end of the outbreak. Do not delay administration of the antiviral agent(s) for prophylaxis unless the results of diagnostic tests to identify the infecting strain(s) can be obtained within 12--24 hours after specimen collection (IA) (*395,405, 418,419*).

b. Administer amantadine, rimantadine, oseltamivir, or zanamivir to patients acutely ill with influenza within 48 hours of illness onset. Choose the agent appropriate for the type of influenza virus circulating in the community (IA) (*395,405,418--421*).

c. Offer antiviral agent(s) (amantadine, rimantadine, or oseltamivir) for prophylaxis to unvaccinated personnel for whom the antiviral agent is not contraindicated and who are in the involved unit or taking care of patients at high risk (IB) (*395,405,418,419,422*).

d. Consider prophylaxis for all health-care personnel, regardless of their vaccination status, if the outbreak is caused by a variant of influenza that is not well matched by the vaccine (IB) (*395*).

e. No recommendation can be made about the prophylactic administration of zanamivir to patients or personnel (Unresolved issue) (*395,423--425*).

f. Discontinue the administration of influenza antiviral agents to patients or personnel if laboratory tests confirm or strongly suggest that influenza is not the cause of the facility outbreak (IA) (*426*).

g. If the cause of the outbreak is confirmed or believed to be influenza and vaccine has been administered only recently to susceptible patients and personnel, continue prophylaxis with an antiviral agent until 2 weeks after the vaccination (IB) (*395,427*).

2. To reduce the potential for transmission of drug-resistant virus, do not allow contact between persons at high risk for complications from influenza and patients or personnel who are taking an antiviral agent for treatment of confirmed or suspected influenza during and for 2 days after the latter discontinue treatment (IB) (*428--432*).

D. Other Measures in Acute-Care Facilities

When influenza outbreaks, especially those characterized by high attack rates and severe illness, occur in the community and/or facility:

1. Curtail or eliminate elective medical and surgical admissions (II) (*416*).
2. Restrict cardiovascular and pulmonary surgery to emergency

cases only (II) (*416*).
3. Restrict persons with influenza or influenza-like illness from visiting patients in the health-care facility (II) (*416*).
4. Restrict personnel with influenza or influenza-like illness from patient care (IB) (*416*).

Severe Acute Respiratory Syndrome

Updated information about prevention and control of severe acute respiratory syndrome in health-care facilities is available in a separate publication (*433*).

Part III: Performance Indicators

To assist infection-control personnel in assessing personnel adherence to the recommendations, the following performance measures are suggested:

1. Monitor rates of VAP; can use established benchmarks and definitions of pneumonia (e.g., NNIS definitions and rates) (*14*). Provide feedback to the staff about the facility's VAP rates and reminders about the need for personnel to adhere to infection-control practices that reduce the incidence of VAP.

2. Establish a SOP for influenza vaccination and monitor the percentage of eligible patients in acute-care settings or patients or residents in long-term--care settings who receive the vaccine.

3. Before and during the influenza season, monitor and record the number of eligible health-care personnel who receive the influenza vaccine and determine the desired unit- and facility-specific vaccination rates as recommended by ACIP.

4. Monitor the number of cases of health-care--associated RSV infections by geographic location within the facility and give prompt feedback to appropriate staff members to improve adherence to recommended infection-control precautions.

5. Periodically review clinicians' use of laboratory diagnostic tests (both culture of appropriate respiratory specimen and the urine antigen test) for legionellosis, especially in patients who are at high risk for acquiring the disease (e.g., patients who are immunosuppressed, including recipients of HSCT or solid-organ transplant, or patients receiving systemic steroids; patients aged >65 years; or patients who have chronic underlying disease such as diabetes mellitus, congestive heart failure, and COPD). Provide feedback on the use of these tests to clinicians.

6. During construction or renovation activities in the facility, monitor personnel adherence to infection-control measures (e.g., use of barriers, maintenance of negative room pressure) that are aimed at minimizing dust dispersion in patient-care areas. Review all cases of health-care--associated aspergillosis to determine the presence of remediable environmental risks.

7. Periodically monitor the frequency of diagnostic testing for pertussis and the time interval between suspicion of the infection and initiation of

isolation precautions for patients in whom pertussis is suspected.

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Box

BOX. Example of semicritical items* used on the respiratory tract

Anesthesia device or equipment including:
- face mask or tracheal tube
  - — inspiratory and expiratory tubing
  - — Y-piece
  - — reservoir bag
  - — humidifier
- Breathing circuits of mechanical ventilators
- Bronchoscopes and their accessories, except for biopsy forceps and specimen brush†
- Endotracheal and endobronchial tubes
- Laryngoscope blades
- Mouthpieces and tubing of pulmonary-function testing equipment
- Nebulizers and their reservoirs
- Oral and nasal airways
- Probes of CO_2 analyzers, air-pressure monitors
- Resuscitation bags
- Stylets
- Suction catheters
- Temperature sensors

* Items that directly or indirectly contact mucous membranes of the respiratory tract should be sterilized or subjected to high-level disinfection before reuse.
† Considered critical items and should be sterilized before reuse.

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