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Isolation Precautions in the Inpatient Setting



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KEYWORDS

- Standard precautions • Transmission-based precautions
- Droplet, airborne, contact precautions • Infectious disease transmission
- Hospital-acquired infections

HOSPITAL MEDICINE CLINICS CHECKLIST

1. Standard precautions are the hygienic measures applied to the care of all patients in health care settings regardless of the presence of infectious pathogens.
2. Transmission-based precautions are implemented for those patients who are known or suspected to be infected or colonized with an infectious agent, and therefore require additional control measures to effectively prevent transmission.
3. Transmission-based precautions should be applied empirically based on clinical suspicion and presence of defined disease processes associated with pathogenic organisms, while confirmatory tests are pending.
4. The most common indication for airborne precautions is suspicion for *Mycobacterium tuberculosis*, or primary or disseminated varicella zoster in an immunocompromised host.
5. The most common indications for droplet precautions are upper respiratory infections concerning for viral causes, or bacterial infections, including *Neisseria meningitidis* or *Haemophilus influenzae*.

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6. The most common indications for contact precautions are *Clostridium difficile* infection, colonization or infection with multidrug-resistant organisms, or excessive bodily secretions.
7. The duration of precaution use is determined by known activity and shedding of pathogens, and in most cases precautions are used for the duration of the illness.
8. A longer duration of droplet precaution use should be considered for immunocompromised patients given prolonged periods of viral shedding.
9. Isolation precautions should be discontinued in a timely manner as appropriate, because they can have a negative impact on patient care, patient experience, and adverse events.
10. Use of contact precautions to prevent infection by multidrug-resistant organisms has been shown to be cost-effective in a variety of health care settings.

DEFINITIONS*How are standard precautions defined?*

Standard precautions are the hygienic measures applied to the care of all patients in health care settings, regardless of suspected or confirmed presence of an infectious agent. Evidence shows that hands of health care personnel may transmit pathogens from one infected or colonized site or patient to another. In addition, shared patient care devices and instruments can also transmit pathogens if not properly sterilized. For this reason, every patient interaction should include use of standard precautions, as listed in **Box 1**.¹

Hand hygiene is an essential component of standard precautions, and can be performed either with soap and water or alcohol-based products. Alcohol-based products are preferred as long as there is no visible soiling of the hands, because they have superior microcidal activity, reduced skin drying properties, and are more convenient.¹ In addition, nail length and type can affect hand hygiene efficacy, because nails can harbor bacterial organisms and yeast, so artificial or unkempt nails should be discouraged in the health care setting.¹

Box 1**Elements of standard precautions**

Use of protective barriers

Proper hand hygiene

Disposal of hazardous waste

Cleaning contaminated surfaces

Respiratory hygiene and cough etiquette

Safe injection practices

Use of masks for lumbar puncture or contact with cerebrospinal fluid

Use of protective barriers, such as gown, gloves, and masks, is not always necessary but should be guided toward the specific clinical encounter and worn if contact with bodily fluids or respiratory secretions is expected.

How are transmission-based precautions defined and classified?

Transmission-based precautions are implemented for those patients who are known or suspected to be infected or colonized with an infectious agent, and therefore require additional control measures to effectively prevent transmission. These precautions include droplet, airborne, and contact, which are discussed in more detail later. Unless knowledge of the infection is known at the time of admission, these precautions are implemented empirically based on clinical suspicion, because confirmation of the infection can take time.¹

EPIDEMIOLOGY

What is the incidence, mortality, and cost associated with hospital-acquired infections?

Two decades ago, between 2 million and 4 million patients each year developed health care–acquired infections in the United States, costing more than \$4.5 billion in health care costs.² More recently approximately 700,000 health care–acquired infections are acquired annually in the United States, resulting in 75,000 deaths, which is the seventh leading cause of death in the United States.^{3,4} Despite this downward trend in the infection rate nationally, largely attributed to aggressive infection control measures, health care–related infections still represent a significant problem.^{3,4}

TRANSMISSION-BASED PRECAUTIONS

Droplet Precautions

What are droplet precautions?

Droplet precautions are appropriate for protection against droplets larger than 5 μm in size, which are spread through close respiratory or mucous membrane contact with respiratory secretions. Respiratory droplets carrying infectious pathogens transmit infection when traveling directly from the respiratory tract of an infectious individual to a susceptible mucosal surface serving as the portal of entry, such as the nasal mucosa, oral mucosa, or conjunctiva. These particles have the ability to travel short distances through the air after a precipitant such as a cough, sneeze, or procedure such as suctioning or intubation, necessitating coverage of the mouth and face.¹ The area of infectious risk has traditionally been defined as a distance of 1 m (3 feet) around a patient, although the distance traveled varies by pathogen type.¹ For this reason, droplet precautions are used on entry into a patient's room for conservative measures.

Box 2 lists pathogens that are spread via the droplet route of transmission and require enactment of droplet precautions.

What materials are required?

Droplet precautions are defined as masks and goggles, or a mask with a face shield, to prevent exposure of mucosal surfaces to respiratory secretions (**Fig. 1**).

Box 2**Pathogens spread via droplet route of transmission**

Bordetella pertussis^a

Influenza virus

Adenovirus

Rhinovirus

Mycoplasma pneumoniae

Group A *Streptococcus*

Neisseria meningitidis

Haemophilus influenzae

Corynebacterium diphtheriae

Mumps virus

^a One notable exception is respiratory syncytial virus (RSV) because this organism requires direct contact with infected secretions, necessitating contact precautions.

What is the indication to start droplet precautions?

All transmission-based precautions must be implemented based on clinical suspicion, and immediately on presentation of the patient to a health care facility. Diagnosis often requires laboratory confirmation with culture data techniques that require long periods of time; therefore, precautions should be implemented when these tests are still pending.

Specific clinical situations and the associated pathogens that warrant use of droplet precautions are shown in **Box 3**.



Fig. 1. Droplet isolation precautions. (Courtesy of UCSF Infection Control Department, San Francisco, CA; with permission.)

Box 3**Clinical syndromes warranting droplet precautions**

Meningitis (*N meningitidis*)

Petechial rash (*N meningitidis*)

Respiratory infection (viral causes)

Parotitis (mumps virus)

When can droplet precautions be discontinued?

Discontinuation of droplet precautions reflects the known patterns of infectious agent shedding and persistence. This period is longer if the patient is immunosuppressed, because shedding can continue for weeks.¹ In this setting, extension of the duration of precaution use is appropriate. **Box 4** provides guidance on specific organisms.

Box 4**Duration of precautions by pathogen***Droplet*

Diphtheria, pharyngeal: until 2 cultures 24 hours apart are negative

H influenzae: 24 hours after start of antibiotics

Pandemic influenza: 5 days after start of symptoms

N meningitidis: 24 hours after start of treatment

Mumps: 9 days after onset of treatment

M pneumoniae: duration of illness

Parvovirus B19: duration of hospitalization if immunocompromised

Bordetella pertussis: 5 days after onset of treatment

Airborne

Mycobacterium tuberculosis: 2 to 3 negative acid-fast bacilli sputum stains

Rubeola (measles): 4 days after appearance of rash

Variola (smallpox): duration of illness

Severe acute respiratory syndrome (SARS): 10 days after resolution of fever

Disseminated varicella zoster virus (VZV): duration of illness (also need contact precautions)

Contact

C difficile: duration of illness

Herpes simplex virus (HSV), VZV: lesions dry and crusted

Abscess or draining wound that cannot be covered: until cessation of drainage

Incontinence or excessive bodily fluids: duration of illness

RSV: duration of illness

Acute viral conjunctivitis: duration of illness

Rotavirus: duration of illness (may have prolonged shedding in immunocompromised hosts)

Lice, scabies: 24 hours after onset of treatment

Parainfluenza: duration of illness (may have prolonged shedding in immunocompromised hosts)

What is the efficacy in preventing disease spread?

The use of droplet precautions has been studied in both severe acute respiratory syndrome (SARS) and influenza epidemics and has proved effective in preventing respiratory spread of these viruses in particular. Mask usage was associated with significant decrease in the rate of infections in health care workers in multiple studies; similarly, inconsistent use was associated with higher risk of acquiring SARS.⁵ When assessing the efficacy of a surgical mask versus an N95 respirator in both the SARS epidemic and the recent 2008 to 2009 influenza epidemic, there were similar rates of infection, with the conclusion that droplet precautions are noninferior to airborne precautions for droplet-borne viral illnesses.^{5,6} Of note, despite these studies, airborne precautions are still recommended for use in the SARS virus.

Airborne Precautions*What are airborne precautions?*

Airborne transmission occurs when particles are created from desiccation of suspended droplets (<5 μm in size) and disseminated as airborne droplet nuclei. Alternatively, small particles in respiratory droplets can remain infective over long periods of time and distance when suspended in the air.¹ These pathogens can travel over long distances by air currents and be inhaled by individuals who are not in direct face-to-face contact with the infectious individual, even beyond the patient room environment. **Box 5** lists pathogens spread via the airborne route and requiring necessary precautions.

What materials are required?

Patients on airborne precautions require placement in rooms with special air handling and ventilation systems, referred to as an airborne infection isolation room. In addition, respiratory protection with a National Institute for Occupational Safety and Health–certified N95-level respirator is required, which prevents inhalation of small particles containing infectious agents (**Fig. 2**).

What is the indication to start airborne precautions?

All transmission-based precautions must be implemented based on clinical suspicion, and immediately on presentation to a health care facility. Certain clinical syndromes warrant suspicion of airborne pathogens, and necessitate initiation of airborne precautions. These clinical syndromes are shown in **Box 6**.

Box 5
Pathogens spread via airborne route of transmission

M tuberculosis
 Rubella (measles)
 Variola (smallpox)
 SARS
 Middle East respiratory syndrome (MERS)
 VZV, primary or disseminated



Fig. 2. Airborne isolation precautions. (Courtesy of UCSF Infection Control Department, San Francisco, CA; with permission.)

When can airborne precautions be discontinued for tuberculosis?

Current recommendations in the United States, Canada, and Europe support discontinuation of airborne precautions if 3 samples from the respiratory tract are negative for acid-fast bacilli (AFB) by smear. However, there is an emerging body of evidence that supports use of 2 negative AFB smears as a marker for discontinuation of precautions. Most respiratory smears for AFB that turn positive do so on the first smear (approximately 80%) or the second smear (an additional 2%–7%), whereas less than 2% turn positive on the third smear.^{7,8} In addition, approximately 12% of cultures that grew AFB had 3 negative AFB smears.^{7,8} Given these data, it is reasonable to change to a 2-smear approach, because reducing the number of sputum collections limits the time under airborne precautions and the associated implications for patient safety, satisfaction, and cost.

For discontinuation of airborne precautions for other indications, see **Box 4**.

What is the efficacy in preventing disease spread for tuberculosis?

Although there have been no clinical trials to guide these recommendations, observational studies and mathematical modeling suggest that all 3 of the following components are required for effective prevention of hospital-acquired tuberculosis:⁹

1. Rapid identification and diagnosis
2. Use of negative pressure ventilated rooms
3. Use of filtered masks

Box 6

Clinical syndromes warranting airborne precautions

Maculopapular rash with cough, coryza, fever (Rubeola)

Cough, fever, upper lobe pulmonary infiltrate (tuberculosis)

Vesicular rash (varicella zoster)

Cough, fever, lung infiltrate in patient with recent travel to country with known detection of emerging infections (eg, SARS, MERS)

Contact Precautions

What are contact precautions?

Contact precautions are intended to prevent transmission of infectious agents spread by direct or indirect contact with patients or their environments. There are 3 indications for use of contact precautions:

1. Presence of epidemiologically important multidrug-resistant microorganisms (MDRO)
2. Spore-forming organisms such as *Clostridium difficile*
3. Excessive wound drainage, bodily discharges, or fecal incontinence

The epidemiologically important multidrug-resistant organisms are included in **Box 7**. These organisms are resistant to all but a few commercially available antibiotic agents and are increasing in prevalence. For example, vancomycin-resistant *Enterococcus* (VRE) isolates accounted for less than 5% of enterococcal species in 1990, but accounted for up to 25% of isolates in 2000; extended-spectrum β -lactamase (ESBL)-producing gram-negative bacilli are now found in up to 44% of *Klebsiella* species.^{10,11}

Given the rapid increase in resistant organisms and limited therapeutic options, prevention of spread within health care settings is essential. These agents are spread manually by the hands of health care workers, and use of contact precautions has been shown to prevent spread and manage outbreaks.¹⁰

There is some evidence that routine, active surveillance for VRE rectal colonization in high-risk patients, as well as use of contact precautions, can prevent clinically significant VRE infections, but this has not been widely accepted.¹¹

The second indication for contact precautions is suspicion or confirmation of *C difficile* infection. *C difficile* is a spore-forming gram-positive anaerobic bacillus, accounting for the most common infectious cause of antibiotic-associated diarrhea and pseudomembranous colitis. Spores have the ability to persist for prolonged periods of time on patients and surfaces, are carried by hand-to-hand contact, and are resistant to routinely used disinfectants, making this pathogen a major cause of health care-associated diarrhea. Over the last decade there has been an increasing incidence and heightened transmissibility of this pathogen, caused in part by emergence of a new strain that produces an excess of toxins A and B, therefore increasing environmental contamination.

What materials are required?

Patients requiring contact precautions should be placed in a single-patient room, with strict adherence to hand hygiene and donning of isolation gowns and gloves to

Box 7

Multidrug-resistant organisms requiring use of contact precautions

- Methicillin-resistant *S aureus*
- Vancomycin-intermediate *S aureus*
- Vancomycin-resistant *S aureus*
- Vancomycin-resistant *Enterococcus*
- Extended-spectrum β -lactamase-producing organisms
- Carbapenem-resistant Enterobacteriaceae
- Multidrug-resistant *S pneumoniae*

prevent unintended contact with the patient's environment. When leaving the patient area, it is critical to remove the protective gear in the appropriate manner: first the gown, followed by the gloves, with care to limit contact with the exposed surface, followed by performance of hand hygiene (Fig. 3).

In addition, when contact precautions are ordered for *C difficile*, spores are resistant to standard alcohol-based sanitizers, so hand washing with soap and water is required after removing gown and gloves.

What is the indication to start contact precautions?

The clinical syndromes described in **Box 8** summarize when contact precautions should be initiated. Of note, contact precautions are not necessary for asymptomatic carriers of *C difficile*.

Controversy exists over the utility of isolation precaution use for health care-associated methicillin-resistant *Staphylococcus aureus* (MRSA). However, approximately 70% of MRSA identified on active surveillance testing were health care-associated isolates, suggesting the importance of preventing spread within the hospital setting.¹²

When can contact precautions be discontinued?

National guidelines are lacking to guide appropriate discontinuation of contact precautions for multidrug-resistant organisms; however, based on a national survey of those hospitals with policies regarding discontinuation, 78% of them require



Fig. 3. Contact isolation precautions. (Courtesy of UCSF Infection Control Department, San Francisco, CA; with permission.)

Box 8**Clinical syndromes warranting contact precautions**

Acute diarrhea with a likely infectious cause in diapered or incontinent patients

Vesicular rash (HSV, VZV, variola)

Abscess or draining wound that cannot be covered

Incontinence or excessive bodily fluids

Bronchiolitis (RSV)

Acute viral conjunctivitis

Lice

Scabies

confirmation of microbiological clearance.¹³ However, most institutions do not actively screen for clearance. Although there are no universally accepted guidelines, 2 methods can be used: (1) it can be assumed that MDRO carriers are colonized permanently and require the use of contact precautions for all hospitalizations; alternatively, (2) an interval free of hospitalizations, antimicrobial therapy, and invasive devices (6–12 months) followed by documentation of clearance can justify discontinuation of contact precautions.¹ This method may be more cost-effective, because data suggest that most patients clear MRSA colonization within months to years. Clearance can be proved with 3 negative nasal swabs for MRSA culture while off antibiotic therapy; alternatively a single nasal swab with MRSA polymerase chain reaction (PCR) is effective. Although PCR testing is more expensive, it may prevent prolonged precautions and the associated adverse effects on patient experience (discussed later).¹⁴ Without an active screening process, few individuals who have cleared MRSA will be identified, and they therefore require lifelong contact precautions per most hospital policies.

For other indications for discontinuation of contact precautions, see **Box 4**.

What is the efficacy in preventing disease spread?

Based on comprehensive transmission modeling, it is clear that both hand hygiene and use of contact precautions is efficacious in preventing spread of MDRO and infections associated with MDRO. Improving compliance with contact precautions decreases the prevalence of colonization as well as MDRO infections (eg, an increase in compliance from 60% to 80% decreases colonization by 10% and infections by 6%).¹⁵

Regarding prevention of *C difficile* infections, one of the most important factors is the degree to which it creates spores and survives on surfaces. Therefore, appropriate environmental control of the patient area has proved effective, assuming use of appropriate cleaning supplies (chlorine-based disinfectants and high-concentration hydrogen peroxide agents). In addition, gloving prevents contact with spores, and although use of gowns has not been well studied, it presumably reduces contact with the environment and contamination of clothes.¹⁶

PERFORMANCE IMPROVEMENT/IMPLICATIONS*What is the cost associated with the use of isolation precautions (and screening)?*

There has been controversy over the cost associated with the use of isolation precautions to prevent spread of MDRO, specifically for screening and precaution

implementation for patients colonized by MRSA. Cost-effectiveness analyses have shown that universal active screening on admission followed by use of contact precautions for those identified as MRSA carriers costs approximately \$10 per admission. However, the potential benefit is realized in the prevention of hospital-acquired MRSA infections. When assessing the cost efficacy across a wide range of prevalence values of MRSA within the institution, screening and use of precautions proved to be the dominant strategy, suggesting that universal screening is the cost-effective strategy.^{3,4,17}

For *C difficile*, a large proportion of hospital-acquired infections are from asymptomatic carriers (84%).¹⁸ Most health care facilities do not currently screen for asymptomatic carriers; however, when evaluating the cost-efficacy data of screening and use of contact precautions, it is reasonable to conclude that the screening and use of contact precautions necessary to prevent 1 case of *C difficile* (with a median cost of approximately \$5000–\$10,000) infection is likely cost-effective.¹⁸ This policy is not yet implemented routinely into practice, but may be in the future.

What is the environmental impact associated with the use of isolation precautions?

The environmental impact associated with use of isolation precautions in the hospital setting is largely attributed to the use of gowns. Most hospitals use single-use gowns for contact precautions, which consume a significant amount of raw materials and energy in their manufacture and transport, and waste once used. To put this into perspective, hospital waste accounts for 2% of national municipal waste, and, of that, gowns and drapes contribute approximately 2% of all hospital waste, or approximately 0.04% of all municipal waste.¹⁹ This is a small overall proportion of waste in this country; however, there may be more environmentally friendly options. With emerging technologies, reusable gowns, compared with disposable gowns, have substantial sustainability benefits with respect to the use of energy and water, and the creation of carbon footprint and waste.²⁰

What is the impact of isolation precautions on patient satisfaction and the patient experience?

Although precautions are essential for infection control, use of precautions has been associated with adverse events regarding patient care. Studies have shown a negative impact on patient mental well-being and behavior, as well as higher depression scores. In addition, health care workers spend less time in direct patient contact, and patient satisfaction decreased as patients perceived they were less well informed of their health care plans.²¹ Regarding patient safety, there was an 8-fold increase in adverse events related to supportive care when patients required the use of isolation precautions.^{22,23} With these data in mind, every effort should be made to provide routine care despite the use of precautions, with the emphasis on timely discontinuation of precautions when appropriate.

What is the impact of a hospital-based infection control program?

Ultimately, the measures discussed earlier should all be part of a well-organized infection control program, because this has been shown to produce better outcomes. In those hospitals with robust programs, there was a 32% reduction in 4 nosocomial infections (catheter-associated urinary tract infections, ventilator-associated pneumonia, surgical site infections, and central line-associated bloodstream infections).¹ The scope of infection control programs continues to grow as the importance of

hospital-acquired infections becomes better understood. Ultimately, questions regarding use of isolation precautions and infection control measures should be guided by local institutional policies.

CLINICAL GUIDELINES

1. 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare settings. US Centers for Disease Control and Prevention.¹

REFERENCES

1. Siegel JD, Rhinehart E, Jackson M, et al, Healthcare Infection Control Practices Advisory Committee. 2007 Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings. *Am J Infect Control* 2007; 35(10 Suppl 2):S65–164. Available at: <http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf>. Accessed May 10, 2015.
2. Centers for Disease Control and Prevention (CDC). Public health focus: surveillance, prevention, and control of nosocomial infections. *MMWR Morb Mortal Wkly Rep* 1992;41(42):783–7.
3. McKinnell JA, Bartsch SM, Lee BY, et al. Cost-benefit analysis from the hospital perspective of universal active screening followed by contact precautions for methicillin-resistant *Staphylococcus aureus* carriers. *Infect Control Hosp Epidemiol* 2015;36(1):2–13.
4. Murthy A, De Angelis G, Pittet D, et al. Cost-effectiveness of universal MRSA screening on admission to surgery. *Clin Microbiol Infect* 2010;16(12):1747–53.
5. Gamage B, Moore D, Copes R, et al, BC Interdisciplinary Respiratory Protection Study Group. Protecting health care workers from SARS and other respiratory pathogens: a review of the infection control literature. *Am J Infect Control* 2005; 33:114–21.
6. Loeb M, Dafoe N, Mahony J, et al. Surgical mask versus N95 respirator for preventing influenza among healthcare workers. *JAMA* 2009;302(17):1865–71.
7. Craft DW, Jones MC, Blanchet CN, et al. Value of examining three acid-fast bacillus sputum smears for removal of patients suspected of having tuberculosis from the “airborne precautions” category. *J Clin Microbiol* 2000;38(11):4285–7.
8. Wilmer A, Bryce E, Grant J. The role of the third acid-fast bacillus smear in tuberculosis screening for infection control purposes: a controversial topic revisited. *Can J Infect Dis Med Microbiol* 2001;22(1):e1–3.
9. Humphreys H. Control and prevention of healthcare-associated tuberculosis: the role of respiratory isolation and personal respiratory protection. *J Hosp Infect* 2007;66(1):1–5.
10. Sturenburg E, Mack D. Extended-spectrum B-lactamase: implications for the clinical microbiology laboratory, therapy, and infection control. *J Infect* 2003;47(4): 273–95.
11. Price C, Paule S, Noskin G, et al. Active surveillance reduces the incidence of vancomycin-resistant enterococcal bacteremia. *Clin Infect Dis* 2003;37(7):921–8.
12. Jarvis W, Schlosser J, Chinn R, et al. National prevalence of methicillin-resistant *Staphylococcus aureus* in inpatients at US health care facilities, 2006. *Am J Infect Control* 2007;35(10):631–7.
13. Shenoy ES, Hsu H, Noubary F, et al. National survey of infection preventionists: policies for discontinuation of contact precautions for methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant *Enterococcus*. *Infect Control Hosp Epidemiol* 2012;33(12):1272–5.

14. Shenoy E, Kim J, Rosenberg E, et al. Discontinuation of contact precautions for methicillin-resistant *Staphylococcus aureus*: a randomized controlled trial comparing passive and active screening with culture and polymerase chain reaction. *Clin Infect Dis* 2013;47(2):176–84.
15. D'Agata E, Horn M, Ruan S, et al. Efficacy of infection control interventions in reducing the spread of multidrug-resistant organisms in the hospital setting. *PLoS One* 2012;7(2):e30170.
16. Gerding D, Muto C, Owens R Jr. Measures to control and prevent *Clostridium difficile* infection. *Clin Infect Dis* 2008;46(Suppl 1):S43–9.
17. Lee B, Bailey R, Smith K, et al. Universal methicillin-resistant *Staphylococcus aureus* surveillance for adults at hospital admission: an economic model and analysis. *Infect Control Hosp Epidemiol* 2010;31(6):598–606.
18. Bartsch S, Curry S, Harrison L, et al. The potential economic value of screening hospital admissions for *Clostridium difficile*. *Eur J Clin Microbiol Infect Dis* 2012; 31(11):3163–71.
19. Rutala W, Weber D. A review of single-use and reusable gowns and drapes in healthcare. *Infect Control Hosp Epidemiol* 2001;22(4):248–57.
20. Overcash M. A comparison of reusable and disposable perioperative textiles: sustainability state-of-the art. *Anesth Analg* 2012;114(5):1055–66.
21. Masse V, Valiquette L, Boukhoudmi S, et al. Impact of methicillin-resistant *Staphylococcus aureus* contact isolation units on medical care. *PLoS One* 2013;8(2): e57057.
22. Abad C, Fearday A, Safdar N. Adverse effects of isolation in hospitalized patients: a systematic review. *J Hosp Infect* 2010;76(2):97–102.
23. Morgan D, Diekema D, Sepkowitz K, et al. Adverse outcomes associated with contact precautions: a review of the literature. *Am J Infect Control* 2009;37(2): 85–93.