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AORN eGuidelines+

Guidelines for Perioperative Practice: Environmental Cleaning

The Guideline for Environmental Cleaning was approved by the AORN Guidelines Advisory Board and became effective as of January 13, 2020. The recommendations in the guideline are intended to be achievable and represent what is believed to be an optimal level of practice. Policies and procedures will reflect variations in practice settings and/or clinical situations that determine the degree to which the guideline can be implemented. AORN recognizes the many diverse settings in which perioperative nurses practice; therefore, this guideline is adaptable to all areas where operative or other invasive procedures may be performed.

Purpose

This document provides guidance on the selection and use of cleaning products, cleaning procedures, personnel education and competency verification, and monitoring cleanliness through performance improvement processes. All perioperative team members have a responsibility to provide a **clean** and safe environment for patients. Perioperative and environmental services leaders can cultivate an environment in which perioperative and environmental services personnel work collaboratively to accomplish cleanliness in a culture of safety and mutual support.

Researchers have shown that cleaning practices in the operating room (OR) are not always thorough or consistent with the policies of the health care organization.[1-3] Jefferson et al[3] observed a mean cleaning rate of 25% for objects monitored in the OR setting in six acute care hospitals. Munoz-Price et al[1] observed cleaning in 43 ORs of a large urban hospital and found only 50% of the surfaces were being cleaned. In both studies, fluorescent gel markers were used to measure cleanliness. These findings demonstrate that some ORs may not be as clean as previously thought,[1] although the literature has not defined the concept of cleanliness.

In a literature review, Ibrahimi et al[4] stated that the amount of bacteria present in the operative site is one of the most important factors associated with surgical site infection (SSI) development, although the minimum number of bacteria that causes an infection varies depending on the qualities of the organism, the host, and the procedure performed. The review authors also found that **fomites** near the surgical field may harbor bacteria. These fomites may serve as a reservoir for wound contamination through either direct contact with the patient's skin or by personnel contact with the fomite and subsequent skin-to-skin or glove-to-skin contact with the patient.

A high risk for pathogen transmission exists in the perioperative setting because of multiple contacts between perioperative team members, patients, and environmental surfaces.[5-7] Cleaning and disinfecting the environment is a basic infection prevention principle used to reduce the likelihood that exogenous sources will contribute to health care–associated infections (HAIs).[8,9] Operating room environmental surfaces and equipment can become contaminated with pathogens that cause SSIs, particularly if cleaning is suboptimal, and pathogens can then be transmitted to the hands of perioperative team members. Thus, thorough cleaning and

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disinfection of **high-touch objects** as part of a comprehensive **environmental cleaning** and disinfection program that includes hand hygiene are essential in preventing the spread of potentially pathogenic microorganisms.[1]

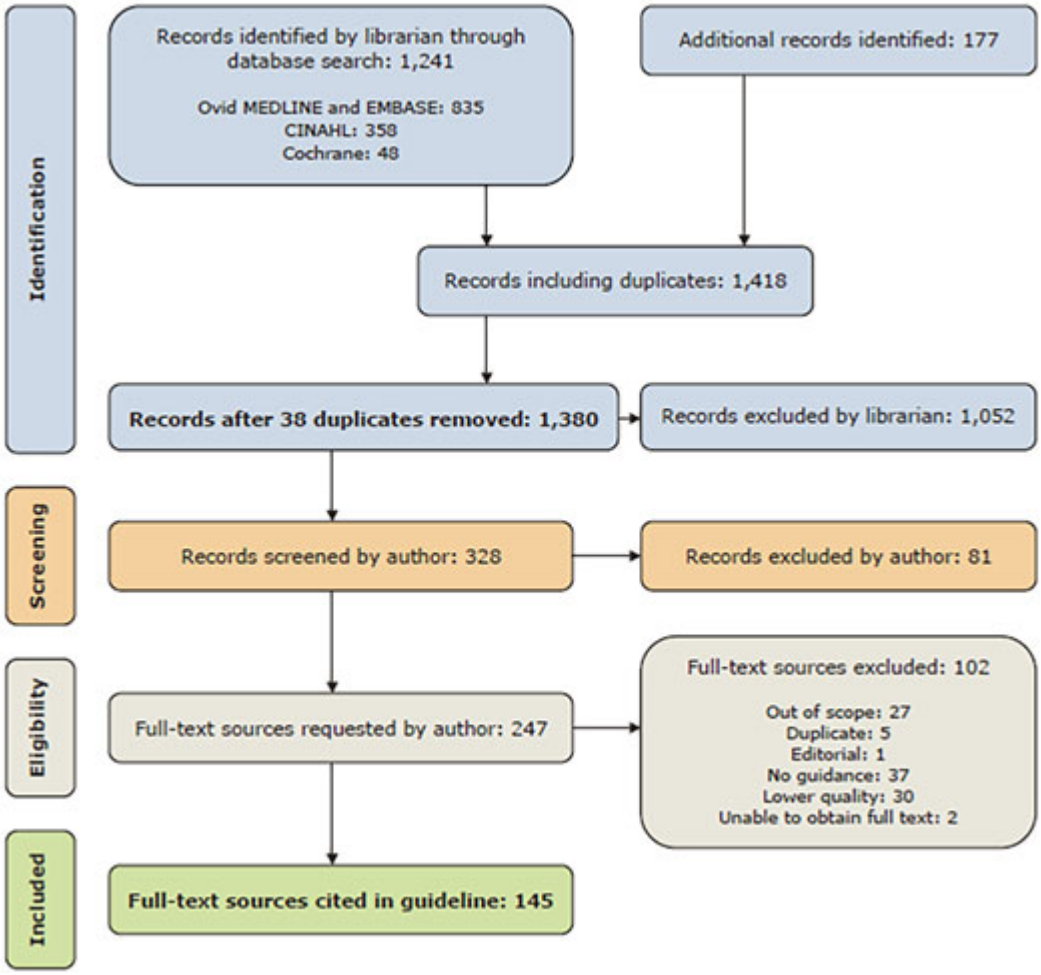
In a prospective multifacility observational study, Loftus et al[10] followed patients undergoing general anesthesia (N = 548) to identify which bacterial reservoir was associated with transmission events from intravenous (IV) tubing three-way stopcocks. The researchers sampled three bacterial reservoirs: providers' hands, the patient's axillae and nasopharynx, and two high-touch sites on the anesthesia machine. All three reservoirs contributed to transmission, although 64% of stopcock contamination was traced to the anesthesia machine. The researchers also linked the bacterial reservoirs to 30-day postoperative infections. Loftus et al[11] conducted a subset analysis of the previous study[10] and found that gram-negative organisms caused 85% of the HAIs, with the source most often being the anesthesia machine. In two additional analyses[12,13] of the original data,[10] researchers examined the transmission of *Staphylococcus aureus* and found that two strains were frequently transmitted in the anesthesia work area and were highly transmissible, virulent, and drug resistant.

Other studies have identified microorganisms that contribute to environmental contamination of surfaces in the OR, including staphylococcal species,[1,5,14,15] *Corynebacterium* species,[14] *Micrococcus* species,[6,14] *Bacillus* species,[6,14] *Klebsiella pneumoniae*,[1,16] *Pseudomonas* species,[1,6] *Acinetobacter* species,[1] *Enterococcus* species,[1,17] and *Escherichia coli.*[1]

Environmental cleaning and disinfection includes considerations for a safe environment of care, transmission-based precautions, and hand hygiene. Although these topics are mentioned briefly where applicable (eg, standard precautions), they are addressed in other AORN guidelines,[18-20] and broader discussions are outside the scope of this document. Laundering of textiles and evaluation of self-disinfecting surfaces are also outside the scope of these recommendations.

Figure 1

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Flow Diagram of Literature Search Results

Adapted from: Moher D, Liberati A, Tetzlaff J, Atman DG; The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. *2009;6(6):e1000097.*

Evidence Review

A medical librarian with a perioperative background conducted a systematic search of the databases Ovid MEDLINE®, Ovid Embase®, EBSCO CINAHL®, and the Cochrane Database of Systematic Reviews. The search was limited to literature published in English from January 2013 through November 2018. At the time of the initial search, weekly alerts were created on the topics included in that search. Results from these alerts were provided to the lead author until May 2019. The lead author requested additional articles that either did not fit the original search criteria or were discovered during the evidence appraisal process. The lead author and the medical librarian also identified relevant guidelines from government agencies, professional organizations, and standards-setting bodies.

Search terms included *adenosine triphosphate, air sampling, ambulatory surgery center/facilit*, ants, aspergill*, auto scrubber, bacterial count, bacterial load, bedding and linens, beds, bioluminescence detection, bleach, body fluids, central processing, central service department, central supply (hospital), checklist, cleaning program/regimen/schedule/standard/policies/guideline/protocol/routine, cleaning zone, cleansing agents, cloths, cockroaches, colony count (microbial), contact surface, contact time, Creutzfeldt-Jakob disease/syndrome, cross infection, curtains, decontamination, decontamination (hazardous materials), detergents, diphtheria, disease reservoirs, disease transmission (infectious), disinfectants, disinfection, dust,*

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dwell time, enhanced environmental cleaning, environmental microbiology/monitoring/cleaning/services/surface, fleas, flies, fluid waste management, fluorescent light, fomites, gram-negative bacteria, gram-positive bacteria, green cleaning, healthcare associated infection, heater-cooler, high-touch objects/ surfaces, hospital housekeeping, hospital laundry service, housekeeping department, housekeeping (hospital), hydrogen peroxide, ice machine, infection control, insects, keyboard covers, laundry, laundry department, laundry service (hospital), lice, luminescent measurements, mattresses, microbial colony count, microfib, mites, mouse, nosocomial infection, occupational health/exposure/ injuries/safety, operating room tables, operating rooms/suites/ theat*, ozone, patient monitors/transfer board, pest control/management, phenols, Phthiraptera, previous patient, prior patient/ room occupant, quaternary ammonium compounds/disinfectant, room contamination, scrub sink, silver, Siphonaptera, sodium hypochlorite, solvents, sterile processing/supply, sterilization and disinfection, sticky mat, storage areas, subacute spongiform encephalopathy, surgical wound infection, surgical wound infection, surgicenters, tacky mat, terminal cleaning/disinfection/ decontamination, textiles, ultraviolet light, ultra-violet light, ultraviolet rays, vermin, viruses, visual inspection, waste disposal (fluid),* and *wet time*.

Included were research and non-research literature in English, complete publications, and publications with dates within the time restriction when available. Historical studies were also included. Excluded were non-peer-reviewed publications and older evidence within the time restriction when more recent evidence was available. Editorials, news items, and other brief items were excluded. Low-quality evidence was excluded when higher-quality evidence was available, and literature outside the time restriction was excluded when literature within the time restriction was available (Figure 1).

Articles identified in the search were provided to the project team for evaluation. The team consisted of the lead author and one evidence appraiser. The lead author and the evidence appraiser reviewed and critically appraised each article using the AORN Research or Non-Research Evidence Appraisal Tools as appropriate. A second appraiser was consulted if there was a disagreement between the lead author and the primary evidence appraiser. The literature was independently evaluated and appraised according to the strength and quality of the evidence. Each article was then assigned an appraisal score. The appraisal score is noted in brackets after each reference as applicable.

Each recommendation rating is based on a synthesis of the collective evidence, a benefit-harm assessment, and consideration of resource use. The strength of the recommendation was determined using the AORN Evidence Rating Model and the quality and consistency of the evidence supporting a recommendation. The recommendation strength rating is noted in brackets after each recommendation.

Note: The evidence summary table is available at http://www.aorn.org/evidencetables/.

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Recommendations

1.

Product Selection and Use

1.1

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Have an interdisciplinary team select disinfectants for use in the perioperative setting based on the following factors:

- Environmental Protection Agency (EPA) registration and hospital-grade rating[8,21] ;
- targeted microorganisms[8,22-24] ;
- **contact times**[8,22,25,26] ;
- manufacturers' instructions for use (IFU)[8,21,23] ;
- compatibility with surfaces, cleaning materials, and equipment[8,21,24,26] ;
- patient population (eg, neonatal)[8,21] ;
- cost[8,21,22,24,26] ;
- safety[8,21,26-29] ; and
- effect on the environment.[21] *[Recommendation]*

A standardized product selection process assists in the selection of functional and reliable products that are safe, cost-effective, and **environmentally preferable** and that promote quality care, as well as decreases duplication or rapid obsolescence.[21,30] For further guidance on pre-purchase evaluation, see the AORN Guideline for Medical Device and Product Evaluation.[30]

The Centers for Disease Control and Prevention (CDC) recommends that EPA-registered disinfectants be used in health care settings.[8]

1.1.1

Do not use high-level disinfectants or liquid chemical sterilants to clean and disinfect environmental surfaces or noncritical devices.[8,26] ***[Recommendation]***

These chemicals are not intended for use on environmental surfaces and are not labeled for use as low- or intermediate-level disinfectants. Potential harms include chemical safety hazards for personnel and patients and damage to surfaces or equipment, which could create a reservoir for pathogens.

1.1.2

Do not use alcohol (ie, ethyl alcohol 60%– 90%, isopropyl alcohol 60%–90%) to disinfect large environmental surfaces (eg, tables, OR bed).[8] ***[Recommendation]***

The risk for fire is a potential harm of using alcohol to disinfect environmental surfaces in the OR because of the oxygenated environment and presence of ignition sources. Furthermore, alcohol (eg, isopropyl alcohol 70%) is an antiseptic and is not an EPA-registered disinfectant.

1.1.3

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Do not use disinfectants (eg, phenolics) to clean infant bassinets or incubators while these items are occupied.[8,21] If disinfectants (eg, phenolics) are used to terminally clean infant bassinets or incubators, prepare solutions in the correct concentrations per the manufacturer's IFU and rinse treated surfaces with water.[8,21] *[Recommendation]*

Hyperbilirubinemia in newborns has been linked to poor ventilation and cleaning of incubators and other nursery surfaces with inadequately diluted phenolic solutions.[8]

1.2

Cleaning chemicals must be prepared, handled, used, stored, and disposed of in accordance with manufacturers' IFU and local, state, and federal regulations.[8,23,25,31] *[Regulatory Requirement]*

The users of EPA-registered disinfectants are required to follow the manufacturers' IFU in accordance with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and noncompliance can be punishable by law.[25] Microbial contamination of disinfectants has been reported with improper dilution of the disinfectant.[8,25]

1.2.1

If the cleaning chemical is removed from the original container, the secondary container must immediately be labeled with the chemical name, concentration, and expiration date.[31] *[Regulatory Requirement]*

1.2.2

If there are no disposal restrictions from regulatory bodies, cleaning chemicals may be discarded along with copious amounts of cold utility water into a drain connected to a sanitary sewer.[26] *[Conditional Recommendation]*

1.3

Safety data sheets must be available and reviewed for each cleaning chemical used in the perioperative setting.[31] *[Regulatory Requirement]*

1.4

Conduct an annual chemical hazard risk assessment of all cleaning chemicals in use.[26,31] *[Recommendation]*

Assessing chemical hazards annually provides a mechanism for reviewing updated chemical safety data from the manufacturers and for identifying new, safer products that become available. For further guidance see the AORN Guideline for a Safe Environment of Care.[18]

1.5

Before applying a disinfectant, remove visible soil (eg, dust, debris) from the surface.[21,25] *[Recommendation]*

The presence of visible soil, dirt, and organic material inhibits the process of disinfection by preventing the disinfectant from interacting with the surface.[21,26]

1.6

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Do not use a spray bottle to apply disinfectants to environmental surfaces in the perioperative practice setting.[8] *[Recommendation]*

Disinfectants that are sprayed produce more aerosols than solutions that are poured or ready-to-use wipes.[8] If the cleaning solution is contaminated, the spray mechanism may provide a route for airborne transmission of disease.[8] Aerosols generated may contaminate the surgical wound, sterile supplies, or the sterile field, or may cause respiratory symptoms (acute or chronic) in personnel and patients.

1.6.1

Disinfectants may be applied by a cloth or poured onto environmental surfaces in a manner that prevents splashing.[21] *[Conditional Recommendation]*

1.7

Apply the disinfectant for the contact time required on the product label for the targeted microorganism (eg, bacteria, viruses, *Clostridioides difficile* [formerly called *Clostridium difficile*]).[21,25] If the IFU require that the surface remain wet for the duration of the contact time, reapply the disinfectant as needed. *[Recommendation]*

The contact time required for disinfection varies by the type of microorganism and disinfectant. The manufacturer determines the amount of contact time needed to kill various types of microorganisms, and this is listed on the product label. If the disinfectant does not remain in contact with the microorganism for the full contact time, disinfection may not be achieved.[22,32]

Hong et al[32] conducted a nonexperimental study to evaluate the bactericidal efficacy of accelerated hydrogen peroxide, quaternary ammonium compounds, and sodium hypochlorite liquid disinfectants against *S aureus* and *Pseudomonas aeruginosa* on hard nonporous surfaces at six different contact times and eight different concentrations. The researchers found that deviation from label contact time or concentrations significantly reduced the disinfectants' efficacy.

In a quasi-experimental study, West et al[33] tested six types of disinfectant towelettes at 10 different contact times (ie, 30 seconds, 1 minute, 2 minutes, 3 minutes, 4 minutes, 5 minutes, 10 minutes, 20 minutes, 30 minutes, 60 minutes) to determine whether contact time and dry time influenced bactericidal efficacy against *S aureus.* The researchers found significant differences in the time it took the disinfectants to dry completely. Extending the recommended contact time or dry time beyond 30 seconds did not enhance disinfection; the log reductions at 30 seconds were not significantly different from those at 60 minutes. Towelette composition (eg, inactive ingredients, alcohol presence, disinfectant concentration) was also a significant variable in bactericidal efficacy.

Rutala et al[34] conducted a quasi-experimental study to test common health care disinfectants (ie, quaternary ammonium compound, phenolic, sodium hypo-chlorite) against *S aureus, Escherichia coli, P aeruginosa,* and *Salmonella choleraesuis* at 30 seconds and 5 minutes. The researchers found that the maximum log reduction was achieved in 30 seconds and was identical to the log reduction at 5 minutes.

West et al[35] conducted a nonexperimental comparative study to test the efficacy of 10 different disinfectant wipes over a 1-, 2-, 4-, and 8-ft square surface area. In this study, the wipes that dried out first reduced the amount of *Staphylococcus* and *Pseudomonas* species better than wipes that stayed wet longer. As the surface area increased, less disinfectant was applied by the wipes.

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Regardless of the research findings, using a contact time that differs from the EPA-registered product label is considered off-label use, and as such the user assumes liability for any injuries and is potentially subject to enforcement action under FIFRA.[25]

1.8

Have an interdisciplinary team select cleaning materials, tools, and equipment based on the following factors:

- surface composition of the items to be cleaned,[21,36]
- manufacturers' IFU for cleaning materials and equipment,[21]
- compatibility with detergents and disinfectants,[21,37]
- durability and life cycle,[21,22,36]
- cost,[21]
- personnel ergonomics and safety,[21] and
- effect on the environment.[21] *[Recommendation]*

A standardized product selection process assists in the selection of functional and reliable products that are safe, cost-effective, and environmentally preferable and that promote quality care, as well as decreases duplication or rapid obsolescence.[21,30] Effective cleaning and disinfection is accomplished when the correct tools and equipment are paired with the correct chemical solutions.[21]

In a quasi-experimental study, Gonzalez et al[36] tested five types of disinfectant wipes on anesthesia machine surfaces and simulated smooth and ridged knobs. The researchers found that device design and the texture of the cleaning cloth affected bacterial removal.

1.8.1

Use low-linting cleaning materials (eg, mop heads, cloths).[38,39] ***[Recommendation]***

Excess lint can be deposited onto surfaces in the perioperative environment where it can be aerosolized and carried to the surgical wound or sterile supplies.

1.8.2

Determine whether to select reusable or single-use cleaning materials (eg, mop heads, cloths) based on the following factors:

- laundering processes,
- laundry turnaround time,
- size of the areas to be cleaned,
- frequency of cleaning,

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- cost,
- effect on the environment, and
- storage space.[8,21,40] *[Recommendation]*

1.8.3

Microfiber cleaning materials may be used.[21,38,39] *[Conditional Recommendation]*

In a comparative study, Rutala et al[38] reported that microfiber mopping systems were more effective than cotton string mops at microbial removal (95% and 68% respectively) and that microbial removal with microfiber was equally effective with and without use of a disinfectant. Diab-Elschahawi et al[39] found in a comparative study that although microfiber cloths were best for decontamination, cotton was most effective after multiple launderings. However, the laundering methods used to process the microfiber cloths in this study were at a higher temperature than that recommended by the CDC, which may have altered their effectiveness.

In another nonexperimental study, Sifuentes et al[41] evaluated the effect of laundering and cleaning practices at 10 facilities on microbial load of both cotton and microfiber towels. The researchers found that regardless of the laundering method (ie, central, in-house laundering), microfiber towels had significantly greater microbial contamination than cotton towels.

Trajtman et al[42] conducted a quasi-experimental study to evaluate the removal and transfer of *C difficile* spores from moistened ceramic surfaces using both cotton and microfiber cloths on a simulated cleaning apparatus. The cotton cloths transferred spores between wet surfaces significantly more often than the microfiber cloths, and the microfiber cloths released significantly fewer spores onto the clean surface than cotton cloths.

Additional research is needed to determine the most effective material for cleaning and disinfecting environmental surfaces in perioperative areas.[24]

1.8.4

Do not use a broom with bristles to sweep the floor in the semi-restricted and restricted areas. *[Recommendation]*

Brooms with bristles are difficult to clean and may harbor pathogens that can be aerosolized during sweeping.

1.9

Dedicate cleaning materials, tools, and equipment for use only in restricted and semi-restricted areas.[21] *[Recommendation]*

The wheels on cleaning carts and equipment can transfer soil and microorganisms from areas outside the restricted and semi-restricted areas. Dedicated equipment may prevent cross contamination of the OR from other patient care areas.[21]

1.10

Before storage and reuse, disassemble cleaning equipment according to the manufacturers' IFU, then clean, disinfect with an EPA-registered disinfectant, and dry the equipment.[8] *[Recommendation]*

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Cleaning the equipment prevents the growth of microorganisms during storage and prevents subsequent contamination of the perioperative area.[8]
1.11

Room decontamination systems (ie, ultraviolet light,[43-56] hydrogen peroxide[57-63]) may be evaluated as an adjunct to manual cleaning procedures.[64] *[Conditional Recommendation]*

The benefits of using room decontamination systems as an adjunct to cleaning procedures are likely to exceed the harms. The benefits may include reduction of contamination on environmental surfaces in the OR that could lead to transmission and patient infection. However, further research is needed to determine the clinical benefit for prevention of SSIs and other HAIs. Further research is also needed to evaluate the potential harms of using these devices in the OR, including their effect on sterile supplies and environmental parameters (eg, temperature, humidity). Additionally, decontamination devices have not been regulated and a variety of testing protocols are being used, making the need for standardized testing and product registration essential.[65] The effectiveness of the device may also vary by the technology used and product configuration. Furthermore, the cost-benefit analysis and the availability of resources needed to implement these systems will depend on the benefit-harm assessment in the local setting.

A systematic review by Leas et al[24] and a literature review by Weber et al[66] describe advantages and disadvantages of ultraviolet and hydrogen peroxide systems. An advantage of both systems is the ability to consistently eliminate residual contamination. However, neither system will physically remove organic or inorganic material. Ultraviolet light systems are dependent on distance and orientation of items to be disinfected and require shorter delivery time than hydrogen peroxide systems. Disinfecting an entire room with a hydrogen peroxide system requires sealing of air vents. However, hydrogen peroxide systems may have a greater sporicidal efficacy than ultraviolet systems. More studies are needed to determine the effect of hydrogen peroxide and ultraviolet systems on patient outcomes.

In a systematic review with meta-analysis, Marra et al[67] evaluated the use of hydrogen peroxide and ultraviolet light systems for reduction of HAIs caused by multidrug-resistant organisms (MDROs). Their analysis of 13 ultraviolet light system studies found a significant reduction in both *C difficile* and vancomycin-resistant enterococci (VRE) infections with use of these systems. The researchers concluded that further research is needed to evaluate hydrogen peroxide systems, although they found two studies that showed these systems also reduced VRE infections.

In another systematic review, Cobb[68] compared methicillin-resistant *S aureus* (MRSA) log reduction by ultraviolet light to log reduction by hydrogen peroxide vapor. Cobb's analysis of 12 studies on ultraviolet light and eight studies on hydrogen peroxide vapor found a significant reduction of MRSA on nonporous surfaces from both treatments. The researchers stated that a limitation of the review was their inability to control for other factors that may have influenced the reduction of MRSA on surfaces, such as the presence of soil and the dosage or intensity of the room decontamination systems.

Because of limited data, the Infectious Diseases Society of America (IDSA) and the Society for Healthcare Epidemiology of America (SHEA)[69] do not recommend the use of automated sporicidal terminal disinfection as a component of *C difficile* infection prevention.

Ultraviolet Light Systems

High-quality evidence is available regarding the use of ultraviolet light–emitting systems as adjunct technology to cleaning for the following outcomes:

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- MDRO reduction on surfaces of patient rooms,[43,45,70-74] simulated patient rooms,[44,47,49] and the OR[53-56];
- MDRO transmission to subsequently admitted patients[48,50,52];
- SSI rates[51]; and
- time required to use the system.[56,70]

Five quasi-experimental studies[43-46,49] and one prospective cluster-randomized crossover trial[48] evaluated **continuous ultraviolet light systems**, with cycle times ranging from 20 to 83.7 minutes. The researchers found that continuous ultraviolet light systems significantly lowered the incidence of patient infections caused by MRSA, VRE and *C difficile*[48] and reduced environmental contamination by vegetative bacteria,[43] VRE,[45,46] *C difficile*,[43-46] *Acinetobacter* species,[45,49] MRSA,[46] *S aureus*,[49] and *Enterococcus faecalis*.[49]

Eleven quasi-experimental studies evaluated **pulsed xenon ultraviolet light systems**, with cycle times ranging from 8 to 20 minutes.[47,50-54,70-74] The researchers found that the pulsed xenon ultraviolet light systems

- significantly decreased SSI rates for Class I (clean) procedures,[51]
- significantly lowered hospital-acquired *C difficile* rates[50,73,74] and VRE rates,[73]
- reduced patient acquisition of VRE,[52]
- significantly reduced contamination of high-touch surfaces in the OR 54 and patient rooms,[70-72]
- decreased the labor burden,[47]
- were practical for daily disinfection of surfaces,[47] and
- may contribute to efficacy and efficiency of standard between-patient cleaning procedures in the OR when used on a 2-minute cycle.[53]

Two quasi-experimental studies evaluated the use of focused multivector ultraviolet (FMUV) light systems in the OR, with cycle times of 90 seconds.[55,56] The researchers found that the FMUV systems significantly reduced microbial contamination of the OR bed, back table, and electrosurgical unit[55] and that there was no significant difference in cleaning time when using FMUV with manual cleaning compared to manual cleaning alone.[56]

Hydrogen Peroxide Systems

High-quality evidence is available regarding the use of hydrogen peroxide systems as adjunct technology to discharge cleaning for the outcome of MDRO reduction on surfaces in patient rooms,[57,59,61,62] simulated patient rooms,[58,60] and a simulated OR.[63]

Two studies evaluated dry-mist hydrogen peroxide, with cycle times ranging from 18 to 52 minutes.[57,58] In a prospective randomized study conducted at two hospitals in France, Barbut et al[57] found that a hydrogen peroxide mist system was significantly more effective than 0.5% sodium hypochlorite solution in eradicating *C*

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difficile spores in patient rooms. Bartels et al[58] conducted a quasi-experimental study in a simulated setting and found that a dry-mist hydrogen peroxide and silver ion vapor decreased environmental contamination in intensive care unit (ICU) settings as an adjunct to **terminal cleaning** procedures.

Five quasi-experimental studies evaluated hydrogen peroxide vapor, with cycle times ranging from 1.5 to 3 hours.[59-63] The researchers found that use of hydrogen peroxide vapor as an adjunct to other cleaning procedures reduced the rate of *C difficile* infections,[59] patient acquisition of MDROs,[62] and surface contamination with VRE,[60] MRSA,[61] and multidrug-resistant *Acinetobacter baumannii.*[63] In a simulated OR, Lemmen et al[63] did not identify any visual damage or alteration of surfaces after three applications of hydrogen peroxide vapor.
2.

Cleaning Procedures

2.1

Have an interdisciplinary team determine cleaning procedures and frequencies based on the type of surfaces and tasks to be performed.[75,76] ***[Recommendation]***

Involvement of an interdisciplinary team (eg, perioperative nursing, sterile processing, environmental services, infection prevention, anesthesia) allows input from personnel who perform environmental cleaning in perioperative areas and from personnel with expertise beyond clinical end-users (eg, infection prevention personnel). As part of a bundled approach to implementing best practices for environmental cleaning, Havill[76] recommended that cleaning procedures be developed by an interdisciplinary team.

Operational guidelines for cleaning frequency in the perioperative setting were identified as a gap in the literature based on the evidence review.

2.2

Identify high-touch objects and surfaces to be cleaned and disinfected.[5,6,8,15,77] ***[Recommendation]***

Contamination of environmental surfaces that are touched frequently creates a risk for hands to acquire pathogens that could be transmitted to patients.[5-7,64,78] Moderate-quality evidence indicates that high-touch objects in the OR are more contaminated than low-touch objects and supports more frequent disinfection of high-touch objects.[5,7,15]

In a two-part descriptive study, Link et al[7] observed 43 surgical procedures and recorded the number of times a surface was touched by unsterile surgical team members' hands during patient care. The five surfaces touched most frequently were the anesthesia computer mouse, OR bed, nurse computer mouse, OR door, and anesthesia cart. The researchers found that a low-touch surface on the top of the OR light dome was less contaminated than the high-touch surfaces, except for the OR bed.

In a nonexperimental study, Alexander et al[5] collected 517 cultures from a variety of surfaces in 33 ORs. The researchers found that surfaces disinfected routinely (eg, back table, work station) had lower levels of bacteria than surfaces that came in contact with a higher number of OR personnel and that were not disinfected as often (eg, computer mouse, telephone). Additionally, they found that vertical surfaces had fewer bacteria than horizontal surfaces.

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As part of a nonexperimental study, Dallolio et al[15] cultured 10 high-touch surfaces (eg, anesthesia cart, OR bed and remote, vitals monitor, instrument table) in 10 ORs before the first scheduled surgery of the day and then again after completion of disinfection between procedures. The surfaces that exceeded the established limits for bacterial growth were an anesthesia computer touch screen, surgical lights, internal door opening buttons, and an intercom.

2.2.1

When cleaning high-touch objects, clean the frequently touched areas of the item (eg, control panel, switches, knobs, work area, handles).[8] ***[Recommendation]***

In a nonexperimental study, Richard and Bowen[78] tested 13 surfaces in six orthopedic ORs before the first surgery of the day and found that items with buttons or controls (eg, tourniquet machine, electrosurgical unit, patient warming device, keyboards) and patient positioning devices were the items with the highest bioburden.

2.3

Determine the frequency and extent of cleaning required when areas are not occupied (eg, unused rooms, weekends).[8,64] ***[Recommendation]***

The presence of personnel generates dust from shedding skin squames, which can harbor bacteria.[8,64] However, further evidence is needed to determine ideal terminal cleaning frequencies and the extent of cleaning and disinfection required in unoccupied perioperative areas.

2.4

Assign responsibility for cleaning perioperative areas and equipment to competent personnel.[21,64,79] ***[Recommendation]***

Assigning cleaning responsibilities is an important component of defining cleaning procedures. After responsibility is determined, appropriate training programs, communication, and standardization can be implemented.[21,79] In a literature review, Dancer[64] discussed the importance of assigning cleaning responsibilities to reduce the number of items that personnel forget to clean.

When cleaning the OR between procedures, having personnel assigned to designated cleaning areas may prevent cross contamination between dirty and clean surfaces and may improve efficiency during turnovers. In an organizational experience to increase compliance with between-patient cleaning, Pederson et al[80] introduced a “pit crew” method to assign personnel specific tasks. Overall compliance with the cleaning protocol between procedures increased from 79% to 93%.

2.5

Perform cleaning activities in a methodical pattern that limits the transmission of microorganisms.[21,81] ***[Recommendation]***

Cleaning an area in a methodical pattern establishes a routine for cleaning so that items are not missed during the cleaning process.[21] The method for cleaning may limit the transmission of microorganisms and reduce the risk of cross contamination of environmental surfaces.[81]

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In an observational study, Bergen et al[81] evaluated the spread of bacteria on surfaces when cleaning with microfiber cloths moistened with sterile water and a detergent in a 16-side method and found that although bacterial counts of *E faecalis* and *Bacillus cereus* were lower after cleaning, the bacteria from contaminated surfaces were spread to clean surfaces. Additional research is needed to determine optimal cleaning methods for the perioperative setting and to evaluate the risk for microbial transmission across environmental surfaces during cleaning activities.

2.5.1

When cleaning with the same cleaning material (eg, cloth, wipe, mop head), progress from clean to dirty areas.[21,81] ***[Recommendation]***

Cleaning the least soiled areas before moving to the most soiled areas diminishes the likelihood of spreading contaminants from dirtier areas to cleaner surfaces.[21]

2.5.2

When cleaning and damp dusting, progress from top to bottom.[21] ***[Recommendation]***

During cleaning of high areas, dust, debris, and contaminated cleaning solutions may contaminate lower areas. If low areas are cleaned first, these areas could potentially be recontaminated with debris from the higher areas.[21]

2.5.3

The room may be cleaned in a clockwise or counter-clockwise direction in conjunction with clean-to-dirty and top-to-bottom methods.[21] ***[Conditional Recommendation]***

Using the same sequence each time provides consistency and lowers the chance of missing items that need to be cleaned.

2.6

Do not return used cleaning materials (eg, mop heads, cloths) to the cleaning solution container.[8,21] ***[Recommendation]***

Used cleaning materials are considered contaminated and returning them to the cleaning solution container contaminates the solution.

2.7

Change reusable cleaning materials after each use. Discard disposable cleaning materials after each use according to the manufacturer's IFU.[8] ***[Recommendation]***

Using a dirty mop or cloth on a clean area or to clean for multiple patients may increase the risk of cross contamination. Discarding disposable material in non-designated areas (eg, toilets) can lead to clogging of pipes or sewer systems.

2.8

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Always consider floors in the perioperative practice setting to be contaminated.[8,25,82,83] ***[Recommendation]***

Even in the best scenario, the floor is essentially contaminated as soon as it is cleaned because of air contaminants settling on the floor after mopping and new contaminants being introduced by air currents or traffic.[25] In a nonexperimental study, Andersen et al[82] investigated the reduction of bacterial contamination of the floor using various cleaning methods and found that even with the best results, the floor and air was contaminated after use of each method.

Deshpande et al[83] conducted a nonexperimental study to evaluate floor contamination in patient rooms at five hospitals, either while the patient occupied the room or after terminal cleaning. The researchers found that floors were contaminated both during admission and after discharge. *C difficile* was the pathogen most frequently isolated from the floors, although MRSA and VRE were recovered significantly more often from *C difficile* isolation room floors.

2.8.1

Consider items that contact the floor for any amount of time to be contaminated.[1,83] ***[Recommendation]***

In a quasi-experimental study, Munoz-Price et al[1] found that the OR floor was a potential reservoir for microorganisms because of inadvertent contamination of items during routine patient care. When patient care items (eg, IV tubing, safety straps) inadvertently touched the floor, the items were potentially contaminated by the floor and could transmit pathogens to the patient if they were not disinfected before contact with the patient.

Deshpande et al[83] conducted a point prevalence survey of 100 occupied isolation and non-isolation rooms at five hospitals to determine the number of patient care objects that touched the floor and the potential for those objects to transfer pathogens. When an item fell to the floor, if possible, the researcher picked it up with gloved or ungloved hands, depending on the patient's isolation status. Ungloved hands were cultured before and after item retrieval, and gloved hands were cultured only after item retrieval. Forty-one patient rooms had one or more items come into contact with the floor. Thirty-one hand or glove cultures were collected of which six grew MRSA, two grew VRE, and one grew *C difficile.*

2.8.2

Clean and disinfect noncritical items (eg, safety straps, positioning devices) per the manufacturer's instructions after these items contact the floor.[8,25] ***[Recommendation]***

2.9

Mop floors with damp or wet mops. Do not dust the floor with a dry mop in semi-restricted and restricted areas.[8,82] *[Recommendation]*

In an observational study, Andersen et al[82] found that wet and moist mopping using a detergent was most effective in reducing organic soil on floors. Although all methods of mopping in the study increased bacterial counts in the air just after mopping, wet methods of mopping produced fewer aerosols than dry methods.

2.9.1

When mopping, progress from the cleanest to dirtiest areas of the floor.[21] ***[Recommendation]***

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The center of the room, where most of the patient care occurs, is most likely to have higher levels of contamination.

2.10

After each patient use, clean and disinfect reusable noncritical, nonporous surfaces such as mattress covers, pneumatic tourniquets, blood pressure cuffs, and other patient equipment according to the manufacturers' instructions.[8] *[Recommendation]*

The CDC recommends low- or intermediate-level disinfection of noncritical patient care items.[8]

2.10.1

Clean and disinfect patient transport vehicles including the straps, handles, side rails, and attachments after each patient use.[8] *[Recommendation]*

2.10.2

Discard single-use items after each patient use.[21] *[Recommendation]*

2.11

Apply a protective barrier covering to noncritical equipment surfaces if the surface cannot withstand disinfection or is difficult to clean (eg, computer keyboards, foot pedals, touchscreen computer monitors).[8,84] *[Recommendation]*

Protecting surfaces that cannot withstand disinfection, in accordance with the equipment manufacturer's instructions for cleaning, provides a mechanism to prevent surfaces from becoming a reservoir for microorganisms. Equipment that is difficult to clean may harbor pathogens in crevices that are not easy to disinfect. Using a barrier covering may prevent contamination of these areas and other areas that are difficult to reach.[8,84]

2.11.1

If a protective barrier covering is used, remove or clean and disinfect the cover per the manufacturer's IFU after each patient use.[8,84,85] *[Recommendation]*

The use of a protective barrier covering does not replace the need to clean the item. In a prospective interventional study, Das et al[85] evaluated the bacterial contamination of keyboards with and without protective covers. After 6 months of use, the researchers found that 96% of all the keyboards were positive for both nonpathogenic and potentially pathogenic bacteria (eg, *S aureus, Streptococcus* species, gram-negative rods). However, the amount of potentially pathogenic bacteria was higher on covered keyboards than on uncovered keyboards. The researchers theorized that the covered keyboards may not have been cleaned as often.

2.11.2

Clean noncritical medical equipment that cannot be covered and cannot withstand disinfection (eg, robots, imaging system components) in accordance with the equipment manufacturers' IFU.[8] *[Recommendation]*

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Computers and other sensitive electronic devices are likely to become contaminated and may be difficult to clean. Electronic components may be damaged by cleaning chemicals.
2.12

Clean and disinfect equipment that is stored outside the surgical suite before bringing it into the semi-restricted area. ***[Recommendation]***

The benefits of cleaning equipment before it is brought to the semi-restricted area include removal of any dust or microorganisms that may contaminate the semi-restricted environment.

2.13

Before cleaning, inspect mattresses and padded positioning device surfaces (eg, OR beds, arm boards, patient transport carts) for any moisture, stains, or damage.[8,86] ***[Recommendation]***

Nonintact surfaces may become reservoirs for microorganisms and may harbor pathogens. Regular inspection for visible signs of compromise or wear, such as tears, cracks, pinholes or stains, facilitates prompt replacement and prevention of cross contamination resulting from underlying surface exposure.[86]

2.13.1

Remove and replace damaged or worn mattress coverings according to facility policy and the manufacturer's instructions.[8,86] ***[Recommendation]***

The CDC does not recommend using patches for tears or holes in mattress coverings because the patches do not provide an impermeable surface.[8]

2.13.2

Avoid penetration of the mattress by needles and other sharp items.[8] ***[Recommendation]***

Inadvertent puncture of a mattress cover provides a reservoir for blood and body fluids to enter the mattress.
3.

Waste and Laundry

3.1

Standard precautions must be followed when cleaning, to prevent contact with blood, body fluids, or other potentially infectious materials.[19,75] ***[Regulatory Requirement]***

All body fluids except sweat (eg, semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva) are potentially infectious.[75]

3.1.1

Personal protective equipment (PPE) must be worn during handling of contaminated items or cleaning of contaminated surfaces, to reduce the risk of exposure to blood, body fluids, and other potentially infectious materials.[8,75] ***[Regulatory Requirement]***

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3.1.2

Gloves must be worn when it is reasonably anticipated that there may be contact with blood, body fluids, or other potentially infectious materials during handling or touching of contaminated items or surfaces.[75] *[Regulatory Requirement]*

3.1.3

Masks, eye protection, and face shields must be worn whenever contact with splashes, spray, splatter, or droplets of blood, body fluids, or other potentially infectious materials is anticipated.[75] *[Regulatory Requirement]*

3.1.4

Wear respiratory protection (ie, an N95 respirator, a powered air-purifying respirator) if cleaning procedures are expected to generate infectious aerosols.[8,19] *[Recommendation]*

3.1.5

Perform hand hygiene after PPE is removed and as soon as possible after hands are soiled.[20] *[Recommendation]*

3.2

When visible soiling by blood, body fluids, or other potentially infectious materials appears on surfaces or equipment, the area must be cleaned and disinfected immediately or as soon as feasible.[8,75] *[Regulatory Requirement]*

Soil on environmental surfaces increases the risk of cross contamination and is more difficult to remove the longer it remains on the surface. Critical patient care activities occurring at the same time as contamination may necessitate delay in removal.

3.3

Take the following steps when cleaning a spill of blood or body fluids:

1. Apply an EPA-registered disinfectant that is effective against bloodborne pathogens (eg, human immunodeficiency virus, hepatitis B virus) to the spill.[25]
2. Soak up the spill with an absorbent material (eg, lint-free towel, absorbent gel) and discard it.[8,21,25,75]
3. Clean and disinfect the surface.[25] *[Recommendation]*

Applying an EPA-registered disinfectant to a spill of blood or body fluids inactivates bloodborne viruses and minimizes the risk for infection to personnel during cleanup.[25]

3.3.1

When an EPA-registered disinfectant is not available, a freshly diluted sodium hypochlorite solution may be used:

- for a small spill (< 10 mL), apply a 1:100 dilution (525-615 ppm available chlorine) to the spill before cleaning;

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- for a large spill (> 10 mL), apply a 1:10 dilution (5,000 ppm to 6,150 ppm available chlorine) to the spill before cleaning and then use a 1:100 dilution to disinfect the surface.[25]

[Conditional Recommendation]

Environmental Protection Agency–registered disinfectants are preferred because they are reviewed for safety and microbial efficacy. However, the CDC recommends use of sodium hypo-chlorite solutions when EPA-registered products are not available.[25]

3.4

Items that would release blood, body fluids, or other potentially infectious materials in a liquid or semi-liquid state if compressed and items that are caked with dried blood, body fluids, or other potentially infectious materials must be placed in closable, leak-proof containers or bags that are color coded, labeled, or tagged for easy identification as biohazardous waste.[75] ***[Regulatory Requirement]***

Leak-proof containers prevent exposure of personnel to blood, body fluids, and other potentially infectious materials and prevent contamination of the environment. Color coding or labeling alert personnel and others to the presence of items potentially contaminated with infectious microorganisms, prevent exposure of personnel to infectious waste, and prevent contamination of the environment.[75]

3.4.1

Manage waste generated during care of patients on transmission-based precautions in accordance with standard waste management procedures per local, state, and federal regulations.[8,19,87] ***[Recommendation]***

3.5

Containers or bags containing regulated medical waste must be transported in closed, impervious containers according to state and federal regulations.[8,75] ***[Regulatory Requirement]***

3.6

Regulated waste must be stored in a ventilated area that is inaccessible to pests until it is transported for treatment and disposal according to state and federal regulations.[8] ***[Regulatory Requirement]***

3.7

Contaminated liquid waste must be disposed of according to state and federal regulations (eg, pouring the liquid down a sanitary sewer, adding a solidifying powder to the liquid, using a medical liquid waste disposal system).[8,75] ***[Regulatory Requirement]***

A well-ventilated area and large amounts of water are necessary to prevent inadvertent exposure of health care workers when pouring liquids into the sanitary sewer.[88]

In a nonexperimental study, Horn et al[89] found that when compared to an open suction cannister system, a closed system was a less hazardous and more efficient way to dispose of fluid waste.

3.8

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Immediately or as soon as possible after use, contaminated sharps (eg, needles, blades, sharp disposable instruments) must be discarded in a closeable, puncture-resistant container that is leak proof on its sides and bottom and is labeled or color coded.[8,75] *[Regulatory Requirement]*

3.8.1

Sharps containers must not be overfilled.[75] *[Regulatory Requirement]*

An overfilled container increases the risk for injury each time additional items are added and makes proper closure of the container difficult.

3.8.2

Broken glassware must not be touched with hands.[75] Use mechanical means, such as forceps, tongs, or a dustpan to handle broken glass. *[Regulatory Requirement]*

Handling broken glassware with hands increases the potential for a sharps injury.

3.9

Laundry contaminated with blood, body fluids, or other potentially infectious materials must be handled as little as possible.[8,75] *[Regulatory Requirement]*

Handling contaminated laundry with a minimum of agitation avoids contamination of air, surfaces, and personnel.[8]

3.9.1

Contaminated laundry must be placed in labeled or color coded containers or bags at the location where it was used.[8,75] *[Regulatory Requirement]*

3.9.2

Contaminated laundry that is wet and may soak or leak through the container or bag must be placed and transported in closed containers or bags that prevent soak-through or leakage of fluids to the exterior.[8,75] *[Regulatory Requirement]*

4.

OR and Procedure Rooms

4.1

Damp dust all horizontal surfaces (eg, furniture, surgical lights, booms, equipment) before the first scheduled surgical or other invasive procedure of the day.[8,64] *[Recommendation]*

Dust is known to contain human skin and hair, fabric fibers, pollens, mold, fungi, insect parts, glove powder, and paper fibers, among other components.[8,18] Airborne particles range from 0.001 micrometers to several hundred micrometers. In settings with dry conditions, gram-positive cocci (eg, coagulase-negative *Staphylococcus* species) found in dust may persist; in settings with surfaces that are moist and soiled, the growth of gram-negative bacilli may persist.[8]

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4.1.1

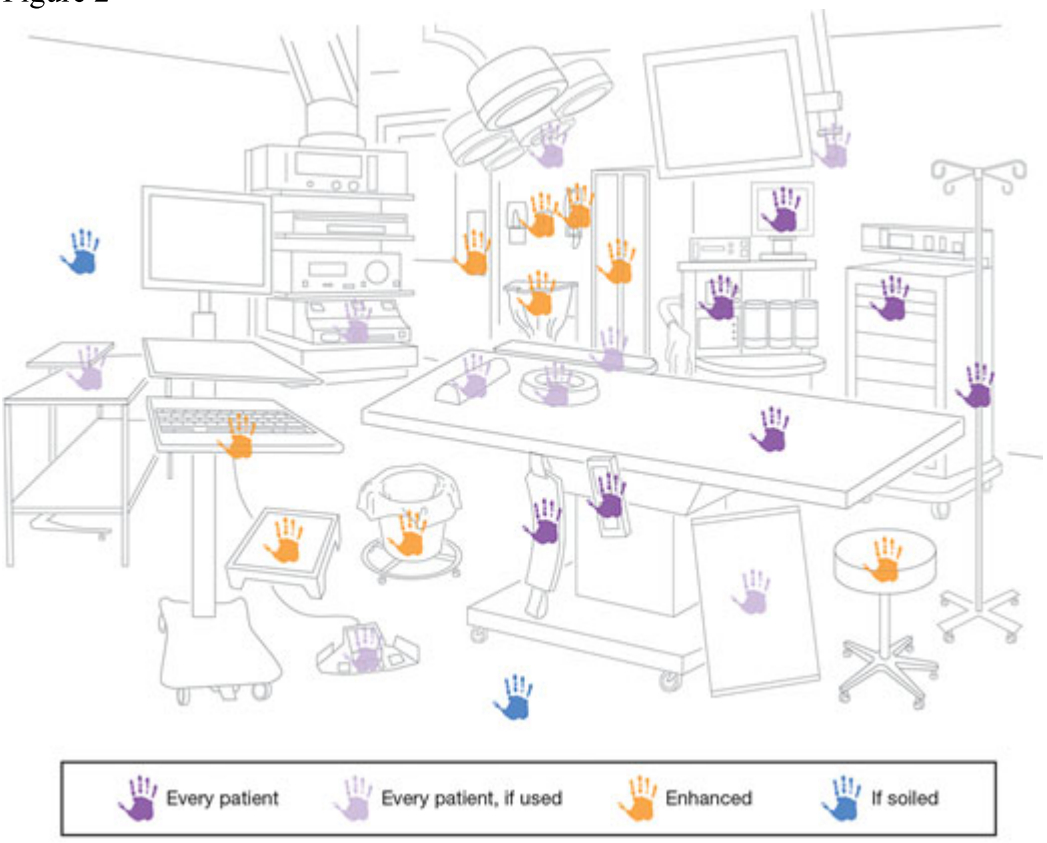
Complete damp dusting before case carts, supplies, and equipment are brought into the room.[21] *[Recommendation]*

4.1.2

Use a clean, low-linting cloth moistened with a disinfectant to damp dust.[21] *[Recommendation]*
4.2

Operating and procedure rooms must be cleaned and disinfected after each patient procedure (Figure 2).[90-93] *[Regulatory Requirement]*

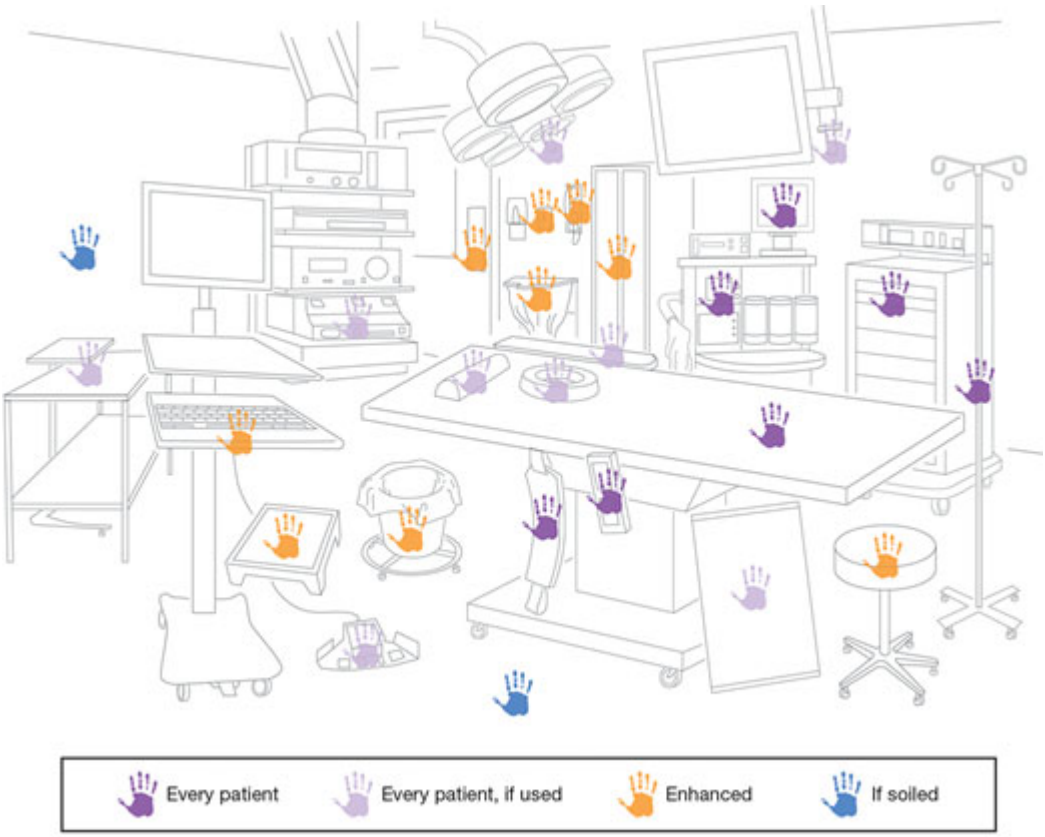
Figure 2



Example of Between-Patient Cleaning: Operating and Procedure Rooms

Figure 2

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Example of Between-Patient Cleaning: Operating and Procedure Rooms

4.2.1

Do not begin environmental cleaning, including trash and contaminated laundry removal, until the patient has left the OR or procedure room.[8,21] ***[Recommendation]***

Environmental surfaces may be recontaminated if cleaning begins while the patient is still occupying the room. Increased room traffic and movement for cleaning activities may generate unnecessary noise and be a distraction from patient care activities, including emergence from anesthesia.

4.2.2

Remove trash and used linen from the room[21] **(See Recommendation 3).** ***[Recommendation]***

4.2.3

Clean and disinfect all items used during patient care, including

- anesthesia carts, including the top and drawer handles[7,21,84,94,95] ;
- anesthesia equipment (eg, IV poles, IV pumps)[21,84] ;
- anesthesia machines, including dials, knobs, and valves[3,84,94-96] ;
- patient monitors, including cables[43] ;

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- OR beds[1,7,8,21] ;
- reusable table straps[21] ;
- OR bed attachments (eg, arm boards, stirrups, head rests)[1,21] ;
- positioning devices (eg, viscoelastic polymer rolls, vacuum pack positioning devices, socket attachments)[78] ;
- patient transfer devices (eg, roll boards)[16] ;
- overhead procedure lights[1,3,15,21] ;
- tables and Mayo stands[1,5,21,78] ; and
- mobile and fixed equipment (eg, sitting or standing stools, suction regulators, pneumatic tourniquets, imaging viewers, viewing monitors, radiology equipment, electrosurgical units, microscopes, robots, lasers).[3,21,78]

[Recommendation]

The anesthesia work area, consisting of the anesthesia machine, anesthesia cart, IV poles, IV pumps, and monitoring equipment, contains irregular, complex surfaces that encounter frequent hand contact. Failing to clean these surfaces properly can lead to cross transmission of potential pathogens.[84] Moderate-quality evidence supports cleaning of the anesthesia machine and cart after patient care.[36,95,96]

4.2.4

Clean and disinfect the floor with a mop after each surgical or invasive procedure when visibly soiled or potentially soiled by blood or body fluids (eg, splash, splatter, dropped item).[1,8,21,38,82] ***[Recommendation]***

4.2.5

Spot clean and disinfect the walls after each surgical or invasive procedure when visibly soiled.[8] ***[Recommendation]***

4.3

Performing terminal cleaning or closing the OR after a contaminated or dirty/infected procedure (ie, Class III, Class IV) is not necessary.[14,97-99] If the patient is infected or colonized with an MDRO, implement enhanced environmental cleaning procedures (see Recommendation 8.1). ***[Recommendation]***

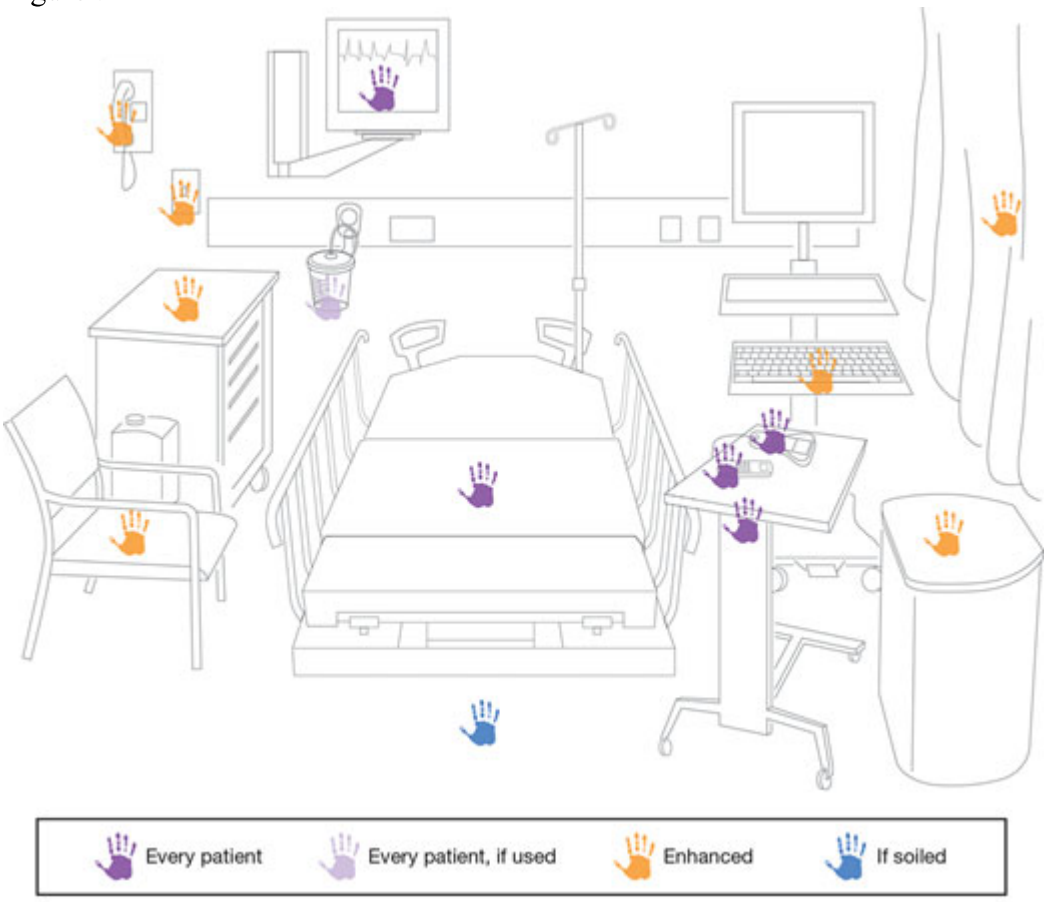
The CDC and moderate-quality evidence support not performing terminal cleaning or closing the OR after surgery on a patient with an infected wound.[14,97-99]

In a retrospective controlled study in a large Canadian hospital, Abolghasemian et al[98] evaluated the incidence of HAIs in 83 patients who had an arthroplasty procedure in an OR in which the previous patient had a known infection. The researchers found that an infection was no more likely to occur in a patient whose surgery followed that of a patient with an infection than that of a patient without an infection. Of note, between-patient cleaning was completed using diluted 7% chlorhexidine solution, which is not an EPA-registered disinfectant, and neither unilateral ultraclean air flow nor orthopedic surgical space suits were used.

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Balkissoon et al[14] conducted a prospective correlational study at an academic medical center in the United States to evaluate microbial surface contamination after standard between-patient cleaning following 14 surgeries on patients with infections and 16 surgeries on patients without infections. The surgeries were open procedures in multiple surgical specialties. The researchers did not find significant differences in bacterial contamination of high-touch surfaces in the OR between the two groups. The researchers concluded that standard between-patient cleaning reduced surface contamination to a minimum regardless of the infection status of the previous patient, and therefore the need for additional cleaning after a contaminated or dirty/infected procedure is not necessary.

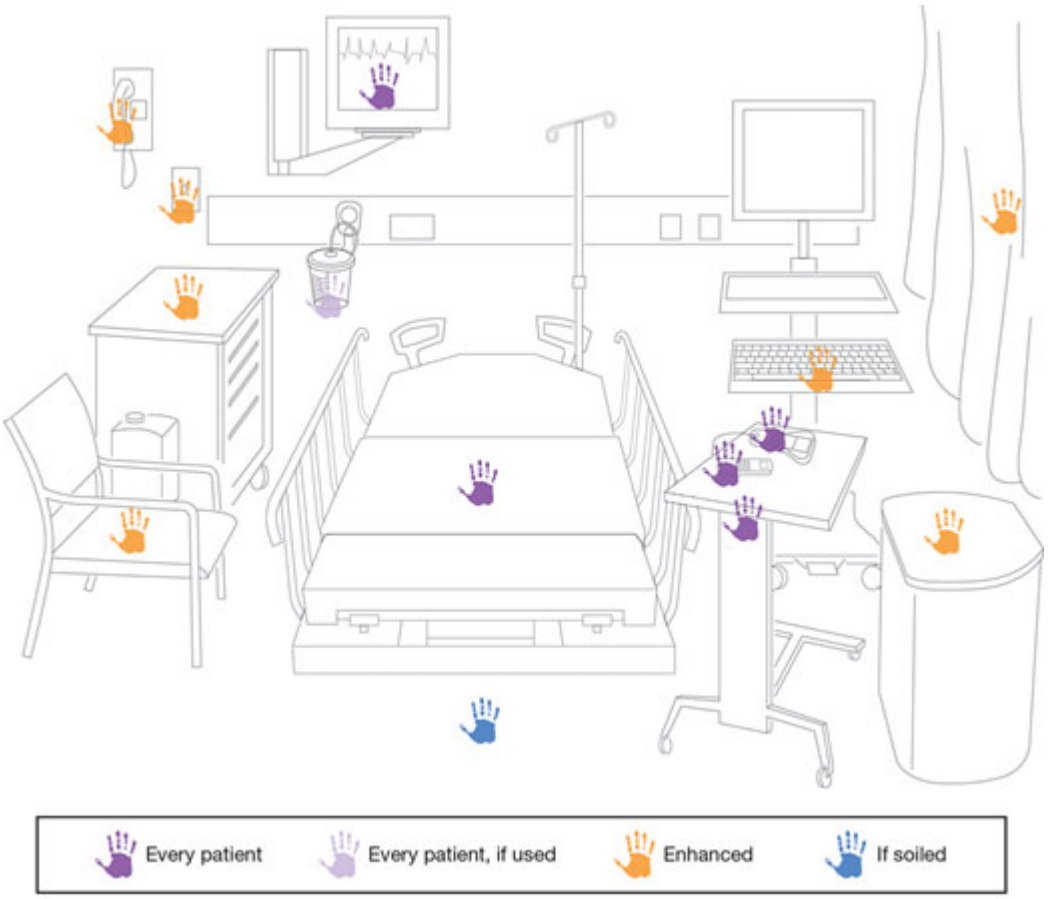
Figure 3



Example of Between-Patient Cleaning: Preoperative and Postoperative Areas

Figure 3

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Example of Between-Patient Cleaning: Preoperative and Postoperative Areas

In an exploratory prospective observational study at a German university hospital, Harnoss et al[99] evaluated the microbial room air concentration, as well as microbial sedimentation at 0.5 m and 1.5 m from the sterile field for 16 general surgeries on patients with infections and 14 general surgeries on patients without infections. Air samples were taken at the start of the procedure, every 30 minutes during the procedure, at the procedure end, and 30 minutes after the procedure. Microbial sedimentation was measured before the procedure and at the end of the procedure. No significant differences were found in microbial concentration of air or sedimentation between the surgeries, leading the researchers to conclude that procedures for patients with and without infections do not need to be spatially separated. However, one limitation was that the type of ventilation was not described.

4.4

Terminally clean operating and procedure rooms each day the rooms are used. ***[Recommendation]***

4.4.1

Clean and disinfect the exposed surfaces, including wheels and casters, of all items, including

- anesthesia carts, including the top and drawer handles[7,21,84,94,95] ;
- anesthesia equipment (eg, IV poles, IV pumps)[21,84] ;
- anesthesia machines, including dials, knobs, and valves[3,84,94-96] ;

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- patient monitors, including cables[43] ;
- OR beds[1,7,8,21] ;
- reusable table straps[21] ;
- OR bed attachments (eg, arm boards, stirrups, head rests)[1,21] ;
- positioning devices (eg, viscoelastic polymer rolls, vacuum pack positioning devices, socket attachments)[78] ;
- patient transfer devices (eg, roll boards)[16] ;
- overhead procedure lights[1,3,15,21,100] ;
- tables and Mayo stands[1,5,21,78] ;
- mobile and fixed equipment (eg, suction regulators, pneumatic tourniquets, imaging viewers, viewing monitors, radiology equipment, electrosurgical units, microscopes, robots, lasers)[3,21,78] ;
- storage cabinets, supply carts, and furni- ture[3,21] ;
- light switches[3,21] ;
- door handles and push plates[3,7,21] ;
- telephones and mobile communication devices[5,15,21] ;
- computer accessories (eg, keyboards, mouse, touch screen)[5,7,78] ;
- chairs, stools, and step stools[21] ; and
- trash and linen receptacles.[3,8,21] *[Recommendation]*

4.4.2

Clean and disinfect the entire floor, including areas under the OR bed and mobile equipment,[21] using either a wet vacuum or mop.[8] *[Recommendation]*

5.

Preoperative and Postoperative Areas

5.1

Preoperative and postoperative patient care areas must be cleaned after each patient has left the area (Figure 3).[8,21,90,91] *[Regulatory Requirement]*

5.1.1

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Clean and disinfect items that are used during patient care, including

- patient monitors,[43,79]
- infusion pumps and IV poles,[79,101]
- patient beds or stretchers,[43,44,77,102,103]
- over-bed tables,[2,40,43,44,77,79,102-107]
- television remote controls,[44,102,103] and
- call lights.[2,77,79,104,105,107] *[Recommendation]*

5.1.2

Clean and disinfect mobile and fixed equipment (eg, suction regulators, medical gas regulators, imaging viewers, radiology equipment, warming equipment) that is used during patient care.[3,21] *[Recommendation]*

5.1.3

Clean and disinfect the floor with a mop when visibly soiled or potentially soiled by blood or body fluids (eg, splash, splatter, dropped item).[1,8,21,38,82] *[Recommendation]*

5.1.4

Spot clean and disinfect the walls when visibly soiled.[8] *[Recommendation]*

5.2

Terminally clean the preoperative and postoperative patient care areas each day the areas are used. *[Recommendation]*

5.2.1

Clean and disinfect the exposed surfaces, including wheels and casters, of all items in the area, including

- patient monitors[43,79] ;
- patient beds or stretchers[43,44,77,79,101-103,107] ;
- over-bed tables[2,43,44,77,79,102-105] ;
- television remote controls[44,102,103] ;
- call lights[2,77,79,104,105] ;
- mobile and fixed equipment (eg, suction regulators, medical gas regulators, imaging viewers, radiology equipment, warming equipment)[3,21] ;

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- storage cabinets, supply carts, and furniture[3,21] ;
- light switches[3,21] ;
- door handles and push plates[3,21] ;
- telephones and mobile communication devices[21] ;
- computer accessories (eg, keyboard, mouse, touch screen)[1,69] ;
- chairs, stools, and step stools[21] ; and
- trash and linen receptacles.[8,21] *[Recommendation]*

5.2.2

Clean and disinfect the entire floor, including areas under mobile equipment,[21] using either a wet vacuum or mop.[8] ***[Recommendation]***

6.

Sterile Processing Areas

6.1

Damp dust all horizontal surfaces in the sterilization packaging area (eg, countertops, workstations) at least daily.[108] *[Recommendation]*

Dust or debris on surfaces can be aerosolized onto instruments being prepared for sterilization or onto sterilized items. Daily damp dusting helps to minimize the opportunity for dust dispersal.

6.1.1

Use a clean, low-linting cloth moistened with a disinfectant to damp dust.[21] ***[Recommendation]***

6.2

Terminally clean sterile processing areas each day the areas are used.[108] *[Recommendation]*

Sterile processing personnel conduct critical processes, such as decontaminating, assembling, and sterilizing surgical instrumentation, in support of operating and invasive procedure rooms. As such, the recommendations for terminal cleaning apply in sterile processing areas as in areas where surgical and other invasive procedures are performed. Furthermore, sterile processing areas where decontamination occurs have some of the highest risks for environmental contamination of all perioperative areas. Environmental cleaning in sterile processing areas is critical for reducing the risk of disease transmission from reservoirs of bloodborne pathogens and microorganisms in the decontamination environment.

The Association for the Advancement of Medical Instrumentation recommends that floors and horizontal work surfaces in sterile processing areas be cleaned daily.[108]

6.3

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Clean and disinfect the clean work areas, such as the packaging area and sterile storage area, before the dirty work areas, such as the decontamination area, to reduce the possibility of contaminating the clean areas.[108] ***[Recommendation]***
6.4

When feasible, avoid terminal cleaning when personnel are actively decontaminating instruments. ***[Recommendation]***

Aerosolization and dispersal of contaminated water can occur during instrument decontamination. If cleaning of surfaces and floors is occurring at same time, there is potential for cross transmission of pathogens.

6.5

Clean and disinfect all work surfaces and high-touch objects in the clean work areas and decontamination areas using a clean, low-linting cloth.[108] ***[Recommendation]***

6.6

Remove trash from receptacles in sterile processing areas at least daily and when they are full.[108] ***[Recommendation]***

6.7

Clean and disinfect all floors in sterile processing areas each day the areas are used.[108] ***[Recommendation]***
7.

Scheduled Cleaning

7.1

Determine a cleaning schedule (eg, weekly, monthly) for areas and equipment that are not terminally cleaned, including

- clean and soiled storage areas;
- sterile storage areas;
- shelving, drawers, and storage bins;
- corridors, including stairwells and elevators;
- walls and ceilings;
- privacy curtains;
- pneumatic tubes and carriers;
- sterilizers and loading carts;

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- sterilizer service access rooms;
- lounges, waiting rooms, locker rooms, bathrooms, offices; and
- environmental services closets.[8,21] *[Recommendation]*

Areas and equipment that are not cleaned according to a schedule may be missed during routine cleaning procedures and become environmental reservoirs for dust, debris, and microorganisms.
7.2

Clean ventilation ducts, including air vents and grilles, and change their filters on a routine basis according to the manufacturers' IFU.[8] *[Recommendation]*

Clean ventilation ducts and filters support optimal performance of the ventilation system.

7.3

Clean and disinfect linen chutes on a routine basis.[8] *[Recommendation]*

Linen chutes become contaminated by dirt and debris with use.

7.4

Clean and disinfect all refrigerators and ice machines on a routine basis according to the manufacturers' IFU.[8] *[Recommendation]*

Refrigerators and ice machines become contaminated with use.

7.5

Clean and disinfect sinks, including eye wash stations, on a routine basis.[8] *[Recommendation]*
8.

Special Pathogens

8.1

Implement enhanced environmental cleaning procedures following the care of patients who are known or suspected to be infected or colonized with MDROs, including

- MRSA,
- VRE,
- vancomycin-intermediate *Enterococcus* species,
- vancomycin-resistant *S aureus*,
- vancomycin-intermediate *S aureus*,

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- carbapenem-resistant *Enterobacteriaceae*,
- multidrug-resistant *Acinetobacter* species,
- *Candida auris*,[109]
- extended spectrum beta-lactamase-producing organisms, and
- *Klebsiella pneumoniae* carbapenemase-producing organisms.[48,87,101,110-114]

[Recommendation]

Decreasing environmental contamination on high-touch surfaces may decrease the risk of MDRO transmission. Moderate-quality evidence supports enhanced environmental cleaning of high-touch surfaces following the care of patients who are infected or colonized with MDROs.[101,111,113,114] A limitation of this evidence is that the researchers did not use an objective method to identify high-touch objects, such as measuring the frequency of touch or contamination level of the surfaces. Furthermore, these studies were performed in the inpatient setting and further research is needed to evaluate enhanced environmental cleaning in the perioperative setting.

In a multi-center stepped-wedge trial, Mitchell et al[114] evaluated the effect of a cleaning bundle that emphasized daily cleaning of high-touch surfaces, a consistent cleaning sequence, and compliance with product manufacturers' instructions on the incidence of health care–associated *S aureus* bacteremia, *C difficile* infection, and VRE infection. The intervention resulted in a significant reduction in VRE infections, but not other infection types. The researchers proposed that use of bundle to reduce VRE would lead to decreased length of stay and antimicrobial resistance treatment cost and also eliminate bacteria similar to VRE.

In a randomized controlled trial, Hess et al[101] evaluated enhanced cleaning procedures in an ICU setting and found that intense cleaning of patient rooms contaminated with identified MRSA or multidrug-resistant *A baumannii* did not significantly decrease contamination of health care workers' gowns and gloves. However, in an observational study, Morgan et al[113] found that environmental contamination was the main determinant of transmission of MDROs to health care workers' clothing, gloves, and gowns. In a quasi-experimental study, Datta et al[111] found that enhanced cleaning significantly reduced MRSA and VRE contamination and decreased the risk of MRSA transmission from the room's previous occupant.

The CDC recommends meticulous cleaning and disinfection of both patient rooms and mobile equipment to reduce the risk of transmission of *C auris*.[109]

8.1.1

Clean and disinfect all items touched during patient care, including

- storage cabinets, supply carts, and furni- ture[3,21] ;
- light switches[3,21] ;
- door handles and push plates[3,21,87] ;
- telephones and mobile communication de- vices[21,87] ;
- computer accessories (eg, keyboard, mouse, touch screen)[1,87] ;

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- chairs, stools, and step stools[21] ;
- trash and linen receptacles[21] ; and
- privacy curtains in the perioperative patient care areas.[115,116]

[Recommendation]
8.1.2

In addition to standard precautions, wear a gown and gloves when performing enhanced environmental cleaning procedures.[8,19] *[Recommendation]*
8.2

Following the care of patients diagnosed with or suspected of infection with *C difficile*, use an EPA-registered disinfectant that is effective against *C difficile* spores when cleaning.[8,19,25] *[Recommendation]*

C difficile presents unique challenges for environmental cleaning. In its spore form, *C difficile* can survive for long periods, up to 5 months, on environmental surfaces. *C difficile* spores also are resistant to several cleaning chemicals (eg, alcohols, phenols, quaternary ammonium compounds).[69] Selection of a cleaning chemical that is effective against *C difficile* spores and removal of the spores from environmental surfaces are important when disinfecting a surface contaminated with *C difficile.*[69,77]

8.2.1

An interdisciplinary team that includes an infection preventionist may determine whether a nonsporicidal disinfectant will be used in a nonoutbreak situation.[69] *[Conditional Recommendation]*

In a review of the literature, McDonald et al[69] found minimal evidence to support the use of sporicidal disinfectant in a nonoutbreak setting. Therefore, IDSA and SHEA[69] recommend daily and terminal cleaning with sporicidal disinfectant in the inpatient setting only during outbreaks or sustained high rates of *C difficile* infections and for reoccurrence of infections in the same patient room.

8.3

Following the care of patients diagnosed with or suspected of infection or colonization with *C auris*, use an EPA-registered disinfectant that is effective against *C difficile* spores.[109] *[Recommendation]*

Some disinfectants may not be effective against *C auris.* Until further information is available, the CDC recommends using an EPA-registered disinfectant that is effective against *C difficile* spores.[109]

However, Rutala et al[117] recently conducted a quasi-experimental study to evaluate the efficacy of disinfectants against *C auris* inoculated onto stainless steel discs. The researchers found that several commonly used disinfectants (eg, phenolic, 1.4% hydrogen peroxide, alcohol-quaternary ammonium compound) were as effective against *C auris* as chlorine-based products, which are primarily used as disinfectants for *C difficile* spores.

8.4

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Restrict room access following the care of a patient diagnosed with or suspected of infection with an airborne transmissible disease (eg, tuberculosis) and following aerosolization activities (eg, intubation, extubation, cough-generating activities) of a patient diagnosed with or suspected of infection with a droplet transmissible disease (eg, influenza) until adequate time has passed for air exchanges per hour to remove 99% of airborne particles from the air (eg, 15 air exchanges per hour for 28 minutes to remove 99.9% of airborne contaminants).[8,19,118] *[Recommendation]*

Patients and personnel entering a room that has transmissible disease particles in the air are at risk for contracting the disease.[19]

8.4.1

If entering the room before a complete air exchange occurs, wear respiratory protection (eg, an N95 respirator) to perform environmental cleaning.[8,118] *[Recommendation]*

8.5

Use special cleaning procedures for environmental contamination with high-risk tissue (ie, brain, spinal cord, eye tissue, pituitary tissue) from a patient who is diagnosed with or suspected of having Creutzfeldt-Jakob disease (CJD). If the environment is not contaminated with high-risk tissue, follow routine cleaning procedures.[8,119] *[Recommendation]*

Currently, no EPA-registered disinfectants claim to inactivate prions on environmental surfaces.[119] When the environment is contaminated with tissue that has a high risk of containing prions, the causative infectious agent in CJD, extraordinary cleaning procedures are necessary in accordance with recommendations from the CDC and SHEA.[8,119]

8.5.1

Before the operative or invasive procedure begins, remove unnecessary equipment and cover work surfaces with a disposable, impervious material that can be removed and decontaminated after the procedure if contaminated with high-risk tissue.[8,119] *[Recommendation]*

Covering environmental surfaces (eg, anesthesia cart, prep stand) minimizes contamination of the environment.

8.5.2

When linens are not contaminated with high-risk tissue, follow routine laundering processes.[119] *[Recommendation]*

8.5.3

Clean noncritical environmental surfaces contaminated with high-risk tissue with a detergent and then decontaminate with a solution of either sodium hypochlorite (1:5 to 1:10 dilution with 10,000 ppm to 20,000 ppm available chlorine) or sodium hydroxide (1N NaOH), depending on surface compatibility.[8,119] *[Recommendation]*

No transmissions of prion diseases from environmental surfaces have been reported; however, it remains prudent to eliminate highly infectious material from OR surfaces that will be contacted during subsequent surgeries.[8,119]

8.5.4

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Perform cleaning and disinfection of surfaces contaminated with high-risk tissues in the following order:

1. Remove the gross tissue from the surface.
2. Clean the area with a detergent solution.
3. Apply the disinfectant solution for a contact time of 30 minutes to 1 hour.
4. Use an absorbent material to soak up the solution.
5. Discard the cleaning material in an appropriate waste container.
6. Rinse the treated surface thoroughly with water.[8,119]

[Recommendation]
8.5.5

Use standard cleaning procedures to disinfect surfaces that are not contaminated with high-risk tissue.[119] *[Recommendation]*

8.5.6

Manage regulated medical waste generated during patient care, including waste that was contaminated by high-risk tissue and has been decontaminated, in accordance with standard waste management procedures per local, state, and federal regulations.[8] *[Recommendation]*

No epidemiological evidence has linked CJD transmission to waste disposal practices.[8]
9.

Environmental Contamination

9.1

Implement cleaning and disinfection procedures for construction, renovation, repair, demolition, and disaster remediation.[8] *[Recommendation]*

According to the CDC, cleaning and disinfection measures during internal and external construction projects reduce contamination of environmental air and surfaces from dust and potential pathogens, such as *Aspergillus* and *Bacillus*, and are key elements of an infection prevention program.[8] Several reports have linked environmental air and surface contamination from construction projects to outbreaks of infection in health care settings.[120-123] However, in a literature review of construction-related fungal case reports from 1974 to 2014, Kanamori et al[124] found a decline in the number of reported cases, which the authors thought could be a result of guidelines and policies on infection prevention and control during construction.

9.1.1

Determine the cleaning and disinfection procedures and frequencies based on the infection control risk assessment. *[Recommendation]*

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An interdisciplinary team that includes an infection preventionist performs an infection control risk assessment before starting any construction project.[8,125,126]

9.1.2

Perform cleaning and disinfection of environmental surfaces to remove dust and debris.[8,123,125] If dust is contaminating areas outside of the construction barriers, assess the barriers to determine their effectiveness and reestablish the barriers. ***[Recommendation]***

While investigating an outbreak of deep bacterial eye infections, Gibb et al[123] reported that fine dust from a construction project was found on horizontal surfaces in the OR. After the ORs were cleaned of dust and reopened, no additional eye infections were reported during the surveillance period.

9.1.3

Perform terminal cleaning before equipment and supplies are placed in the area where the construction, renovation, repair, demolition, or disaster remediation has been completed.[8] ***[Recommendation]***

9.2

If flooding or a water-related emergency occurs, including sewage intrusion, inspect the area for water damage and implement a cleaning and disinfection process.[8] ***[Recommendation]***

9.2.1

When surfaces remain in good repair, allow them to dry for 72 hours and perform terminal cleaning.[8] ***[Recommendation]***

9.2.2

When surfaces are damaged or cannot dry within 72 hours, perform remediation to replace the surface with new materials after the facility engineer determines that the underlying structure is dry.[8] ***[Recommendation]***

9.3

Perform terminal cleaning of affected areas when condensation is observed on surfaces.[8] ***[Recommendation]***

Condensation can contain debris or infectious organisms and can contaminate surfaces where sterile supplies are placed or serve as a cross-contamination source.

9.4

When contamination of the incoming air occurs, perform terminal cleaning of the affected areas, including ventilation ducts, air vents, and grilles, and change air filters after the source of the contamination is identified and contained.[8,120] ***[Recommendation]***

10.

Pests

10.1

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Take measures to prevent pest infestation of the perioperative environment, including removing food, containing biological waste, and keeping windows and doors closed.[8] *[Recommendation]*

Pests may cause disease and microorganism transmission by serving as a vector.[8,127-130] Insects in health care settings have been shown to carry more pathogens than insects in residential settings. Pathogens isolated from insects in health care settings also have been shown to have antibiotic resistance.[8,129]

10.2

If preventive measures fail to eliminate the cause of the infestation, consult a credentialed pest control specialist.[8] *[Recommendation]*

Identification of the species, life cycle, diet, and virulence potential can aid in determining necessary actions.[131] A credentialed pest control specialist trained in integrated pest management uses this information to select the most economical actions with the least possible hazard to the environment and personnel.[21,132]

10.2.1

Terminally clean the area after an infestation is resolved.[8] *[Recommendation]*

The presence of open sterile supplies, patients' compromised tissue integrity, and mixing of medications in perioperative areas necessitates the removal of any residue from the environment.[131]

11.

Education

11.1

Provide education and complete competency verification activities related to the principles and processes of environmental cleaning. *[Recommendation]*

Moderate-quality evidence supports educating personnel on the principles and processes of environmental cleaning.[24,94,114,133] In a systematic review, Leas et al[24] found 23 studies that included education as a key component to improve environmental cleaning.

Before implementing a cleaning bundle in a quasi-experimental study, Mitchell et al[114] allotted 2 weeks at each facility for facilitators to deliver multiple education sessions to environmental services personnel on cleaning procedures, roles and responsibilities, and the relationship of cleaning to HAI reduction. One component of the education was identification of frequent touch points in the patient care environment, which led to an increased cleaning compliance during the course of the study.

Hota et al[133] conducted a quasi-experimental study and found that surface contamination with VRE was related to a failure to clean rather than failure of a product or cleaning procedure. Cleaning thoroughness and site contamination improved significantly after implementation of an education program for housekeeping personnel.

In a prospective cohort study, Goebel et al[94] found a significant decrease in post-procedure contamination after providing education to housekeeping personnel that was specific to anesthesia workspace cleaning. After two education sessions that included demonstrations and hands-on sessions, the housekeeping personnel completed

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post-procedure cleaning for 100 orthopedic surgeries. Another 100 post-procedure room cleanings were performed by nurse anesthetists, who normally cleaned the area as part of their job. The housekeeping group took less time to clean and had a 67% reduction in bacterial load compared to the nurse anesthetist group. Additionally, no patients in the rooms cleaned by housekeeping personnel developed HAIs, but six patients in the rooms cleaned by the nurse anesthetists developed HAIs.

In an organizational experience report, Armellino et al[134] found that standardized checklists, competency verification, and education were necessary for improving cleaning compliance. A baseline audit of facility cleaning practices revealed large variability in processes. On further exploration, the researchers discovered that competency verification occurred shortly after hire but was sporadically validated thereafter. Consequently, the organization developed sequenced protocols, reeducated personnel, and implemented an ongoing competency verification process.

In a literature review, Dancer[64] found that cleaning education was often no more than a "perfunctory introduction to the cleaning process" and that a lack of understanding of the basic microbiologic principles underlying cleaning processes can allow potential reservoirs of pathogens in the environment to go unrecognized. Dancer further described the consequences of limited training in environmental cleaning, such as improper maintenance of cleaning equipment, inappropriate use of cleaning chemicals, and exposing patients to contaminated surfaces.

11.1.1

Incorporate topics for education and competency verification related to the principles and processes of environmental cleaning, including

- basic principles of microbiology[21,64,126] ;
- signs and labels or color coding required for contaminated items[75] ;
- the modes of transmission of bloodborne pathogens and the employer's exposure control plan[75] ;
- the use and limitation of methods for reducing the exposure (eg, engineering controls, work practices, PPE)[21,75] ;
- the hepatitis B vaccine, its efficacy and safety, the method of administration, and the benefits of vaccination[75] ;
- location and use of eye wash stations[18] ;
- types, proper selection, proper use, location, removal, handling, decontamination, and disposal of PPE[19,21,23,75] ;
- location of safety data sheets[18] ;
- identification and handling of hazardous chemicals[18] ;
- hazardous and medical waste disposal[18,21] ;
- review of the organization's policies and procedures[126] ;

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- selection of cleaning chemicals, materials, and equipment based on the intended use and compatibility with surfaces[126] ; and
- reading and interpreting the disinfectant product labels, including contact times.[26]

[Recommendation]

11.1.2

Trained observers may use knowledge assessment tools to verify competence. ***[Conditional Requirement]***

In a literature review, Kak et al[135] concluded that competence is best measured through evaluation of performance by experts or trained observers. To provide accurate evaluations, assessors must be trained but the length of training depends on the expertise of the assessor, what is to be assessed, and the instrument to be used. Other methods to evaluate competency include objective structured examinations, interviews, or simulations.[126,135]

11.1.3

Develop educational materials appropriate in content, vocabulary level, literacy, and language for the target personnel.[24,75,79] ***[Recommendation]***

11.1.4

Provide education when new disinfectants, equipment, or processes are introduced.[23] ***[Recommendation]***

11.2

Personnel at risk for occupational exposure to blood, body fluids, or other potentially infectious materials must receive training before assignment to tasks where occupational exposure may occur, at least annually, and when changes to procedures or tasks effect occupational exposure risk.[75] ***[Regulatory Requirement]***

The Occupational Safety and Health Administration requires employers to provide training on the Bloodborne Pathogens standard during working hours at no cost to employees.[75]

11.3

Provide education that addresses human factors related to the principles and processes of environmental cleaning.[24,136,137] ***[Recommendation]***

Human factors include the interpersonal and social aspects of the perioperative environment (eg, coordination of activities, teamwork, collaboration, communication).[24] Effectively implementing the principles and processes of environmental cleaning requires that perioperative and environmental services personnel demonstrate not only procedural knowledge and technical proficiency but also the ability to anticipate needs, coordinate multiple activities, work collaboratively with other team members, and communicate effectively.

Matlow et al[136] conducted focus groups and administered questionnaires to evaluate ICU environmental service workers' attitudes and beliefs and intent about their jobs and found that the environmental services workers' attitudes and beliefs may affect intent and effectiveness of their cleaning practices.

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Mitchell et al[137] conducted a cross-sectional survey of 923 environmental services personnel before and after implementation of a cleaning bundle, which included optimizing product use, cleaning technique, staff training, auditing with feedback, and communication. The survey focused on knowledge, reported practices, attitudes, roles, and perceived organizational support. A high level of knowledge and role importance was noted by participants both before and after the survey. However, the perception of lack of organizational support and investment in cleaning resources did not change during the course of the study, which led the researchers to conclude that the attitudes of personnel may be determinants of cleaning performance and to recommend taking human factors into consideration when developing interventions for cleaning improvement.
12.

Quality

12.1

Perform process monitoring as part of an overall environmental cleaning program, including

- compliance with regulatory standards[90,91] ;
- a review of products and manufacturers' IFU[8] ;
- monitoring cleaning and disinfection practices[23,69] ; and
- reporting and investigation of adverse events (eg, outbreaks, product issues, corrective actions, evaluation).[23] *[Recommendation]*

12.2

Establish a process for evaluating cleaning thoroughness.[1,107,133] *[Recommendation]*

High-quality evidence supports the importance of cleaning thoroughness.[1,107,133] In a prospective study conducted at a large teaching hospital, Munoz et al[1] used fluorescent markers and cultures of environmental surfaces to evaluate cleaning thoroughness in the OR. The researchers found that improvement in thoroughness of cleaning practices in the OR significantly decreased surface contamination with potentially pathogenic organisms.

Hota et al[133] conducted a quasi-experimental study and found that surface contamination with VRE was related to a failure to clean rather than failure of a product or cleaning procedure. Cleaning thoroughness and site contamination improved significantly after implementation of an education program for environmental services personnel.

In an interrupted times series study to introduce a new method of daily patient room cleaning using disposable disinfectant wipes at a large tertiary hospital, Alfa et al[107] used fluorescent markers to monitor cleaning practices for high-touch surfaces. The researchers found that when there was an 80% or greater compliance with fluorescent marker removal, there was significant reduction in *C difficile*, MRSA, and VRE infection rates.

12.3

Measure cleaning practices using qualitative methods[2,3,48,80,103-105,114,134,138] (eg, visual observation of cleaning process, visual inspection of cleanliness, fluorescent marking) and quantitative

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methods[5,14,15,55,78,102,106,116,139-143] (eg, cultures, adenosine tri-phosphate [ATP] monitoring). ***[Recommendation]***

Environmental monitoring programs allow health care organizations to provide measurable, objective data on the cleanliness of the environment. Data generated by measurement of cleaning practices provide complementary information that can be used to drive process improvement activities, encourage compliance with established cleaning protocols, educate personnel, and verify personnel competency.

In a systematic review of monitoring methods, Leas et al[24] found few studies that compared one method against another, no randomized controlled trials, and inconsistent benchmarks for cleanliness. The researchers concluded that more studies are needed to compare methods, determine validated consensus benchmarks, and correlate cleanliness measurements with clinical outcomes (eg, patient colonization, infection).

The CDC tool kit Options for Evaluating Environmental Cleaning describes an interdisciplinary approach to implementing a comprehensive environmental monitoring program that is specific to the level of monitoring desired by the health care organization.[79]

Qualitative Measures

Moderate-quality evidence is available regarding the use of qualitative fluorescent marking methods for assessing environmental cleanliness.[3,103-105,114] The researchers found that fluorescent marking

- improved thoroughness of daily terminal cleaning in the OR[3];
- led to significant improvements in ICU room cleaning[104];
- improved cleaning of high-touch objects in the patient's immediate environment[105];
- improved inpatient room cleaning as part of a bundled approach[114]; and
- was useful for determining the frequency of high-touch surface cleaning during terminal cleaning, although it was not as reliable for detecting surface contamination levels as quantitative measures.[103]

Low-quality evidence is available regarding the use of qualitative remote video auditing (RVA) methods for assessing environmental cleanliness.[80,134] Two organizations reported using RVA with independent observers to improve cleaning in ORs.[80,134]

Before beginning RVA for a 17-room OR, Pederson et al[80] developed explicit standards and audit tools for between-patient and terminal cleaning. Shortly after introduction of the standards, audit tools, and RVA, compliance for between-patient cleaning was 79% and compliance for terminal cleaning was 67%. However, after introduction of a "pit crew" concept, in which personnel were assigned specific tasks before beginning between-patient cleaning, compliance rose to 93%. As a result of the low compliance score for terminal cleaning, remedial training and re-education of environmental services personnel was initiated, leading to a 94% compliance score. A secondary measure of the RVA intervention was reduction of SSIs, which decreased by 10% compared to the previous year.[80]

Armellino et al[134] used RVA to improve and maintain compliance with terminal cleaning in the ORs of two facilities. Before beginning RVA, the terminal cleaning process was placed into sequential steps and used to develop an audit tool. After the first week of RVA, Facility 1 reported 52% compliance with protocol and Facility 2 had 33% compliance. However, after 3 months of continuous daily feedback to personnel and

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reporting of findings to perioperative and organizational administration, Facility 1 increased compliance to 98% and Facility 2 increased to 88%. Twelve months later when RVA was used again to evaluate practices, Facility 1 had 97.8% and Facility 2 had 99.7% compliance.

For the most objective approach to monitoring, the CDC recommends using an independent observer who is not part of the environmental services department, such as an infection preventionist or a health care epidemiologist.[79]

Quantitative Measures

Moderate-quality evidence is available regarding the use of quantitative culturing for assessing environmental cleanliness.[5,15,106] The researchers found that culturing methods

- identified the specific type of bacteria or fungi on the surface,[14,116,143]
- determined the density of organisms on a surface,[5,55]
- identified surface contamination on a contact culture plate that was not found by ATP methods,[106]
- were a cost-effective method for identifying environmental contamination,[5]
- used contact culture plates on flat surfaces,[15] and
- used culture swabs on irregular surfaces.[15]

Moderate-quality evidence is available regarding the use of ATP methods for assessing environmental cleanliness.[78,102,106,140-142] The researchers found that ATP monitoring

- identified suboptimal cleaning practices[102];
- improved cleaning of high-touch objects when implemented with an education and feedback program[102];
- identified areas that may need additional cleaning[78];
- could have detected nonviable debris[141,142];
- reached surface areas that contact culture plates could not[142];
- was a good method to evaluate high-touch sites that may have bacterial contamination[106];
- was a quick and objective method for assessing hospital cleanliness, but thresholds appeared to be poorly standardized[140]; and
- was limited in its' ability to detect bacterial spores.[144]

12.3.1

Multiple qualitative and quantitative methods may be used to assess environmental cleaning practices.[103] *[Conditional Recommendation]*

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Using multiple qualitative and quantitative methods provides a comprehensive assessment of cleaning practices. In a prospective observational study, Boyce et al[103] found that although fluorescent marking was useful for determining cleaning frequency, this method was not as reliable for detecting surface contamination levels as were quantitative measures.
12.3.2

Provide feedback of assessment findings to personnel and leaders.[2,24,102,104,107,134] ***[Recommendation]***

Measurement and feedback improve cleaning thoroughness. Moderate-quality evidence supports the sharing of monitored data, along with follow-up education to improve cleaning compliance.[2,24,102,104,107,134]

In a systematic review, Leas et al[24] found that in addition to organizational culture and leadership, standardization of processes and feedback to personnel were key to improving cleaning practices.

Boyce et al[102] reported in a prospective intervention study conducted at a university-affiliated community teaching hospital that use of an ATP assay showed suboptimal cleaning practices, and implementation of an education and feedback program improved cleanliness of high-touch objects in patient rooms. The researchers found that the instant results of the ATP assay were useful in improving cleaning practice.

Carling et al[2] conducted a quasi-experimental study in 36 acute care hospitals and found that cleaning can be significantly improved with a combined approach of a highly objective targeting method, repeat performance feedback to environmental services personnel, and administrative interventions. In another quasi-experimental study, Carling et al[104] found that repeated performance feedback to environmental services personnel as part of an objective fluorescent targeting method led to significant improvements in ICU room cleaning.

Alfa et al[107] also conducted a quasi-experimental study and found a significant reduction in HAIs after implementing a clearly defined cleaning protocol, use of an effective disinfectant, and monitoring of compliance with same-day feedback.

Mitchell et al[137] administered a cross sectional survey to environmental services personnel and found that they desired feedback but felt feedback on a regular basis was lacking.

As part of organizational improvement project, Armellino et al[134] conducted a 3-month feedback period to provide daily results of OR terminal cleaning audits to appropriate personnel, along with remedial education. The researchers found that combined monitoring program with feedback resulted in sustained improvement in terminal cleaning.
12.4

Record completion of terminal and scheduled cleaning procedures on a checklist or log.[24,126] ***[Recommendation]***

Checklists that outline the health care organization's cleaning procedures guide cleaning personnel in performing terminal and scheduled cleaning procedures so that items are not missed. A checklist or log also facilitates communication between perioperative team members and environmental services personnel that the environment is safe and clean for patients.

As part of a systematic review, Leas et al[24] identified checklists as a means to standardize procedures and support adherence to best practices. In a multi-society expert opinion document,[126] the authors recommended

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creating a checklist to ensure all surfaces are cleaned and disinfected as part of a bundled approach for a successful cleaning program.
12.4.1

The cleaning checklist may be designed for the specific setting and workflow of the area and modified when there is a change in equipment or workflow.[114,145] *[Conditional Recommendation]*

New technologies or changes in workflow or standards of practice may require modification of a checklist or log.[145] To avoid checklist fatigue, Burian et al[145] recommended that a checklist be designed for a specific setting and the work-flow that occurs in that area. When conducting a quasi-experimental study, Mitchell et al[114] allowed for customization of a cleaning bundle by each of the 11 facilities, to take into context the facility's existing cleaning products and schedules.

Glossary

Clean: The absence of visible dust, soil, debris, or blood.

Contact time: The specific length of time a disinfectant must remain in contact with a microorganism to achieve disinfection. Synonyms: dwell time, kill time.

Disinfection: A process that kills pathogenic and other microorganisms by physical or chemical means.

Enhanced environmental cleaning: Cleaning of surfaces that extends beyond routine cleaning and is performed following the care of a patient who is infected or colonized with a multidrug-resistant organism.

Environmental cleaning: The process of cleaning, disinfecting, and monitoring for cleanliness.

Environmentally preferable: Products or services that have lesser or reduced effect on human health and the environment compared to competing products or services that serve the same purpose.

Focused multivector ultraviolet light system: An ultraviolet light delivery system that uses modular panels and reflectors to create a target zone that allows UV-C light to contact item surfaces from many directions.

Fomite: An inanimate object that, when contaminated with a viable pathogen (eg, bacterium, virus), can transfer the pathogen to a host.

High-touch object: A frequently touched item or surface.

Continuous ultraviolet system: An ultraviolet light delivery system that delivers UV-C light in a constant-on mode for a set time. Low pressure mercury lamps are most often used for UV-C delivery.

Pulsed xenon ultraviolet system: An ultraviolet light delivery system that uses a xenon lamp to produce intense pulses of UV-C light.

Regulated medical waste: Liquid or semi-liquid blood or other potentially infectious materials, contaminated items that would release blood or other potentially infectious materials in a liquid or semi-liquid state if compressed, items that are caked with dried blood or other potentially infectious materials and are capable of releasing these materials during handling, contaminated sharps, and pathological and microbiological wastes containing blood or other potentially infectious materials.

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Scheduled cleaning: Periodic cleaning (eg, weekly, monthly) of areas and equipment that are not cleaned daily or after every use.

Surgical suite: An area or areas of the building containing the preoperative, intraoperative, and postoperative patient care areas and provisions for support areas.

Terminal cleaning: Thorough environmental cleaning that is performed at the end of each day the room or area is used.

Utility water: Water obtained directly from a faucet that has not been purified, distilled, or otherwise treated. Synonym: tap water.

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Acknowledgments

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