ASIA PACIFIC SOCIETY OF INFECTION CONTROL

APSIC GUIDELINES FOR ENVIRONMENTAL HYGIENE: SURFACE CLEANING, AIR AND WATER QUALITY IN HOSPITALS

The Asia Pacific Society of Infection Control (APSIC) would like to acknowledge the contribution and expertise of the ASEAN workgroup that developed this document:

Chairperson:

Dr. Anucha Apisarnthanarak, Thailand – President of APSIC and Chief, Division of Infectious Diseases, Thammasat University Hospital, Thailand

Members :

1. A/Prof Moi Lin Ling, Singapore – Past–President of APSIC and Director, Infection Prevention & Epidemiology, Singapore General Hospital
2. Dr. Namita Jaggi, Chairperson – Lab services and Infection Control and Chief-Education and Research, Artemis Hospital
3. Ms. Patricia Ching – Principal Nurse of WHO Collaborating Centre for Infectious Disease Epidemiology and Control, School of Public Health the University of Hong Kong
4. Dr. Zhiyong Zong, China – Director, Center of Infectious Diseases, West China Hospital, Sichuan University
5. Ms. Lily Liang, – Infection Control Nurse Manager, Dental Services, National Healthcare Polyclinics

Table of Contents

Glossary

Aspergillus - a fungus which spores are present in the air we breathe but does not normally cause illness. However, an individual with a weakened immune status may be susceptible to *Aspergillus* infection

Biofilm - microbial communities that are characterized by cells attached to a substrate or to each other, are embedded in a matrix of extracellular polymeric substances, and exhibit increased resistance to dislodgment during cleaning and disinfection and to the effects of antimicrobial agents

Candida - a genus of yeasts. Many species are harmless parasites of hosts including humans, but other species, or harmless species in the wrong location, can cause disease

CDC – U.S. Centers for Diseases Control and Prevention

cfu - colony forming units

Cleaning - removal of debris, blood or body fluid usually with detergent and water or enzyme cleaner and water, of adherent visible soil, blood, protein substances, microorganisms, and other debris from the surfaces, devices and equipment by manual or mechanical process that render it safe for handling and / or further decontamination

Construction - a process that consists of the building or assembling of infrastructure.

Decontamination - according to OSHA, “the use of physical or chemical means to remove, inactivate, or destroy bloodborne pathogens on a surface or item to the point where they are no longer capable of transmitting infectious particles and the surface or item is rendered it safe for handling, use or disposal

Demolition - the tearing-down of buildings and other structures

Disinfectant - usually a chemical agent (but sometimes a physical agent) that destroys disease-causing pathogens or other harmful microorganisms but might not kill bacteria spores. It refers to substances applied to inanimate objects

Ducts - pipe or tubular runway for carrying smoke or grease

DUWL - **Dental Unit Waterline**, small bore tubing, usually plastic, used to deliver dental treatment water through a dental unit such as the lines connecting to the chairside dental handpiece

Exhaust hood - an enclosure or canopy provided with a draft for carrying off fumes, sprays, smoke, gas or vapor

EPA – U.S. Environmental Protection Agency

Fusarium – a fungus causing vascular wilt disease.

Grease filters - an apparatus containing a filter medium for grease

HAI - Healthcare Associated Infection

HBV - Hepatitis B Virus

HCP - healthcare personnel; persons working in healthcare facilities

HEPA Filter (*High Efficiency Particulate Air filter*) - is a high-performance filtration device capable of removing particulate matter with minimum collection efficiency of 99.97% for a 0.3 micrometer (micron) diameter of a thermally-generated dioctylphthalate (DOP) particle.

Heterotrophic bacteria - They are type of bacteria that require organic carbon sources to grow and survive. They are essential for the ecosystem, but some species can cause harm to humans and animals. They are found in every type of water. Examples of heterotrophic bacteria include *Escherichia coli, Staphylococcus,aureus, Pseudomonas aeruginosa*. Detecting heterotrophs in water is done by using a method called Heterotrophic Plate Count (HPC).

HIV - Human Immunodeficiency Virus

HVAC - Heating, Ventilation, Air Condition

ICU - Intensive Care Unit

Legionella - a pathogenic Gram-negative bacterium, including species that cause legionellosis (Legionnaires' Disease).

MDRO - multidrug-resistant organism

MRSA - Methicillin-resistant *Staphylococcus aureus*

Mycobacteria - bacteria with a thick, waxy coat that makes them more resistant ot chemical germicides than other types of vegetative bacteria.

Nocardia - a bacterium causing infection in the lungs, brain or skin. It occurs mainly in people with weakened immune systems.

Neutropenia - a condition with an abnormally low level of neutrophils in the blood.(i.e., <1000 cells/mL)

Spores - reproductive cells produced by certain fungi and some bacteria.

Offal - waste or by-product of a process

Oncology - the branch of medicine that deals with cancer

PPE - Personal Protective Equipment

Potable water- water suitable for drinking

Sanitation - promotion of hygiene and prevention of disease by maintenance of sanitary condition

SDS - Safety Data Sheet

Spatter - visible drops of liquid or body fluid that are expelled forcibly into the air and settle out quickly, as distinguished from particles of an aerosol, which may remain airborne indefinitely

UV-C - ultraviolet light C (wavelength)

Ventilation - circulation of air in a room; a system of providing fresh air

VRE - Vancomycin-Resistant *Enterococcus*

Chapter 1: Environmental Hygiene: Surface Cleaning, Air and Water Quality

Contamination of hospital surface, air, and water supplies with hospital pathogens is a well-recognized cause of common-source outbreaks of infection. Hospital patients shed pathogens into their surrounding environments that may resulting in surface contamination which can serve as a source for subsequent transmission. In recent years, air and water quality also serve as an important source of pathogens transmission, particularly during the COVID-19 pandemic. Pathogen transfer from an affected patient to a susceptible host occurs most commonly via the hands of healthcare personnel (HCP), but contaminated objects, surfaces, water and air can be either directly or indirectly involved in the transmission pathway. Therefore, modern hospital design and hygienic practices have been largely directed at controlling healthcare-associated pathogens that come from contaminating air, hands, equipment, water and surfaces.

Evidence is accumulating that contaminated surfaces, water or air make an important contribution to the epidemic and endemic transmission of *Clostridioides difficile*, vancomycin-resistant enterococci, methicillin-resistant *Staphylococcus aureus*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and norovirus and that improved environmental decontamination contributes to the control of outbreaks bacterial and fungal spores, and viruses that are shed from infected and/or colonized patients (and sometimes HCP) into the hospital environment. Patients are the prime source of contamination, so surfaces in the vicinity of patients that are touched frequently by HCP and patients—termed “high-touch surfaces” (defined by direct observation)—have a higher frequency of contamination than other sites. The presence of a pathogen on a surface does not necessarily represent a transmission risk. Furthermore, the microbial load (number of bacteria) is not different between high and low touch surfaces. The infectious dose for most environmentally associated healthcare associated pathogens appears to be low. Importantly, despite the comparatively low concentration of contamination on surfaces compared with that on the skin of patients, touching a VRE-contaminated surface carries approximately the same risk for acquisition of VRE on hands as touching an affected patient. Therefore, the presence of a pathogen on a surface at any concentration may be a risk for transmission, and this is reflected in proposed guidelines for microbiological hygiene standards. In addition, healthcare associated pathogens can survive on surfaces for prolong period. *C. difficile* spores, VRE, MRSA, *Acinetobacter* species and *Candida auris* can survive for 4–5 months or more on dry surfaces, and norovirus can survive for a week or more. Several studies have shown that various bacterial pathogens

can be acquired on the hands of HCP through contact with environmental surfaces in the absence of direct patient contact. A number of studies have also identified the previous presence of a colonized or infected patient in a side room as a risk factor for the acquisition of the same pathogen by a new occupant, presumably because of residual room contamination that is not removed through terminal cleaning and disinfection. This effect has been shown for VRE, MRSA, *C. difficile*, multidrug-resistant *P. aeruginosa*, and *A. baumannii.* Together, this evidence suggest that the contaminated surface environment contributes to the transmission of healthcare associated pathogens and that improved cleaning and disinfection reduces the risk of HAIs.All touchable surfaces in a hospital room should be routines cleaned and disinfected. Non-touchable surface (e.g., wall, ceiling)- only require periodic cleaning and disinfection.

Despite expanding knowledge on environmental cleaning, limited data is available concerning the role of environmental cleaning to limit transmission of healthcare associated pathogens in the Asia Pacific region. In this Guideline, we provide evidence and practices of environmental hygiene focusing on surface cleaning, air and water quality.

References:

1. CDC and ICAN (2019) Best Practices for Environmental Cleaning in Healthcare Facilities in Resource-Limited Settings. Atlanta, GA: US Department of Health and Human Services, CDC; 2019. Available from: https://www.cdc.gov/hai/prevent/ resource-limited/index.html. Accessed on 11 June 2024.

2. Best Practices for Environmental Cleaning for Prevention and Control of Infections in All Health Care Settings. Ontaria, Canada: Public Health Ontario: 2018. Available at: https://www.publichealthontario.ca/-/media/documents/b/2018/bp-environmental-cleaning.pdf. Accessed on 11 June 2024.

3. Ling ML, Apisarnthanarak A, Thu le TA, Villanueva V, Pandjaitan C, Yusof MY. APSIC Guidelines for environmental cleaning and decontamination. Antimicrob Resist Infect Control; 2015:4:58. doi: 10.1186/s13756-015-0099-7.

4. Ventilation in buildings. Centers for Disease Control and Prevention May 12, 2023. Available at: https://cdc.gov/coronavirus/2019-ncov/community/ventilation.html. Accessed on 11 June 2024.

5. Scanlon MM, Gordon JL, Tonozzi AA, and Griffin SC (2022). Reducing the Risk of Healthcare Associated Infections from *Legionella* and Other Waterborne Pathogens Using a Water Management for Construction (WMC) Infection Control Risk Assessment (ICRA) Tool. Infectious Disease Reports, 14(3).

6. Huslage K, Rutala WA, Sickbert-Bennett E, Weber DJ. A quantitative approach to defining "high-touch" surfaces in hospitals. Infect Control Hosp Epidemiol. 2010;31:850-853.

7. Huslage K, Rutala WA, Gergen MF, Sickbert-Bennett EE, Weber DJ. Microbial assessment of high-, medium-, and low-touch hospital room surfaces. Infect Control Hosp Epidemiol. 2013;34:211-212.

8. Boyce JM, Opal SM, Chow JW, et al. Outbreak of multidrug-resistant *Enterococcus faecium* with transferable vanB class vancomycin resistance. *J Clin Microbiol* 1994;32:1148–1153.

9. Otter JA, Yezli S, French GL. The role played by contaminated surfaces in the transmission of healthcare associated pathogens. *Infect Control Hosp Epidemiol* 2011;32:687-699.

10. Denton M, Wilcox MH, Parnell P, et al. Role of environmental cleaning in controlling an outbreak of *Acinetobacter baumannii* on a neurosurgical intensive care unit. *J Hosp Infect* 2004;56:106–110.

11. Huslage K, Rutala WA, Sickbert-Bennett E, Weber DJ. A quantitative approach to defining “high-touch” surfaces in hospitals. *Infect Control Hosp Epidemiol* 2010;31:850–853.

12. Weber DJ, Rutala WA, Miller MB, Huslage K, Sickbert-Bennett E. Role of hospital surfaces in the transmission of emerging health care–associated pathogens: norovirus, *Clostridium difficile*, and *Acinetobacter* species. *Am J Infect Control* 2010;38(suppl):S25–S33.

13. Drees M, Snydman D, Schmid C, et al. Prior environmental contamination increases the risk of acquisition of vancomycin-resistant enterococci. *Clin Infect Dis* 2008;46:678–685.

14. Huang SS, Datta R, Platt R. Risk of acquiring antibiotic-resistant bacteria from prior room occupants. *Arch Intern Med* 2006;166:1945–1951.

15. Rutala WA, Weber DJ. Monitoring and improving the effectiveness of surface cleaning and disinfection. Am J Infect Control 2016; 44 (Suppl 5): e69-76.

16. Kramer A, Schwebke I, Kampf G. How long do healthcare associated pathogens persist on inanimate surfaces? a systematic review. *BMC Infect Dis* 2006;6:130.

17. Hayden MK, Blom DW, Lyle EA, Moore CG, Weinstein RA. Risk of hand or glove contamination after contact with patients colonized with vancomycin-resistant *Enterococcus* or the colonized patients’ environment. *Infect Control Hosp Epidemiol* 2008;29:149–154.

18. Boyce JM, Potter-Bynoe G, Chenevert C, King T. Environmental contamination due to methicillin-resistant *Staphylococcus aureus*: possible infection control implications. *Infect Control Hosp Epidemiol* 1997;18:622–627.

19. Ray AJ, Hoyen CK, Taub TF, Eckstein EC, Donskey CJ. Healthcare associated transmission of vancomycin-resistant enterococci from surfaces. *JAMA* 2002;287:1400–1401.

Chapter 2: Selection of Finishes and Surfaces in the Healthcare Setting

Housekeeping surfaces require regular cleaning and removal of soil and dust. Healthcare facilities should have policies that include the criteria to be used when choosing furnishings and equipment for patient care areas. In general, the following factors are to be considered in these criteria:

a) Choosing finishes, furnishings and equipment that can be easily cleaned.
b) Ensuring compatibility of the healthcare setting's cleaning and disinfecting agents with the items and surfaces to be cleaned.

It is highly recommended that Infection Prevention and Control (IPC), Occupational Health and Safety and Housekeeping work collectively in decision making with respect to choices of furniture and finishing for the facilities.

Attention is to be paid to the following when choosing finishes and surfaces:

c) Easy maintenance and repair (e.g., sharp corners on floors are to be avoided), instead, rounded corners are recommended for easy cleaning and maintenance.
d) Fabrics used in upholstered furniture in patient care areas must be fluid-resistant, non-porous and can withstand cleaning with hospital-grade disinfectants.
e) Choose materials that are less likely to support microbial growth (e.g. plastics and metals). Wet organic substrates (e.g., wood) should be avoided in hospital areas with immunocompromised patients.
f) Cloth items such as curtains, pillows, mattresses and soft furnishings should:
    i) Be seamless where possible or have double-stitched seams;
    ii) Be easily accessed for cleaning;
    iii) Have removable covers for cleaning;
    iv) Have foam cores that are resistant to mold;
    v) Not be damaged by detergents and disinfectants;
    vi) Be quick-drying
    vii) Be maintained with good repair
    viii) Mattresses and pillows should be covered by a non-porous cleanable plastic (to prevent contamination).

Carpets are not recommended in patient care areas (intensive care units, laboratory areas, areas around sinks) as there is the likelihood of spills of contaminated liquids. and risk of infection from dust and particulates housed in these carpets. Also, it is not recommended to use carpets in patient care areas housing immunocompromised patients (e.g., transplant units, some oncology units) as these are at risk for invasive fungal infections. Plastic coverings, including mattress covers and pillow covers, should be cleaned with hospital approved cleaning agent on a regular basis; inspected for damage (mattress and pillow covers should be replaced when torn, cracked or have evidence of liquid penetration). The mattress or pillow should be replaced if it is visibly stained.

Hospital Equipment

IPC should be consulted when purchasing new equipment. Factors to note include keypads and monitoring screens that can be easily cleaned and disinfected. Plastic skins may be effective to cover computer keyboards, allowing ease of cleaning but must be compatible with the health care setting's cleaning and disinfecting products.

Recommendations:

1. Healthcare settings should have policies that include the criteria to be used when choosing finishes, furnishings and equipment for patient care areas **[BIII]**.
2. IPC, Environmental services and Occupational Health and Safety should be involved in the selection of surfaces and finishes in healthcare settings **[CII]**.
3. Surfaces, furnishings, equipment and finishes in health care settings should [BII]:
    a. Be easily maintained and repaired;
    b. Be cleanable with hospital-grade detergents, cleaners and disinfectants
    c. Be smooth, nonporous, seamless and unable to support microbial viability.
4. Carpets should not be used in patient care areas and especially in areas that house or serve immunocompromised patients or where there is a high likelihood of contamination with blood or body fluids **[BII]**.

Equipment that cannot be adequately cleaned, disinfected or covered, including electronic equipment, are not recommended for use in the patient care area **[BIII]**.

References

1. Sehulster L, Chinn RY. Guidelines for environmental infection control in health-care facilities. Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). MMWR Recomm Rep 2003;52(RR-10):1-42. Available from: http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/Enviro_guide_03.pdf. Accessed July 10, 2024

2. PIDAC- Best Practices for Environmental Cleaning for Prevention and Control of Infections 2012.Available from: https://www.publichealthontario.ca/en/BrowseByTopic/InfectiousDiseases/PIDAC/Pages/PIDAC_Documents.aspx. Accessed July 10, 2024

3. Streifel AJ, Stevens PP, Rhame FS. In-hospital source of airborne Penicillium species spores. *J Clin Microbiol* 1987;25(1):1-4

4. Anderson RL, Mackel DC, Stoler BS, Mallison GF. Carpeting in hospitals: an epidemiological evaluation. *J Clin Microbiol* 1982;15(3):408-15.

5. CDC and ICAN. Best Practices for Environmental Cleaning in Healthcare Facilities in Resource-Limited Settings. Atlanta, GA: US Department of Health and Human Services, CDC; Cape Town, South Africa: Infection Control Africa Network; 2019. Available from: https://www.cdc.gov/hai/prevent/resource-limited/index.html. Accessed July 13, 2024

Chapter 3: Cleaning Agents and Disinfectants for Healthcare Settings

1. Introduction

Cleaning is the removal of foreign material (e.g., soil, and organic material) from objects and is normally accomplished using water with detergents or enzymatic products. Disinfection is the process by which any microorganisms that remain after cleaning are reduced to a level at which they are not harmful, which is only effective if the equipment or surface is thoroughly cleaned with a detergent solution beforehand.

The selection and appropriate use of cleaning agents and disinfectants is critical for effective environmental cleaning.

There are different kinds of products available for environmental cleaning and disinfection, which all have distinct properties and advantages and disadvantages to their potential use in healthcare.

2. Ideal properties for effective cleaning agents and disinfectants

i. Ideal properties for cleaning agents:

- **Efficacious**: should remove dirt, soil, and various organic substances.
- **Nontoxic**: it should not be irritating to the skin or mucus membranes of the user, visitors, and patients.
- **Easy to use:** directions for preparation and use should be simple and contain information about PPE as required.
- **Acceptable odor:** it should not have offensive odors to users and patients.
- **Solubility:** it should be easily soluble in water (warm and cold).
- **Economical/Low cost:** it should be affordable
- **Environmentally friendly**: should not cause environmental pollution upon disposal; biodegradable

ii. Ideal properties for disinfectants:

- **Broad spectrum:** it should have a wide antimicrobial range, including those pathogens that are common causes of healthcare associated infections (HAIs) and outbreaks.
- **Rapid action:** it should be fast acting and have a short contact time.
- **Remains wet:** it should keep surfaces wet long enough to meet recommended contact times with a single application.

- **Not affected by environmental factors:** it should be active in the presence of trace quantities of organic matter (e.g., blood) and compatible with cleaning supplies (e.g., cloths) and products (e.g., detergents) and other chemicals encountered in use.
- **Material compatibility:** it should be proven compatible with common healthcare surfaces and equipment.
- **Persistence:** it should have residual antimicrobial effect on the treated surface.
- **Cleaner:** it should have some cleaning properties.
- **Nonflammable:** it should have flash point of more than 65°C (150°F).
- **Stability:** it should be stable in concentration and use dilution.

3. Products for environment cleaning and disinfection

3.1. Cleaning products

Cleaning products include liquid soap, enzymatic cleaners, and detergents. They remove organic material (e.g., dirt, body fluids) and suspend grease or oil. This is done by combining the cleaning product with water and using mechanical action (i.e., scrubbing and friction). For most environmental cleaning procedures, select neutral detergents (pH between 6 and 8) that are easily soluble (in warm and cold water). There are specialized cleaning products, for specific areas within the healthcare facility (e.g., bathroom/toilet cleaners, floor polishers, glass cleaners).

3.2. Disinfectants

Disinfectants are not substitutes for cleaning, unless they are a combined detergent-disinfectant product. Low-level disinfection is generally adequate for environmental cleaning procedures, but there are specific cases where intermediate-level disinfection with sporicidal properties (e.g., *C. difficile*) is required.

Disinfectants are carefully evaluated for their performance and only U.S. EPA-registered hospital approved disinfectants should be used. Common low- and intermediate-level disinfectants that are used in healthcare settings include:

- **Quaternary ammonium compounds (Quat)**
- **Alcohols (ethyl or isopropyl)**
- **Chlorine releasing agents (e.g., bleach)**
- **Improved hydrogen peroxide**

The perfect disinfectant for healthcare disinfection has not been introduced; however, there is a wide array of excellent disinfectants that offer a range of characteristics. See Commonly used disinfectants **(Appendix A)**

3.3. Combined detergent-disinfectants

Combined (one-step) detergent-disinfectant products can generally be used in place of a two-step (separate detergent and disinfectant product) process when disinfection is indicated for specific environmental cleaning procedures.

When using a combined product for environmental cleaning, it is recommended to periodically (i.e., on a scheduled basis) use a rinse step to remove residues from surfaces while ensuring that the combined product stays wet on the surface for the required contact time. A combined detergent-disinfectant (1-step product) should not be used for cleaning of *C. difficile* contaminated environment and spills of blood or bodily fluids. The EPA's List K includes disinfectants that are effective against *C. difficile* spores, and some ready-to-use wipes on this list are designed to target C. difficile. Some of these wipes require a pre-cleaning step if there is visible soil or large amounts of organic material before using the disinfectant. Always ensure the wipe stays wet for the full contact time specified to effectively kill *C. difficile* spores.

4. Cleaning and disinfection, equipments and supplies

Surface cleaning supplies

a) Portable containers: Containers should be clean, dry, appropriately-sized, labelled, and dated.
   - Narrow-necked bottles are preferred over buckets.
   - Squeeze bottles are preferred over spray bottles.

b) Surface cleaning cloths: It should be cotton or microfiber (disposable wipes can be used if resources allow). Color-coding may be applied to prevent cross contamination between areas, red cloths are used for toilet areas, blue for general patient areas, and yellow for isolation areas.

c) Disinfectant cleaning wipes: Ready-to-use wipes that are saturated with an appropriate disinfectant product (quaternary ammonium compounds, alcohol or chlorine) can be used an as alternative to cleaning cloths and have been found to be highly effective (>4-$\log_{10}$ reduction) in removing/inactivating epidemiologically important pathogens.

Floor cleaning supplies

Mops (especially cotton-string mops) should be kept adequately clean and disinfected changing the water-disinfectant mixture after every 3-4 rooms (ideally after each room), no longer than 60-minute intervals in order to prevent the spread of heavy microbial contamination. The frequent laundering of cotton-string mops (e.g., daily) is recommended.

Microfiber cloths are often preferred over cotton for both cleaning cloths and mop heads because microfiber absorbs more dirt and microorganisms than cotton. However, microfiber cloths can be damaged by high pH and therefore not compatible with all disinfectant products (especially chlorine-based). They need to be laundered separately from cotton cloths/linens, which can be expensive.

5. New technologies for room decontamination and outbreak situations.

'No-touch' technologies such as hydrogen peroxide vapor systems, ultraviolet-C light devices and electrostatic spraying are supplementary options, usually for terminal disinfection and outbreak situations. Their advantage is they eliminate human factors such as relying on an operator to ensure that all surfaces are disinfected adequately. Multiple studies have proven their efficacy However, the convenience of using these technologies for routine cleaning and disinfection is limited due to cost considerations, regulatory requirements and the need for prior conservative wipe disinfection.

i. Ultraviolet (UV) light

The wavelength of UV radiation ranges from 328 nm to 210 nm (3280 A to 2100 A). Its maximum bactericidal effect occurs at 240–280 nm. The microbicidal activity. results from destruction of nucleic acid through induction of thymine dimmers. Bacteria and viruses are more easily killed by UV light than are bacterial spores.

Automated mobile ultraviolet light devices emitting UV-C at 254 nm can be placed in patient rooms after patient discharge and terminal cleaning can be performed. These systems often reduce the VRE and MRSA by >4-$\log_{10}$, and *C. difficile* by 1–3-$\log_{10}$. Several investigators summarized multiple studies that assessed the effectiveness of UV devices. Boyce and Donskey summarized the UV-C doses needed to yield a ≥3-$\log_{10}$ reduction of healthcare-associated pathogens and factors affecting UV-C efficacy. In general, the studies showed >3- $\log_{10}$ vegetative bacteria can be killed on carriers in 5-25 minutes by UV devices and UV requires greater time and energy to kill a spore forming organisms. Weber et al. (2023) quoted in his review of various studies comparing new decontamination technologies.

A multicenter cross-over trial conducted by Anderson et al in 9 hospitals to evaluate the 3 strategies (Quat plus UV-C, bleach alone and bleach plus UV-C) compared to the standard strategy (Quat). Result showed bleach and/or UV-C decontamination decreased the clinical incidence of MDROs by 10-30%. The UV-C system offers faster decontamination which reduces the "down" time of the room before another patient can be admitted. Morikane et al. conducted a study in a Japanese tertiary hospital to assess the effectiveness of portable pulsed xenon ultraviolet (PX-UV) devices in controlling multidrug-resistant organisms (MDROs). The study found that adding PX-UV disinfection to manual cleaning significantly reduced the incidence of newly acquired MRSA and drug-resistant Acinetobacter. PX-UV further decreased the microbial burden by 59% after manual cleaning. The study by Vaivoothpinyo and colleagues found that adding pulsed xenon ultraviolet (PX-UV) light to standard cleaning protocols in Thai ICUs significantly reduced the incidence of multidrug-resistant gram-negative organisms and *Acinetobacter baumannii* infections. However, this intervention did not affect patient outcomes like length of stay or 30-day mortality.

ii. Hydrogen peroxide (HP) Systems- Vapors/mist

A "dry gas" vaporized hydrogen peroxide system that utilizes 30 % hydrogen peroxide has been shown to be effective against *Mycobacterium tuberculosis, Mycoplasma, Acinetobacter*, *C. difficile*, *Bacillus anthracis*, viruses, and prions. Significant reductions (often 6-$\log_{10}$) of a number of these pathogens have been reported. This system has also been used to decontaminate rooms previously occupied by patients with the Lassa fever and Ebola virus infection. Concerns over its cost, room turn-around-times and lack of randomized controlled trials establishing its impact on reducing HAIs have hampered adoption of this technology in healthcare settings. Passaretti et al. conducted a 30-month study to evaluate the impact of hydrogen peroxide vapor (HPV) disinfection on MDRO transmission in a hospital setting. They found that HPV decontamination significantly reduced environmental contamination and lowered the risk of MDRO acquisition in patients, compared to standard cleaning methods. Specifically, patients in HPV-treated rooms were 64% less likely to acquire any MDRO and 80% less likely to acquire VRE.

iii. Electrostatic Spraying

One "no touch" strategy that may improve thorough application to surfaces is the use of a disinfectant as a spray. The EPA has also highlighted the use of electrostatic sprayers for disinfection. Donskey and colleagues evaluated the use of a dilute sodium hypochlorite disinfectant applied via electrostatic sprayer after manual precleaning of visibly soiled areas.

Their study demonstrated rapid and effective decontamination of bacteriophage MS2 (a surrogate for SARS-CoV-2) from surfaces such as wheelchairs, portable medical equipment, and patient waiting area chairs. Solomon et al compared three sporicidal disinfectants—electrolyzed water, sodium dichloroisocyanurate, and peracetic acid/hydrogen peroxide (PAA/H_2O_2)—found that sodium dichloroisocyanurate, when applied with wipes and an electrostatic sprayer, had the fewest samples with no bacterial growth and fewer than 2.5 CFU/cm^2, though the difference was not statistically significant. One study done by Cadnum *et al* evaluated an electrostatic sprayer device, which delivers electrostatically charged droplets with an average size of 40-80 m that are attracted to the surface. The disinfectant used contained 0.25% sodium hypochlorite (i.e., 2500 ppm) effective to reduce *Clostridioides difficile* spores by ≥6-log_{10} colony-forming units with a 5-minute contact time and bacteriophage MS2 by ≥6-log_{10} plaque-forming units with a 2-minute contact time. It is used as a spray to reduce microbial contamination on irregular surfaces such as wheelchairs, portable equipment and waiting room chairs. The use of spray was conducted with minimal precleaning to remove visible soil. Hence, these electrostatic sprayers could be used for decontamination of portable equipment and as an adjunctive technology to surface disinfection with wipes in patient rooms on contact precautions.

iv. <u>Coating surfaces with heavy metals</u>

Creating “self-disinfecting surfaces” by coating surfaces with heavy metals such as copper or silver that have innate antimicrobial properties or applying to surfaces compounds that retain their antimicrobial activity for weeks or months has received some attention as a new strategy for disinfecting.

Table 2: Antimicrobial properties of metals

Metal/alloy	**Property**
Silver	Binds strongly with disulfide and sulfhydryl groups present in proteins of microbial cell walls, leading to cell death
copper	The antimicrobial activity of copper may be due primarily to its ability to form reactive oxygen radicals that damage nucleic acid and proteins

Organosilane*	Comprised of a surfactant plus an antimicrobial substance such as a quaternary ammonium moiety. These compounds are designed to minimize bacterial contamination of surfaces by maintaining their antimicrobial activity on surfaces for weeks or months.

* Limited literature to substantiate the effectiveness of organosilane-type compounds

Recommendations:

Cleaning product used in the healthcare setting:

1. Should be approved by occupational health and safety, and environmental services and must be used according to the manufacturers' recommendations such as recommended use-dilution, material compatibility, storage, shelf-life, and safe use and disposal. **[CIII]**
2. Surface cleaning cloths and mop heads or floor cloths should be cotton or microfiber (disposable wipes can be used if resources allow); The frequent laundering of cotton-string mops (e.g., daily) is recommended. **[CIII]**
3. 'No-touch' technologies such as hydrogen peroxide vapor systems, ultraviolet-C light devices, electrostatic spraying may be considered for terminal room decontamination after discharge of patients on contact precautions, especially if the patient had a high consequence pathogen (e.g., Ebola, Lass, *C. auris*). **[BII]**

References:

1. Centers for Disease Control and Prevention. National Center for Emerging and Zoonotic Infectious Diseases (NCEZID).Division of Healthcare Quality Promotion (DHQP). Best Practices for Environmental Cleaning in Healthcare Facilities in Resource-Limited Settings. 2019. Available from: https://www.cdc.gov/healthcare-associated-infections/media/pdfs/environmental-cleaning-RLS-508.pdf. Accessed July 4 2024

2. Dancer SJ. Controlling hospital-acquired infection: focus on the role of the environment and new technologies for decontamination. *Clin Microbiol Rev*. 2014; 27:665–90.

3. Fichet G, Antioga K, Comoy E, Deslys JP, McDonnell G. Prion inactivation using a new gaseous hydrogen peroxide sterilisation process. *J Hosp Infect*. 2007; 67:278–86.

4. Otter JA, Barnicoat M, Down J, Smyth D, Yezli S, Jeanes A. Hydrogen peroxide vapour decontamination of a critical care unit room used to treat a patient with Lassa fever. *J Hosp Infect*. 2010; 75:335–7.

5. Weber DJ, Rutala WA, Anderson DJ, Sickbert-Bennett EE. ..úNo touch..Ñ methods for health care room disinfection: Focus on clinical trials. *Am J Infect Control*? 2023; 51(11S):A134-A143.

6. Humphreys H. Self-disinfecting and microbiocide-impregnated surfaces and fabrics: what potential in interrupting the spread of healthcare-associated infection? *Clin Infect Dis*. 2014; 58:848–53.

7. Salgado CD, Sepkowitz KA, John JF, Cantey JR, Attaway HH, Freeman KD, et al. Copper surfaces reduce the rate of healthcare-acquired infections in the intensive care unit. *Infect Control Hosp Epidemiol*. 2013; 34:479–86.

8. Baxa D, Shetron-Rama L, Golembieski M, Golembieski M, Jain S, Gordon M, et al. In vitro evaluation of a novel process for reducing bacterial contamination of environmental surfaces. *Am J Infect Control*? 2011; 39:483–7.

9. Boyce, John M., Curtis J. Donskey. Understanding ultraviolet light surface decontamination in hospital rooms: A primer. *Infection Control & Hospital Epidemiology*. 2019; 40(9):1030-35.

10. Chetan Jinadatha, Frank C. Villamaria, Nagaraja Ganachari-Mallappa, Donna S. Brown, I-Chia Liao, Eileen M. Stock, et al Can pulsed xenon ultraviolet light systems disinfect aerobic bacteria in the absence of manual disinfection? *Am J Infect Control*? 2015; 43(4):415-7.

11. Jennifer L. Cadnum, Annette L. Jencson, Scott H. Livingston, Daniel F. Li, Sarah N. Redmond, Basya Pearlmutter,et al.. Evaluation of an electrostatic spray disinfectant technology for rapid decontamination of portable equipment and large open areas in the era of SARS-CoV-2, *Am J Infect Control*. 2020; 48(8):951-4.

12. Deverick J Anderson, Luke F Chen, David J Weber, Rebekah W Moehring, Sarah S Lewis, Patricia F Triplett, et al. Enhanced terminal room disinfection and acquisition and infection caused by multidrug-resistant organisms and Clostridium difficile (the Benefits of Enhanced Terminal Room Disinfection study): a cluster-randomised, multicentre, crossover study. *The Lancet*. 2017; 389(10071):805-14.

Appendix A: Commonly used disinfectants in healthcare settings

Disinfection	Advantages	Disadvantages
Low-level disinfectant: Quaternary ammonium compounds e.g., alkyl dimethyl benzyl, ammonium chloride, alkyl dimethyl ethylbenzyl ammonium chloride **<u>Spectrum of activity</u>** • Bactericidal • Virucidal (only enveloped viruses) • Fungicidal	• May be used on food contact surfaces. • Wide material compatibility: • Noncorrosive • Detergent properties, with good cleaning ability • Low cost	• Skin irritant, can also cause respiratory irritation • Narrow spectrum • Activity reduced by various materials (e.g., cotton, water hardness, microfiber cloths, organic material) • Could induce cross resistance with antibiotics • Persists in the environment and waterways
Intermediate-level disinfectant: Alcohols (60-80%) e.g., isopropyl alcohol, ethyl alcohol, and methylated spirits	• Broad spectrum (but not sporicidal) • Rapid action • Nontoxic • Non-staining, no residue • Noncorrosive • Low cost • Good for disinfecting small equipment or devices that can be immersed	• Slow acting against non-enveloped viruses • Does not remain wet • Inactivated by organic material • Can damage materials (plastic tubing, silicone, rubber, deteriorate glues) • Flammable

Disinfection	Advantages	Disadvantages
Intermediate-level disinfectant: Chlorine releasing agents e.g., bleach/sodium or calcium hypochlorite, sodium dichloroisocyanurate (NaDCC) **Spectrum of activity** • Bactericidal • Virucidal • Fungicidal • Mycobactericidal • Sporicidal (hypochlorites only at 5000ppm or 0.5%)	• Hypochlorites are broad spectrum (sporicidal) • Rapid action • Nonflammable • Low cost • Widely available • Can reduce biofilms	• inactivated by organic material • can release toxic chlorine if mixed with acids or ammonia • skin and mucous membrane irritant • damages fabrics, carpets • corrosive • Leaves residue • Offensive odors • subject to deterioration if exposed to heat and UV
Intermediate-level disinfectant: Improved hydrogen peroxide e.g., 0.5% enhanced action formulation hydrogen peroxide, 3% hydrogen peroxide **Spectrum of activity** • Bactericidal • Virucidal • Fungicidal • Mycobactericidal • Sporicidal (only at 4-5%)	• Rapid action • Nontoxic • Detergent properties, with good cleaning ability • Not affected by environmental factors • Active in the presence of organic material • Safe for environment	• contraindicated for use on copper, brass, zinc, aluminum • High cost

Chapter 4: Best practice guidelines for cleaning patient care areas

Introduction

The patient environment is defined as the immediate space around a patient that may be touched by the patient and healthcare personnel (HCP) when providing care. This is divided into three categories:

- Intensive care units (ICUs): The room or bed space and items and equipment inside the room or bed space.
- Single room: The area inside the curtain, including equipment, medical devices, furniture, telephone, personal belongings, and the bathroom.

Environmental surfaces, objects, and medical devices serve as potential reservoirs for pathogens. like MRSA, VRE, Carbapenem resistant *Enterobacterales* and non-fermenters and *C. difficile*. Their presence in the environment for extended periods of time increases the risk of infection transmission. Cross transmission can occur by HCP through inadequate hand hygiene after directly or indirectly touching contaminated environmental surfaces contributing to 20-40% of HAIs.

Therefore, environmental cleaning is an essential element in preventing transmission of HAIs. This should be augmented by multifaceted interventions involving support of leadership, continuous trainings, and regular monitoring of effectiveness of cleaning and disinfection are desired.

Types of Environmental Surfaces

Environmental surfaces can be classified in two ways

I. Based on type of surface
    - **Medical equipment surfaces**: include knobs, handles on hemodialysis machines, x-ray machines, and instrument carts
    - **Housekeeping surfaces**: floors, walls, and tabletops

II. Based on risk
    - **High Risk surfaces**: Heavily contaminated surfaces and equipment that are routinely exposed to large amount of blood and/or other body fluids and require more frequent and thorough environmental cleaning. Examples include surfaces in burn units, dialysis units, intensive care units, organ transplant units, operation theatres and emergency department etc.

- **Moderate Risk surfaces**: Surfaces and/or equipment are not routinely but may become contaminated with blood and/or other body fluids. Examples include patient rooms, nursing stations, outpatient department consultation rooms etc.
- **Low Risk surfaces**: Lightly or non-contaminated surfaces and/or equipment that are not exposed to blood or body fluid. Examples include lounges, offices, and surfaces not regularly accessible.

III. Frequency of contact by HCP/ patients associated distribution

- **High-touch**: surfaces that have frequent contact with hand (e.g., door knobs, bed rails, computer keyboard, bedrails, IV poles, sink handles, bedside tables, counters where medications and supplies are prepared, edges of privacy curtains, patient monitoring equipment (e.g., keyboards, control panels), transport equipment (e.g., wheelchair handles), call bells, doorknobs, light switches
- **Low-touch**: surfaces that have minimal contact with hands (e.g., wall, ceiling, mirror, ceiling lamp, floor, ceiling fixtures, window sills, artwork on the wall).

Types of Cleaning

- **Routine Cleaning**: Routine cleaning of inpatient areas occurs while the patient is admitted, focuses on the patient zones and aims to remove organic material and reduce microbial contamination to provide a visually clean environment.

- **Terminal Cleaning and Disinfection**: Terminal cleaning of inpatient areas, which occurs after the patient is discharged/transferred, includes the patient zone and the wider patient care area and aims to remove organic material and significantly reduce and eliminate microbial contamination to ensure that there is no transfer of microorganisms to the next patient.

  Terminal cleaning process:

  a. Remove soiled/used personal care items (e.g., cups, dishes) for reprocessing or disposal. Remove facility-provided linens for reprocessing or disposal;
  b. Inspect window treatments. If soiled, clean blinds on-site, and remove curtains for laundering.
  c. Reprocess all reusable (noncritical) patient care equipment; see Non-critical patient care equipment.
  d. Clean and disinfect all low- and high-touch surfaces, including those that may not be accessible when the room/area was occupied (e.g., patient mattress, bedframe, tops of shelves, vents), and floors.

e. Clean (scrub) and disinfect handwashing sinks.

- **Scheduled Cleaning**: Scheduled cleaning occurs concurrently with routine or terminal cleaning and aims to reduce dust and soiling on low touch items or surfaces. Perform scheduled cleaning on items or surfaces that are not at risk for soiling under normal circumstances, using neutral detergent and water. But if they are visibly soiled with blood or body fluids, clean and disinfect these items as soon as possible.

General Cleaning Practices and Cleaning Techniques (Appendix A)

Cleaning Frequency

- **High risk**: clean after each case/event/procedure and at least twice per day, clean additionally as required.
- **Moderate risk**: clean at least once daily, clean additionally as required (e.g., gross soiling).
- **Low risk**: clean according to a fixed scheduled, clean additionally as required (e.g., gross soiling)

Recommended Cleaning and Disinfection methods for various areas and equipment are summarized as Appendix B.

Cleaning practices to manage spills of blood or body fluid

- Wear appropriate PPE (Disposable plastic apron, gloves, boots, mask etc). Gloves should be removed and hand hygiene to be performed between cleaning patient rooms or bays
- Confine the spill and wipe it up immediately with absorbent (paper) towels, cloths, or absorbent granules (if available) that are spread over the spill to solidify the blood or body fluid (all should then be disposed as infectious waste). If spill involves sharp instruments or broken glass, first disinfect the area as below (i.e., 10,000ppm free chlorine, then remove sharp items by use of utensils (i.e., never by hand), use towels or cloths to initially remove blood or body fluids, the re-disinfect as below.
- Disinfect by using a facility-approved intermediate-level disinfectant. Typically, chlorine-based disinfectants at 10,000 ppm free chlorine (1:100) are adequate for disinfecting spills (however, do not use chlorine-based disinfectants on urine spills) preparation. Please note that the initial concentration of chlorine-based products should have concentration of 5.25% (52,500 ppm).

- Allow the disinfectant contact time (e.g., 20-30 minutes), and then rinse the area with clean water to remove the disinfectant residue.
- Immediately send all reusable supplies and equipment (e.g., cleaning cloths, mops) for reprocessing (i.e., cleaning and disinfection) after the spill is cleaned up.
- Replenish the spill kit after the cleaning.

Cleaning of shared clinical equipment

Shared clinical equipment could potentially serve as a vehicle of transmission of infectious agents between patients though they come in contact with intact skin only and the possibility of introduction of infection is low.

Few examples of possibly contaminated surfaces on shared medical equipment include knobs or handles on haemodialysis machines, X-ray machines, instrument trolleys and dental units. This can be reduced by applying surface barriers (e.g. clear plastic wrap, bags, sheets, tubing or other materials impervious to moisture) on equipment. In absence of surface barriers, cleaning clinical surfaces including equipment should be practiced.

Shared medical equipment such as blood pressure cuffs, glucometers infusion pump; intravenous stand; medication trolley; resuscitation trolley; and wheelchair should be disinfected after every use. In resource limited settings, the challenges include lack of time and trained environmental services personnel to achieve the effectiveness of cleaning.

Specialized Cleaning

Specialized cleaning is recommended for high-risk areas housing severely sick patients including

- Highly dependent patients, (e.g., ICU patients)
- Immunosuppressed patients (e.g., bone marrow transplant, chemotherapy)
- Patients undergoing surgery or invasive procedures (e.g., operating theatres rooms)
- Patients who are regularly exposed to blood or body fluids (e.g., labor and delivery wards, burn units)

  The frequency of cleaning is increased as per the risk of infection and selection of chemicals is critical in specialized cleaning.

Recommendations

1. The Occupational Health and Safety policies of the contracting services must be reviewed and audited to ensure its consistency with the healthcare facility's Occupational Health and Safety policies. **[BII]**
2. Continuous trainings and education of cleaning staff on use of personal protective equipment, cleaning agents and their preparation and cleaning of infected and non-infected areas. **[BII]**
3. Non-critical medical equipment requires cleaning and disinfection after each use and policies clearly defining the frequency and level of cleaning and personnel responsible for the cleaning should be present. **[AII]**

References

1. Suleyman G, Alangaden G, Bardossy AC. The Role of Environmental Contamination in the Transmission of Nosocomial Pathogens and Healthcare-Associated Infections. *Curr Infect Dis Rep*. 2018;20(6).

2. PIDAC - Best Practices for Environmental Cleaning for Prevention and Control of Infections 2012. Accessed May 25, 2024. Available from: https://www.publichealthontario.ca/en/BrowseByTopic/InfectiousDiseases/PIDAC/Pages/PIDAC_Documents.aspx. Accessed July 23, 2024

3. Sehulster L, Chinn RY. Guidelines for environmental infection control in health-care facilities. Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). MMWR Recomm Rep 2003;52(RR-10):1–42. Available from: http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/Enviro_guide_03.pdf. Accessed July 23, 2024

4. Olmsted RN. Prevention by design: construction and renovation of health care facilities for patient safety and infection prevention. *Infect Dis Clin N Am.* 2016; 30(3):713–28.

5. Apisarnthanarak A, Weber DJ. Environmental Cleaning in Resource-Limited Settings. *Curr Treat Options Infect Dis*. 2018; 10(1):48-54.

6. Ling ML, Apisarnthanarak A, Thu le TA, Villanueva V, Pandjaitan C, Yusof MY. APSIC Guidelines for environmental cleaning and decontamination. *Antimicrob Resist Infect Control*. 2015 Dec 29; 4:58.

7. Microbiological Advisory Committee to the Department of Health (2006). Sterilisation,disinfection and cleaning of medical equipment. London: Department of Health. ISBN 1-85-839518-6.

8. CDC and ICAN. Best Practices for Environmental Cleaning in Healthcare Facilities in Resource-Limited Settings. Atlanta, GA: US Department of Health and Human Services, CDC; Cape Town, South Africa: Infection Control Africa Network; 2019. Available from: https://www.cdc.gov/hai/prevent/resource-limited/index.html. Accessed July 28, 2024

9. National Guidelines for infection prevention and control in healthcare facilities. National Centre for Disease Control, Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India. Jan 2020. Available from: https://ncdc.mohfw.gov.in/wp-content/uploads/2024/07/National-Guidelines-for-IPC-in-HCF-final1.pdf. Accessed July, 29, 2024

Appendix A: General Cleaning Practices and Cleaning Technique

1) General Cleaning Practices

1. Use fresh cleaning cloths at the start of each cleaning session.
2. Thoroughly wet (soak) a fresh cleaning cloth in the environmental cleaning solution.
3. Fold the cleaning cloth in half until it is about the size of your hand. Wipe surfaces using the general strategies as above (e.g., clean to dirty, high to low, systematic manner), making sure to use mechanical action (for cleaning steps) and allow required contact time.
4. Regularly rotate and unfold the cleaning cloth to use all the sides.
5. For higher-risk areas, change cleaning cloths between patient beds

2) Cleaning Technique

- **Visual site assessment:** To formulate cleaning strategies and
- **Proceed from Cleaner to Dirtier:** To avoid spreading dirt and microorganisms.
- **Proceed from High to Low (Top to Bottom):** To prevent dirt and microorganisms from dripping or falling and contaminating already cleaned areas.
- **Proceed in a Methodical, Systematic Manner:** To avoid missing areas

Appendix B: Recommended Cleaning and Disinfection methods for various areas and equipment

Area/Items	Process	Item/ equipment	Method/ procedure
General clinical areas	Dust mops Mop (No broom will be used for sweeping)	Sweeping	• Sweep with the dust mop or damp mop to remove surface dust. Sweep under the furniture and remove dust from corners. Gathered dust must be removed using a hearth brush and shovel. • The sweep tool should be cleaned or replaced after use.
Ceiling and walls	Sweeping tool Duster Bowl/ small bucket of soap solution Plain water	Damp dusting	• Damp dusting with a long-handled tool for the walls and ceiling done with very little moisture, just enough to collect the dust. • Damp dusting should be done in straight lines that overlap one another. • Change the mop head/ cover when soiled.
Floors (clinical areas) – daily mopping	Detergent/ sanitizer–hot water Three buckets (one with plain water and one with solution; one bucket for hypochlorite (1:50 dilution)	Cleaning Daily mopping	• Prepare cleaning solution using cleaning agent with warm water (detergent/ sanitizer). • Use the three-bucket technique for mopping the floor, one bucket with plain water and one with the detergent solution. • First mop the area with the warm water and detergent solution. • After mopping clean the mop in plain water and squeeze it. • Repeat this procedure for the remaining area. • Mop area again using hypochlorite 1:50 dilution after drying the area. • In between mopping if solution or water is dirty change it frequently. • Mop the floor starting at the far corner of the room and work towards the door. • Clean articles between cleaning. Note: Mopping should be done thrice a day, in each shift
	Care of mop	Hot water Detergent Hypochlorite 1:1000	• Clean with hot water and deterrent solution, disinfect it with hypochlorite and keep for drying upside down.

Area/Items	Process	Item/ equipment	Method/ procedure
Walls and doors, door knobs	Damp cloth or Sponge squeeze mop Detergent	Thorough washing	• The walls and doors are to be washed with a brush, using detergent and water once a week (usually on Sundays); gently apply cloth to soiled area, taking care not to remove paint, then wipe wall with warm water to remove excess cleaning agent. • Door knobs and other frequently touched surfaces should be cleaned daily.
Floors	Scrubbers Hot water Detergent Mop	Thorough washing	• Scrub floors with the hot water and detergent with using minimal water. (Do not pour the water.) • Clean with plain water • Mop area, and allow to dry • Hypochlorite 1:100 mopping can be done.
Isolation room	Detergent/ Sanitizer–warm water Three buckets (one with plain water and one with solution); separate bucket for hypochlorite (1:50 dilution)	Terminal cleaning	Before cleaning an isolation room, liaise with infection control team for details of any special requirements. Staff will be instructed on specific cleaning procedures required with reference to – Safety uniform to be worn. – Chemicals or disinfectants to be used. – Also, if bed screen and shower screen are to be cleaned or changed, refer cleaning in isolation rooms.
All clinical areas/ Laboratories	Hypochlorite 1:100 (1%) Rag piece Absorbent paper Unsterile gloves Spill care kit Mop Hot water	Blood and body fluid spill care	• Wear non-sterile gloves. • Cover the spill with hypochlorite (1:100). • For large spills, cover with rag piece/ absorbent paper for 10–20 minutes contact time. • Clean up spill and discard into infectious waste bin, and mop area. with soap and hot water. • Clean the mop and mop area with 1% hypochlorite. • Wash mop with detergent and hot water and allow it to dry.

Area/Items	Process	Item/ equipment	Method/ procedure
Bookcase, files, lockers, tables, cupboard, wardrobes, benches, shelves and cots	Damp duster Warm water Detergent Dry duster	Damp dusting	Damp dust with warm water and detergent.
Cots, railings and lockers	Detergent/ Sanitizer–hot water Three small buckets/ or big bowls One with plain water One with solution One for hypochlorite 1:100 dilution	Daily dusting	Damp dust with warm water and detergent followed by disinfection with hypochlorite or as per hospital policy.
Bed pans, urinals kidney trays, sputum mugs, urine measuring jugs	Detergent water Brush scrubber Hypochlorite (1:50)	Cleaning and disinfection	• After washing with soap and water immerse in 1:50 dilution of hypochlorite for 20 minutes. • Keep it for air dry in a stand in such a way that water will drain downward.
Suction bottles	Soap and water Hypochlorite 1%	Cleaning and Disinfection	• Should be emptied in sluice room. If soiled with blood and bodyfluids they should be decontaminated with 1% hypochlorite. • Wash with detergent and disinfect with hypochlorite for 20 minutes. • Must be cleaned daily and in between each patient. • To be stored dry when not in use.
Non-critical equipment (Stethoscope, BP apparatus, Thermometer)	Detergent and water Alcohol-based disinfection	Cleaning	• Should be cleaned with detergent and water. • Should be wiped with alcohol before each patient contact.

Chapter 5: Infection Prevention & Control During Construction and Renovation

Cleaning is of particular importance both during construction and after completion of the construction project. Contractors and hospital/healthcare staff may interpret what is considered to be 'clean' differently.

'Construction Clean' is the level of cleaning performed by construction workers to remove gross soil, dust and dirt, construction materials and workplace hazards within the construction zone. This is done at the end of the day, or more frequently if needed, to avoid accumulation of dust. Hotel Clean and Hospital Clean begin where the construction site ends, i.e., outside the hoarding and are generally done by the staff of the health care setting. Construction and renovation activities in the hospital may be associated with transmission of pathogens such as filamentous fungi, including *Aspergillus* spp, *Candida* spp, *Fusarium* and also bacteria such as *Legionella* and *Nocardia*. The most commonly reported hospital construction-related infection is due to *Aspergillus*, which represent the greatest threat to neutropenic patients.

Construction and renovation activities in the hospital facility are associated with variable levels of risks to the patients. Activities that are associated with significant generation of dusts create risks to immune compromised patients. New construction projects and major demolition of buildings create a lot of dust, which may carry *Aspergillus* spores. Moderate levels of dust may be associated with activities such as sanding of walls prior to painting, construction of new walls and major cabling activities. Inspection and noninvasive activities such as removal of ceiling board for visual inspection, painting and minor plumbing works are low risk activities that generally cause minor generation of dusts.

Patients who are at risk should be identified prior to the construction and renovation activities. Immunocompromised and ventilated patients are at high risks of construction-associated Aspergillosis. Medium risk patients include endoscopy, cardiology, radiology and physiotherapy units. Office areas pose low risks to patients.

Pre-construction and renovation consultation should be carried out in advance between all the stakeholders. This will help to identify the scope and nature of work and also to assess the degree of risks and potential patient groups that may be affected. Close monitoring of filamentous fungi isolation rates, especially *Aspergillus* by the microbiology laboratory and prompt feedback to infection control units may be helpful to implement control measures.

Procedures to contain or minimize dispersal of dust are necessary during construction activities. Examples include physical partitioning, rerouting of human traffic away from work areas, wet mopping and door mat placement at entrance, prompt debris removal, blocking and sealing of air vents where appropriate, and use of negative pressure at the construction sites.

Prior to the construction and renovation activities, an 'Infection Control (Risk Assessment (ICRA)' (Appendix A) must be completed to ensure good indoor air quality. The risk assessment consists of the following 3 steps:

1. Identify the type of construction project
2. Identify those patient areas
3. Match the type of construction activity with the patient risk

A walk-through of the construction project will be conducted if needed by the Project Manager and Department of IPC. Once a determination has been made regarding the 'risk class' an 'IPC Permit' shall be completed by the IPC Team. The 'IPC Permit', along with the risk assessment, must be signed by the Head of Department of IPC before the project is initiated.

Once the project is started, the IPC Team shall conduct periodic frequent rounds in order to verify IPC compliance. If issues are identified, the Project Manager shall be notified at once for corrective measures. If corrective measures are not adequate; the head of Department of IPC has the authority to stop further work on the renovation/construction project until corrective measures are adequately addressed.

Before any area is handed over for patient use, the affected domestic water piping system needs to be flushed for a minimum of 4 minutes to prevent healthcare-associated legionellosis. This is followed by measurement of residual free chlorine levels based on the Water Management Construction Infection Control Risk Assessment Matrix (see Appendix B). Sampling for *Legionella* spp. is required for projects classified as Water Management Construction Risk Level 2 and above.

Recommendations:

1. Healthcare facilities should have a plan to assess risks for HAIs for renovation and construction activities. **[AIII].**
2. Risks for fungal and *Legionella* infections are assessed using a risk assessment matrix. **[BIII]**

References

1. PIDAC Best Practices for Environmental Cleaning for Prevention and Control of Infections (December 2009). Available from: http://www.oahpp.ca/resources/documents/pidac/Best%20Practices%20for%20Environmental%20Cleaning.pdf

2. Sehulster L, Chinn RY. Guidelines for environmental infection control in health-care facilities. Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). MMWR Recomm Rep 2003;52(RR-10):1-42. Available from: http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/Enviro_guide_03.pdf.

Appendix A:

STEP 1: Identify the Infection Control Risk Assessment (ICRA)

TYPE OF CONSTRUCTION ACTIVITY OR PROJECT (circle type of project):

Type A	**Inspection and non-Invasive Activities** Includes but not limited to: • Activities which do not generate dust or require cutting of walls or access to ceilings other than for visual inspection. e.g., Removal of ceiling tiles for visual inspection, painting but not sanding, electrical work, minor plumbing that disrupt water supply to localized patient care area (e.g. in one room)
Type B	**Small scale short duration activities which create minimal dust** Include but not limited to: e.g., Activities that require access to duct spaces, cutting of walls, ceilings, sanding of walls for painting, plumbing that requires disruption to water supply of more than one patient care area (> two rooms) for less than 30 minutes.
Type C	**Work that generates a moderate to high level of dust or requires demolition or removal of any fixed building components or assemblies.** Include but not limited to: • Sanding of walls for painting or wall covering • Removal of floor coverings, ceiling tiles and case work • New wall construction • Minor duct work or electrical work above ceilings • Major cabling activity • Any activity that cannot be completed within a single work shift.
Type D	**Major demolition, construction & renovation projects** Includes but not limited to: • Activities that require consecutive work shifts • Require heavy demolition or removal of a complete cabling system • New construction / new building project.

STEP 2: Using the following table, identify the patient risk groups affected by the activity. If more than one risk group will be affected, select the higher risk group.

RISK GROUPS. IDENTIFY PATIENT AT RISK (circle area involved):

LOW RISK	MEDIUM RISK	HIGH RISK	HIGHER RISK
• All office area • Nonclinical areas	• Admitting Unit • Outpatient Areas • Food prep areas • Radiology • Nuclear Medicine • MRI • Endoscopy Unit • Outpatient Physical Therapy (Rehab) • Psychiatric Services (outpatient) • Cardiology services (outpatient)	• Trauma & Emergency Department • Labor & Delivery Ward • Pediatrics Wards • Pharmacy • Newborn Nursery • Clinical Pathology • Day Care Surgery • Central Stores • Laboratories • Medical Units • Surgical Units • Hemodialysis Unit	• Bone Marrow Transplant Unit • Burn Intensive Care Unit • Cardiac Cath Lab • Pharmacy Sterile Unit • Operating Rooms • Negative Air / Positive Air Pressure Rooms • Isolation Rooms (in all wards/ Units) • Intensive Care Units • Cardiac Intensive Care Unit • Dialysis Unit • PICU • CSSD • Oncology Ward • Any area / ward / unit caring for immunocompromised patients

STEP 3: Match the planned **Construction activity type** (A, B, C, D) with the **Patient Risk Group** (low, medium, high, highest) to determine the **Class of Precautions** (I, II, III, IV or level of IPC activities required.

RISK CLASS DETERMINATION

PATIENT RISK GROUPS	CONSTRUCTION ACTIVITY TYPE A	CONSTRUCTION ACTIVITY TYPE B	CONSTRUCTION ACTIVITY TYPE C	CONSTRUCTION ACTIVITY TYPE D
Low Risk	I	II	II	III / IV
Medium Risk	I	II	III or II	IV
High Risk	I	II or III	III / IV	IV
Highest Risk	II / III	III / IV	III / IV	IV

Description of Required Infection Control Precautions by Class

	Pre-Construction	During Construction of Project	Upon Completion of Project
CLASS I		1. Execute work by methods to minimize raising dust from construction operations 2. Immediately replace a ceiling tile displaced for visual inspection	Clean work area upon completion of task.
CLASS II	1. Identify the type of construction project 2. Identify those patients at risk area 3. Discuss with Department of Engineering**,** Department of Facilities, Department of Nursing, Department of OSHA and Contractor regarding control of dust generation, patient placement and putting up of barriers 4. Get infection control permit	1. Provide active means to prevent airborne dust from dispersing into atmosphere. 2. Water mist for work surfaces to control dust while cutting 3. Seal unused doors with duct tape 4. Block off and seal air vents. 5. Place dust mat at entrance and exit of work area. 6. Remove or isolate air handling system in areas where work is being performed	1. Contain construction waste before transport in tightly covered containers. 2. Wipe work surfaces with detergent and water / disinfectant forward areas. 3. Wet mop and/ or vacuum with HEPA-filtered vacuum before leaving work area. 4. Remove alterations of air handling system in the area where the work is being performed.
CLASS III	1. Identify the type of construction project 2. Identify those patients at risk area 3. Discuss with Department of facilities**,** Department of Nursing, Department of OSHA and Contractor regarding control of dust generation, patient placement and putting up of barriers 4. Get infection control permit	1. Remove or isolate air handling system in area where work is being done to prevent contamination of duct system. 2. Complete all critical barriers i.e., sheetrock, plywood, plastic, to seal area from non-work area 3. Maintain negative air pressure within work site if necessary. Cease work immediately if negative pressure lost. 4. Contain construction waste before transport in tightly covered containers. 5. Cover transport receptacles or carts. Tape covering unless solid lid.	1. Do not remove barriers from work area until completed project is inspected by the Department of Engineering, Department of Infection Control, and thoroughly cleaned by Department of Facilities. 2. Remove barrier materials carefully to minimize spreading of dirt and debris associated with construction. 3. Vacuum work area including barriers with HEPA-filtered vacuums. 4. Wet mop area with water & detergent / disinfectant in ward areas. 5. Remove alteration to the air handling system in areas where work is being performed.

CLASS IV	1. Identify the type of construction project 2. Identify those patients at risk area 3. Discuss with Department of Facilities Department of Nursing and Department of OSHA and Contractor regarding control of dust generation, placement of patients and putting up of barriers 4. Get infection control permit	1. Isolate air handling system in area where work is being done to prevent contamination of duct system. 2. Complete all critical barriers i.e., sheetrock, plywood, plastic, to seal area from non-work area 3. Maintain Negative air pressure within the work site. Cease work immediately if negative pressure lost. 4. Contain construction waste before transport in tightly covered containers. 5. Cover transport receptacles or carts. Tape covering unless solid lid. 6. Seal holes, pipes, conduits and punctures appropriately. 7. Construct anteroom and require all personnel to pass through this room so they can be vacuumed using HEPA vacuum before leaving the work site; or they can wear cloth or paper coveralls that are removed each time they leave the work site. 8. All personal entering the work site are required to wear shoe covers. Shoe covers must be changed each time the worker exits the work area.	1. Do not remove barriers from work area until completed project is inspected by Department of Engineering, Department of Infection Control and thoroughly cleaned by Department of Facilities 2. Remove barrier materials carefully to minimize spreading of dirt and debris associated with construction. 3. Contain construction waste before transport in tightly covered containers. 4. Contain transport receptacles or carts. Tape covering unless solid lid. 5. Vacuum work area with HEPA-filtered vacuums. 6. Wet mop area with disinfectant. 7. Remove isolation of air handling system in areas where work was performed.

Description of Required IPC Precautions by Class

	Pre-Construction	**During Construction Project**	**Upon Completion Project**
CLASS II, III & IV			1. Put on air conditioning full blast for 2 days 2. Lock doors to prevent intruder 3. Final walk through inspection 4. Observe if any dust on furniture 5. Review effectiveness of any problems noted before 6. Air sampling if necessary.

Appendix B: Water Management Construction - ICRA

Pre-Construction Risk Assessment Checklist

Use this checklist in conjunction with WMC ICRA Checklist for improving water quality and safety associated with construction activities. Please identify all risk factors within the construction project scope. This checklist should be reviewed by IPC and Facilities Management to determine WMC Project Category, Building Occupant Risk Groups, and Risk Mitigation Level. Describe additional information in the Note(s) Section to clarify extend of construction project scope.

Project Name:		Facility:	
Project Scope of Work Description:			
Location/Department:		Project date:	
A. External construction or projects (outside main buildings)			
SITE WMC RISK FACTORS	**YES**	**NO**	**NOTES SECTION**
Excavation			
• Potential for soil and sediment invasion			
• Describe location(s)			
Underground utility connections			
• Potential for soil and sediment invasion			
Repressurization of building main / point-of-entry water system			
• Will the building main entry be shut-down or experience re-pressurization?			
Site / Civil Water service disruption			
• New construction tie-ins			
• Replacement valves			
• Hydrants			
• Meters			
• Pumping failures			
• Pipeline breaks			
• Other system repairs			
• Emergency conditions			
Lengthy underground piping connections			
• Site routing of water utility piping			
• Fire hydrant locations and piping routing with dead-ends			
• Distance from building main connection to the street connection / invert			
Vibration activities			
• Pile Driving / structural foundation			
• Jackhammering			
• Saw cutting			
Demolition activities			
• Creates air fumes of dust or water aerosols toward patient care areas			
• Drift of debris toward cooling towers			
• Drift of debris toward cooling HVAC intake vents			
Demolishing building water system components			
• Impacting other building water supply			

connection points				
• Other Site / Civil utility demolition activities				
Demolishing underground tunnels				
• Utility				
• Walking / passage / transportation				
Construction equipped with water reservoirs (i.e. typically spray activities)				
• Water tankers				
• Paving equipment				
• Spray nozzles				
• Misters				
• Other				
Water main disruptions				
• Opportunity for water main breakage				
• Length of shut down in hours / days				
• Off-site construction of PUB water delivery system				
Central Utility Plant Modifications / Alterations				
• Underground utility connections				
Cooling Towers				
• Replacement				
• Addition				
Disinfection of underground utility connections or building				
• Does the project call for building water main disinfection?				
• When during the project is this activity scheduled to be performed?				
High Water Age / Stagnation Challenges (circle one)				
How long will building water system experience dormancy or shut-downs?				
<1 day	≤ 7 days	≤ 30 days	> 30 days	
Inadequate residual disinfectant				
Is disinfectant residual measurement between total residual oxidant (TRO) > 0.5 ppm or < 4.0 ppm / or / free residual oxidant (FRO) ≥ 0.2 ppm				
Provide verification of existing residual disinfectant measurements				
• Incoming PUB water main				
• Pre – Post water softener				
• Return hot water loop system				
• Distal distribution points on each floor of construction				
Confirm existing temperature control ranges				
• Hot water storage temperature				
• Hot water range (per WMP at fixture delivery)				
• Cold water range (per WMP)				
• Does the project utilize point-of-use mixing valves?				
Unoccupied areas or low or no use areas pre or post occupancy				
• Shell areas with water in piping system				
• Unoccupied areas with water in piping system				

• Low use areas with water in piping system			
B. Internal construction or projects (within main buildings)			
Vibration activities			
• Demolition			
• Jackhammering			
• Saw cutting			
• What departments are above, below, or downstream / near vibration activities?			
Efficiency design challenges			
• Water system design for conservation measures			
• Participating in locally recognized building rating systems, e.g., Green Mark, WELS rating, where applicable			
• Auto-fixtures (electronic, sensor, or push button e.g., surgical scrub sinks)			
• Aerators			
• Ligature-resistant fixtures (i.e., behavioral health, security fixtures)			
• Other – mixed temperature fixtures, etc.			
Re-pressurization (start-up and shut-down)			
• Will any part of the building water system experience re-pressurization?			
Building / Plumbing Water service disruption			
• New construction tie-ins			
• Replacement valves			
• Meters			
• Pumping failures			
• Other system repairs or component replacement			
• Emergency conditions			
Construction equipment with water reservoirs typically with spray activities			
• Showers			
• Spray nozzles			
• Misters			
• other			
Disinfection of BWDS			
• Does the project call for BWDS disinfection?			
• Have ports and isolation valves been installed for this section of the building?			
• When during the project is this activity scheduled to be performed?			
High Water Age / Stagnation Challenges (circle one)			
How long will building water system experience dormancy or shut-downs?			

<1 day	≤ 7 days	≤ 30 days	> 30 days			
Inadequate residual disinfectant						
Is disinfectant residual measurement between total residual oxidant (TRO) > 0.5 ppm or < 4.0 ppm / or / free residual oxidant (FRO) ≥ 0.2 ppm						
Provide verification of existing residual disinfectant measurements						
• Incoming PUB water main						
• Pre – Post water softener						
• Return hot water loop system						
• Distal distribution points on each floor of construction						
Confirm existing temperature control ranges						
• Hot water storage temperature						
• Hot water range (per WMP at fixture delivery)						
• Cold water range (per WMP)						
• Does the project utilize point-of-use mixing valves?						
Unoccupied areas or low or no use areas pre or post occupancy						
• Shell areas with water in piping system						
• Unoccupied areas with water in piping system						
• Low use areas with water in piping system						
Central Utility System Modifications / Alterations						
• Water heaters						
• Heat exchanges						
• Water storage						
• Hot water loop system						
• Boiler system						
• Other central building water system compounds						

Reference: Scanlon MM, Gordon JL, Tonozzi AA, and Griffin SC (2022). Reducing the Risk of Healthcare Associated Infections from *Legionella* and Other Waterborne Pathogens Using a Water Management for Construction (WMC) Infection Control Risk Assessment (ICRA) Tool. *Infectious Disease Reports*, 14(3).

Appendix C: Water Management Construction ICRA Checklist

Step 1.

Using Table 1, evaluate the Building Water Distribution System (BWDS) construction activities and scope of work to be performed, duration and level of water age for the project, and determine the Water Management Construction (WMC) Project Category:

Table 1: WMC Project Category

Category	BWDS Construction Activities and Scope of Work	Water Age Category
A	• Minimally invasive BWDS • Brief duration	Low (≤ 24 hours)
B	• Small scale BWDS • Short duration	Modest (≤ 7 days)
C	• Moderate to high levels of BWDS construction	Medium (≤ 30 days)
D	• Major BWDS demolition, renovation, infrastructure, and/or new construction	High (> 30 days)

Category	Examples:
A	**BWDS inspection, maintenance/repair and non-invasive activities of brief duration, and low water age.** Includes but not limited to: • replacing fixture trim(s) • replacing fixture "in-kind" (i.e., meaning 1:1 or like for like) • impact and risk is only to building users in the immediate area of construction • water by fixture or area is shut down for ≤ 24 hours (minimal water age/stagnation)
B	**Small scale BWDS, short duration activities which create minimal water disruption, and modest water age.** Includes but not limited to: • replacing or installing fixtures and trim • working within wall cavities and / or ceiling areas • water by fixture or area is shut down for ≤ 7 calendar days (1 work week for water age)
C	**Work generates moderate to high BWDS disruption or removal of any fixed BWDS components or assemblies with medium water age.** Includes but not limited to: • plumbing work requiring multiple fixtures (existing, replacement or new) • major water system component replacement (boilers, heaters, water main, etc.) • work in wall cavities or ceilings with major disruption to local and downstream occupied areas • change of functional building space programme (i.e., moving / changing room or dept. functions) in existing building • water by fixture, component, or area is shut down ≤ 30 days

D	**Major BWDS demolition, renovation, infrastructure, and/or new construction projects with high water age.** Includes but not limited to: • change in functional building space programme (i.e., series of rooms and departments) • tenant improvements (i.e., existing buildings, or tenant space within unoccupied buildings) • new shell and core buildings, additions, or expansions on campus (i.e., near existing patient environments) • acquisition of building with unknown water quality / safety conditions • infrastructure projects connecting to building water systems (i.e., underground piping, utility tunnels, etc.) • water by fixture or area is not active (new start-up) or was shut down (> 30 days)

Step 2.

Using Table 2, identify the Occupant Risk Groups (i.e., patients, visitors, volunteers, staff, etc.) and affected departmental areas. If more than one building occupant risk groups will be affected, select the higher risk group. Contact Facilities Management or IPC Department if any risk group needs further clarification for relationships to the BWDS construction scope of work.

Table 2: Building Occupant Risk Groups

Low Risk	Medium Risk	High Risk	Highest Risk
• Office areas • Non-patient areas	• Cardiology • Nuclear Medicine • Physiotherapy / Occupational Therapy / Speech Therapy Department • Radiology/MRI • Patient care areas not covered under high or highest risk groups • Public corridors (through which patients, supplies and linen pass) • Lab not specified as high or highest risk groups • Cafeteria / Kitchen • Material management department • Linen room • Pharmacy	• Coronary Care Unit • Emergency Medicine • Labour & Delivery • Laboratories (specimen) • Newborn Nursery • Endoscopy Centre • Paediatrics • Pharmacy laboratory • Medical and Surgical wards (including HD and ICA) • Rehabilitation ward • Vascular and interventional radiology	• Any areas caring for immuno-compromised patients • Oncology ward • Bone marrow transplant unit • Haematology ward and Centre • Neonatal ward • Burn Unit • Cardiac Cath Lab / angiograph procedure areas • Central Sterile Supply • Intensive Care Units • Operating theatres including Ambulatory Surgery • Dialysis Centre

Step 3.

Match the Building Occupant Risk Group (Low, Medium, High, Highest) with the planned WMC Project Category (A, B, C, D) on the WMC Infection Control Risk Assessment Matrix (Table 3) to determine the WMC Risk Mitigation Level (WMC - 1, 2, 3, or 4) for hazard control strategies to be implemented over the entire duration of the construction project scope (Table 4).

Larger scale projects (WMC - 4 with > 30 days of dormancy or new start-up) as indicated in WMC-ICRA Category D should conduct a pre-construction risk assessment (PCRA). The PCRA checklist should be reviewed by IPC and Project Officer.

Table 3: WMC Infection Control Risk Assessment Matrix

Occupant Risk Group	**WMC Project Category**			
	A	**B**	**C**	**D**
	Minimally invasive BWDS, brief duration, and low water age (≤ 24 hours)	Small scale BWDS, short duration, and modest water age (≤ 7 days)	Moderate to high levels of BWDS construction, and medium water age (≤ 30 days)	Major BWDS demolition, renovation, infrastructure, and/or new construction with high water age (>30 days)
Low Risk	**WMC - 1**	**WMC - 2**	**WMC - 3**	**WMC - 3 / 4**
Medium Risk	**WMC - 1**	**WMC - 2**	**WMC - 3**	**WMC - 4**
High Risk	**WMC - 2**	**WMC - 3**	**WMC- 3 / 4**	**WMC - 4**
Highest Risk	**WMC - 2**	**WMC - 3 / 4**	**WMC - 3 / 4**	**WMC - 4**

BWDS: building water distribution system

Step 4.

Review, finalize, and implement the selected WMC Risk Mitigation Levels determined as risk group (Table 4). All mitigation measures (hazard controls) and associated numeric values (i.e., temperature, residual free chlorine levels, pH, or other) need to be reviewed, coordinated and implemented in context with the organization's on-going Water Management Programme. Contact Facilities Management or IPC Department for clarification on individual hazard controls defined for the project duration.

Table 4: WMC Risk Mitigation Level and Hazard Control Strategies

WMC – 1	1. Flush fixture (hot) for minimum 4 minutes; following flushing collect water temperature using digital thermometer; perform the same minimum 4-minutes flushing (cold) and collect water temperature; record both measurements. 2. Perform repair or replacement of plumbing components (i.e., plumbing fixture, trim or other). 3. When construction activities are completed, and area is ready to return to service, flush the fixture for minimum of 4 minutes hot, then 4 minutes cold. Take corresponding temperature and residual free chlorine levels measurements. Repeat steps until measurements are the same or better than pre-existing conditions: • Outlet temperature: hot water range (45^{0}C to 48.9^{0}C for new building; maximum 40 ^{0}C for existing buildings). • Residual free chlorine levels: minimal of 0.20 ppm 4. Report any odour, discoloured water, flecks or floating debris at baseline or at work completion; none should be present. 5. Record information on organization's flushing form or in the project information record system.

WMC – 2	**Perform ALL of WMC – 1 risk mitigation and adjust for scale of project and**: 1. For high and highest risk areas: • Prior to construction activities determine baseline measurements (temperature, residual free chlorine levels, pH, or other). • Collect residual free chlorine levels using a digital colorimeter instrument and record measurement. 2. Establish enclosure to prevent aerosolized water (and potential pathogens) from dispersing into the environment. 3. Close door of area (i.e., patient room door, toilet/shower room door, etc.) 4. Install non-flammable visqueen or clear plastic sheeting or other approved vapor barrier for protection 5. Install isolation valve, backflow prevention device, or other piping isolation method, when needed 6. Construction staff to: • leave barriers in place until all plumbing work is complete including flushing activities • thoroughly clean and dry area(s) upon completion of construction work • remove barriers or seals in place 7. Environmental Services to perform routine cleaning before the area is occupied. 8. When construction activities are completed, and area is ready to return to service, flush the fixture for minimum of 4 minutes hot, then 4 minutes cold. Take corresponding temperature and residual free chlorine levels measurements. Repeat steps until measurements are the same or better than pre-existing conditions: 9. Outlet temperature: hot water range (45^{0}C to 48.9^{0}C for new building; maximum 40 ^{0}C for existing buildings). • Residual free chlorine levels: minimal of 0.20 ppm 10. For high and highest risk areas: • Carry out analytical laboratory sampling for water quality (drinking water standard) when necessary (depends on the work carried out), residual free chlorine levels and culture for *Legionella* sp. for water outlets of renovated cubicle OR the 3 designated sites for sampling along a floor.
WMC – 3	**Perform ALL of WMC – 1 and 2 risk mitigation levels and adjust for scale of project and:** 1. Prior to construction activities determine baseline measurements (temperature, residual free chlorine levels, pH, or other). 2. Collect residual free chlorine levels using a digital colorimeter instrument and record measurement. 3. Perform flushing protocol (4 min. per day every other day @ all fixtures in *unoccupied* areas adjacent to the construction zone). Report on flushing form (or record in the project information record system). 4. Obtain residual free chlorine levels and temperature readings post flushing activities 1 day per week in unoccupied and occupied areas at 10 % of designated fixture locations as representative sample of fixtures to maintain adequate temperature and residual free chlorine levels where there is no valve to isolate the water system from renovated area. Report on fixture analysis form (or record in the project information record system). 5. Review any disinfection (i.e., hyperchlorination) procedures to be performed with the Owner's Project Representative including location(s), method, schedule, and timing to return water system for potable usage, where applicable. Provide any reports of activities for building water main (i.e., point-of-entry), building distribution systems (hot and / or cold). 6. Where necessary (where there is no valve to isolate the water system from renovated area), provide any temporary inline or point-of-use filtration during construction for designated sinks, showers, or other fixtures or piping lines to reduce risk of exposure. 7. Review installation for patient and medical equipment with water reservoirs (i.e., ice machines or other) on the project and preventive maintenance prior to occupant start up. 8. Carry out analytical laboratory sampling for water quality (drinking water standard) when necessary (depends on the work carried out), free chlorine levels and culture for *Legionella* sp. for water outlets of renovated cubicle OR the 3 designated sites for sampling along a floor.

WMC - 4	**Use WMC – 1, 2, and 3 risk mitigation levels and prepare a project specific WMC plan and operations and**: 9. Contact the Building Owner's Project Representative for preparing a WMC Project Analysis. 10. Conduct a project-specific pre-construction risk assessment for potential growth and spread of waterborne pathogens. Complete WMC-ICRA Pre-Construction Risk Assessment Checklist. • Review site / construction activity risk factors • Review building design and construction risk activity risk factors 11. Based upon the risk assessment prepare a project-specific WMC plan for commissioning the building water system(s) per recommendations by the hospital Water Management Committee. • Establish a WMC plan with scheduled milestones starting from the date of water activation through first-day of patient care operations • Implement / operationalize project specific controls (i.e., protocols for flushing, temperature, and residual free chlorine levels) • Confirm WMC plan & operations with verification and validation. 12. Obtain Building Owner's Project Representative approval of the WMC plan, process, and documentation. 13. Implement the agreed upon WMC Plan for achieving water quality and safety. 14. Obtain approval from the hospital Water Management Committee for new start-up before initiating patient care operations.

Reference: Scanlon MM, Gordon JL, Tonozzi AA, and Griffin SC (2022). Reducing the Risk of Healthcare Associated Infections from *Legionella* and Other Waterborne Pathogens Using a Water Management for Construction (WMC) Infection Control Risk Assessment (ICRA) Tool. *Infectious Disease Reports*, 14(3).

Chapter 6: Assessment of Cleanliness and Quality Control

In 2003, the U.S. Centers for Disease Control and Prevention (CDC) Guidelines for Environmental Infection Control in Healthcare Facilities—Environmental Surfaces recommended that hospitals clean and disinfect ‘‘high-touch surfaces.’’ A subsequent CDC guideline strongly recommended (Category 1B) that hospitals ‘‘monitor (i.e., supervise and inspect) cleaning performance to ensure consistent cleaning and disinfection of surfaces in close proximity to the patient and likely to be touched by the patient and health care professionals.’’ Checklists and audit tools (examples) will assist supervisory staff in monitoring and documenting cleaning and disinfection. Feedback of these results to Housekeeping staff had been shown to increase motivation and engagement with resulting improvements in cleaning scores. In a Thai national survey on environmental cleaning and disinfection, findings suggested that implementing environmental cleaning and disinfection protocol was commonly performed in majority of Thai hospitals (90%), but assessment of cleanliness was less commonly performed in Thai hospitals (45%).[4] Notable, Hospital epidemiologist presence was associated with the existence of an environmental cleaning and disinfection (ECD) checklist and of ECD auditing, while good and excellent hospital administrative support were associated with better adherence to ECD protocols and ECD checklists. The data emphasize the role of administration support, presence of hospital epidemiologist to be important pre-requisite for effective monitoring of cleanliness and quality control.

There are several methods for assessing environmental cleanliness:

a. Conventional program of direct and indirect observation (e.g., visual assessment, observation of performance, patient/resident satisfaction surveys);
b. Enhanced program of monitoring residual bioburden (e.g., environmental culture, adenosine triphosphate (ATP) bioluminescence); and environmental marking tools (e.g., fluorescent marking)

Conventional program of direct and indirect observation

Observation of the cleaned environment and of the individuals doing the cleaning may be accomplished directly, with the use of checklists and other monitoring tools completed by supervisory or other trained staff; or indirectly, as feedback from patients based on their ‘perceptions’ of cleanliness through a survey. Neither of these methodologies have been standardized. A visually clean surface may not be microbiologically or chemically clean. It is expected that visual assessment should have a cleaning rate of 100% in a healthcare setting.

Enhanced program

A. Environmental culture

Routine environmental cultures in healthcare settings are neither cost-effective nor generally recommended. The presence of a particular microorganism on an environmental surface does not confirm it as the cause of a patient's infection, even if it is the same strain. However, it is normally considered in investigation of major outbreaks.

B. ATP Bioluminescence

Detection of ATP - which is present in all types of organic material (including bacteria, food, and human secretions and excretions) - on environmental surfaces has been used for years in the food and beverage industries to assess the adequacy of cleaning procedures. A specialized swab is used to sample a standardized surface area, which is then analyzed using a portable handheld luminometer. The amount of ATP, both microbial and non-microbial, is quantified and expressed as relative light units (RLU). Of note is that very high RLU readings may represent either the viable bioburden, organic debris including dead bacteria, or a combination of both. ATP measurements can be confounded by food and drink residues, disinfectants, microfibre and manufactured plastics found in the cleaning and laundering industries. Additional studies from multiple health care settings are needed before a standardized ATP bioluminescence breakpoint can be established for defining surfaces as adequately cleaned. ATP testing can be used to provide instant feedback on surface cleanliness, demonstrating deficiencies in cleaning protocols. and techniques to staff. It may also be used for the evaluation of novel cleaning methods such as steam cleaning and microfibre cloths. At the present time, a validated cutoff for an ATP level that predicts and increased risk the patient will develop an HAI is not available.

Flourescent Marking

Environmental marking measures the thoroughness of cleaning using a surrogate marking system. It involves the use of a colorless solution or Glo Germ powder that is applied to objects and surfaces in the patient's environment prior to cleaning, followed by detection of residual marker (if any) immediately after cleaning, usually involving fluorescence under ultraviolet (UV) light. Solutions used as markers must be environmentally stable, dry quickly, be easily removed with light cleaning and be invisible in regular room light but be easily visualized using other means. The marker solution is applied to high-touch surfaces in patient rooms prior to cleaning, then evaluated to see if the solution was removed by the cleaning. Environmental marking may be used either on a daily basis to assess routine cleaning, or prior to discharge to assess terminal cleaning.

Recommendations:

1. There should be a process in place to measure the quality of cleaning in the healthcare setting. [AII]
2. Methods of monitoring cleanliness should include at least the conventional visual assessment and/or fluorescent marking. [AII]
3. Results of cleaning audits should be collated and analyzed with immediate feedback to staff, and an action plan developed to identify and correct deficiencies. [AII]
4. Result of fluorescent monitoring should be reported the IPC Committee periodically (e.g., monthly).

References

1. Centers for Disease Control and Prevention/Healthcare Infection Control Advisory Committee (HICPAC) Guidelines for environmental infection control in health care facilities. Atlanta, GA: Centers for Disease Control and Prevention. 2003. Available from: www.cdc. gov. Accessed June 20, 2024.
2. Siegel JD, Rhinehart E, Jackson M, Chiarello L. Healthcare Infection Control Practices Advisory Committee. Management of multidrug-resistant organisms in healthcare settings. 2006 Available from: http://www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf. Accessed June 20, 2024.
3. Carling PC and Bartley JM. Evaluating hygienic cleaning in health care settings: What you do not know can harm your patients. Am J Infect Control 2010;38:S41-50.
4. Apisarnthanarak A, Weber DJ, Ratz D, Saint S, Khawcharoenporn T, Greene MT. National Survey of Environmental Cleaning and Disinfections in Hospitals in Thailand. Infect Control Hosp Epidemiol 2017;38:1250-1253.
5. PIDAC - Best Practices for Environmental Cleaning for Prevention and Control of Infection. Available from: http://www.oahpp.ca/resources/documents/pidac/Best%20Practices%20for%20Environmental%20Cleaning.pdf Accessed June 20, 2024.
6. Boyce JM, Havill NL, Dumigan DG, Golebiewski M, Balogun O, Rizvani R. Monitoring the Effectiveness of Hospital Cleaning Practices by Use of an Adenosine Triphosphate Bioluminescence Assay. Infect Control and Hosp Epidemiol;2009:678-684.
7. Carling PC , Janet L Briggs, Jeanette Perkins, Deborah Highlander. Improved Cleaning of Patient Rooms Using a New Targeting Method. Clin Infect Dis;2006:42: 385-388.

Chapter 7: Care and Storage of Cleaning Supplies and Utility Rooms

All chemical cleaning agents and disinfectants should be appropriately labeled and stored in a manner that eliminates risks of contamination, inhalation, skin contact or personal injury. Chemicals must be clearly labeled with Safety Data Sheets (SDS) readily available for each item in case of accidents.

An automated dispensing system should be used to ensure integrity of dilution ratios and to eliminate the need for decanting. Calibration of the dispensing system should be regularly monitored. If a refillable bottle is filled with a disinfectant solution, it should never be topped up with fresh disinfectant. Always use a clean, dry, appropriately sized bottle, label the product and date it. The product should be discarded when past the expiry date for stability. Equipment used to clean toilets (e.g., toilet brushes, toilet swabs) should not be carried from room-to-room.

If feasible, the toilet brush may remain in the room; if not, consideration should be given to using disposable toilet swabs. Toilet cleaning and disinfecting equipment should be discarded when the patient/resident leaves or as required. In mult-bed rooms, a system should be developed for replacement of toilet brushes on a regular basis or as required. When choosing a tool for cleaning toilets, consideration should be given to equipment that will minimize splashing.

Housekeeping Rooms/Closets

The staff that performs housekeeping duties in the healthcare setting uses housekeeping rooms or closets. Sufficient housekeeping rooms/closets should be provided throughout the facility to maintain a clean and sanitary environment, with at least one per patient/resident floor.[1] In general, housekeeping room or closet:

a) Is a dedicated room, not used for other purposes;

b) Shall be maintained in accordance with good hygiene practices;

c) Shall have a dedicated hand washing sink with running water (such sinks should NOT be used for disposal of body fluids or chemicals);

d) Shall have access to an eyewash station;

e) Shall have appropriate personal protective equipment available, including safety eyewear;

f) Should have an appropriate water supply and a sink/floor drain;

g) Should be well ventilated;

h) Should have suitable lighting;

i) Should be easily accessible in relation to the area it serves;

j) Should have locks fitted to all doors;

k) Should be appropriately sized to the amount of materials, equipment, machinery and chemicals stored in the room/closet and allow for proper ergonomic movement within the room/closet;

l) Should never contain personal clothing or grooming supplies, food or beverages;

m) Shall have chemical storage that ensures chemicals are not damaged and may be safely accessed;

n) Should be free from clutter to facilitate cleaning; and

o) Should be designed so that, whenever possible, buckets can be emptied without lifting them.

Cleaning equipment requires attention to avoid cross-transmission of microorganisms and proliferation of microorganisms in dirty environments:

a) Tools and equipment used for cleaning and disinfection must be cleaned and dried between uses (e.g., mops, buckets, rags);

b) Mop heads should be laundered daily; all washed mop heads must be dried thoroughly before storage;

c) Cleaning equipment shall be well maintained, clean and in good repair;

d) Cleaning carts:

   i. Should have a separation between clean and soiled items;

   ii. Should never contain personal clothing or grooming supplies, food or beverages;

   iii. Should be thoroughly cleaned at the end of the day.

Soiled Utility Rooms/Workrooms

Each patient care area should be equipped with a room that may be used to clean soiled patient equipment that is not sent for central reprocessing (e.g. IV poles, commode chairs). A soiled utility room/workroom should:

a) Be physically separate from other areas, including clean supply/storage areas;

b) Be designed to minimize the distance from point-of-care;

c) Have a work counter and clinical sink (or equivalent flushing-rim fixture)

d) Have a dedicated hand washing sink with both hot and cold running water (such sinks should never be used for disposal of body fluids or chemicals);

e) Have adequate space to permit the use of equipment required for the disposal of waste;

f) Have PPE available to protect staff during cleaning and disinfecting procedures; and

g) Be adequately sized within the unit.

If a soiled utility room is used only for temporary holding of soiled materials, the work counter and clinical sink is not required; however, facilities for cleaning bedpans must be provided elsewhere. Soiled utility rooms/workrooms should not be used to store unused equipment.

Clean Supply Rooms

Each patient/resident care area should be equipped with a room/area that is used to store clean supplies and equipment. A clean supply room/area should:

a) Be separate from soiled workrooms or soiled holding areas;

b) Be able to keep supplies free from dust and moisture;

c) Be adjacent to usage areas and easily available to staff;

d) Be equipped with a work counter and dedicated handwashing sink if used for preparing patient care items.

e) Clean items should ideally be stacked on wire mesh shelves several centimeters above the floor to allow dust to settle to the floor. Clean items should NOT be stored on the floor or in cabinets under a sink.

Recommendations:

1. Cleaning agents and disinfectants shall be labeled with SDS information. **[BII]**
2. Cleaning agents and disinfectants shall be stored in a safe manner in storage rooms or closets. **[BII]**
3. Automated dispensing systems, which are monitored regularly for accurate calibration, are preferred over manual dilution and mixing. **[BII]**
4. Disinfectants should be dispensed into clean, dry, appropriately-sized bottles that are clearly labeled and dated; not topped up; and discarded after the expiry date. **[BII]**
5. Equipment used to clean toilets: **[BII]**
    a. Should not be carried from room-to-room;
    b. Should be discarded when the patient/resident leaves and as required; and
    c. Should minimize splashing.
6. Sufficient housekeeping rooms/closets should be provided throughout the facility to maintain a clean and sanitary environment. **[BII]**
7. Cleaning and disinfection equipment should be well maintained, in good repair and be cleaned and dried between uses. **[BII]**
8. Mop heads should be laundered daily and dried thoroughly before storage. **[BII]**
9. Cleaning carts should have a clear separation between clean and soiled items, should never contain personal items and should be thoroughly cleaned at the end of the day. **[BII]**

References:

1. Facility Guidelines Institute. Guidelines for design and construction of hospitals and outpatient facilities. Chicago, IL: American Society for Healthcare Engineering of the American Hospital Association; 2022.
2. Best Practices for Environmental Cleaning for Prevention and Control of Infections in All Health Care Settings, 3rd Edition April 2018 https://www.publichealthontario.ca/-/media/documents/b/2018/bp-environmental-cleaning.pdf

Chapter 8: Air and Water Quality

Indoor air quality

As we learnt from past pandemics, occasionally respiratory viruses may be transmitted through fine droplets or droplet nuclei especially when aerosol generating procedures (AGPs) are done in clinical areas. Hence, there should be adequate ventilation within each setting to prevent possibility of transmission during routine patient care activities.

Risk for fungal especially mould infections should be considered in areas where there are immunocompromised hosts. Design parameters should be consulted in the design of these areas. Maintenance should also be paid attention to ensure that these areas do not have reservoirs for mould development on surfaces of walls, ceiling, etc.

The healthcare facility should be built according to at least national or international specifications e.g. ASHRAE (USA), HTM (UK), etc. The IPC team should be in close collaboration with the architects, engineers and project teams in designing of new facilities or renovation of existing healthcare facilities.

Ventilation system design

The general purpose of ventilation in buildings is to provide healthy air through dilution and removal of existing pollutants. To fulfil this, the following factors will need to be considered:

- Ventilation rate – this relates to amount of outdoor air provided and quality of outdoor air.
- Airflow direction – air should flow from clean to less clean zones.
- Air distribution or airflow pattern – this relates to efficiency of distribution and removal of air including pollutants from area.

Buildings may be ventilated using any of the 3 modes:

- Natural ventilation – this is provided by wind or diffusion effects through doors, windows, etc. and dependent on climate, building design and human behavior.
- Mechanical ventilation – this is provided by mechanically powered equipment e.g. fans and blowers installed directly in walls or in air ducts for supplying air into, exhausting air from, a room.

- Hybrid or mixed-mode ventilation – this uses both natural and mechanical ventilation, which kicks in when the natural ventilation flow rate is too low.

In assessing ventilation performance, the key questions posed are:

1. Does the system provide sufficient ventilation rate (i.e. air changes per hour (ACH)) or flow rate in L/sec/person?
   - Minimum 160 L/sec/person or 12 ACH where AGPs are performed.
   - Minimum 60 L/sec/person or 6 ACH for general wards and outpatient departments.
   - Minimum 2.5 L/sec/m^3 for corridors and other transient spaces without fixed patient numbers.
2. Is the airflow direction from a clean to less clean zone?
3. Is air quality adequate for immunocompromised patients (e.g., stem cell transplants)?
   - Ideally, these should be housed in appropriate rooms with HEPA filtered units and positive pressured.

Maintenance checks of the air-conditioning and mechanical ventilation (ACMV)

Regular review of the system is necessary. Regular and proper ACMV equipment and system maintenance should be carried out as per national requirement. Critical ventilation systems should be inspected at least 6 monthly and certified at least once every two years or as required by national requirement. Carbon dioxide (CO_2) monitoring may be used as a proxy for ventilation adequacy where the recommendation is keeping CO_2 below 800 ppm.

Water

Wet environments pose some risks for HAIs in the healthcare setting as it promotes microbial growth and serve as a source for antimicrobial resistant pathogens. Certain conditions within the plumbing system e.g. sink and drains, shower heads, etc. may encourage microbial growth or biofilm development. A healthcare water management program is highly recommended to identify risk points and corrective actions planned to minimize the growth and spread of waterborne pathogens. An appointed multidisciplinary team comprising facility managers, IPC professionals, infectious disease physician, microbiologist and administrator will be responsible to design, implement and review these plans.

Common measures that reduce risks associated with HAIs include the following:

1. Regular cleaning (at least daily) and disinfection of surfaces near drains, skin basin, faucet, faucet handles and surrounding counter top
2. Avoiding placement of patient care items within 2m of sink unless there are barriers e.g., a splash guard.
3. Preventing direct water discharge from faucet to drain
4. Using sinks with adequate depth and width and regulated water flow to prevent splashing. However, sensor taps or flow straighteners or aerators should be avoided as these harbor biofilms.

The healthcare facility should have a water management policy that addresses the following:

- Surveillance or monitoring system for *Legionella* growth at cooling towers, shower head, etc. and corrective actions to be taken in response systems performing outside of control limits
- Response plan in event of identification of a patient with healthcare onset Legionellosis and/or outbreaks
    - Full investigation is recommended for source of *Legionella* when:
        - ≥1 case of definite healthcare associated legionellosis (a case in patient who has been admitted to unit at least 10 days prior to onset of illness)
        - ≥2 case of possible healthcare associated legionellosis identified within 12 months of each other.

The water management program should be reviewed regularly and revised accordingly when any of the following events occur:

- Data review (e.g. shower heads sampled for *Legionella* culture) – results that suggests that control measures are persistently out of control limits
- Major maintenance or water service change e.g. new construction, changes in municipal water supply, changes in equipment or treatment products

The water management for construction infection control risk assessment (WMC-ICRA) tool is recommended for use in risk assessment of the building water distribution system (see Appendix B and C).

Recommendations

1. The IPC team should be in close collaboration with the architects, engineers and project teams in designing of new facilities or renovation of existing healthcare facilities. **[AIII]**
2. Critical ventilation systems should be inspected at least 6 monthly and certified at least once every two years or as required by national requirement. **[BIII]**
3. A healthcare water management program is highly recommended to identify risk points and corrective actions planned to minimize the growth and spread of waterborne pathogens. **[AIII]**

References

1. Roadmap to improve and ensure good ventilation in the context of COVID-19. World Health Organization 2021. Available from https://iris.who.int/bitstream/handle/10665/339857/9789240021280-eng.pdf?sequence=1. Accessed on 10 May 2024.

2. Ventilation in buildings. Centers for Disease Control and Prevention May 12, 2023. Available on https://cdc.gov/coronavirus/2019-ncov/community/ventilation.html. Accessed on 10 May 2024.

3. Scanlon MM, Gordon JL, Tonozzi AA, and Griffin SC (2022). Reducing the Risk of Healthcare Associated Infections from *Legionella* and Other Waterborne Pathogens Using a Water Management for Construction (WMC) Infection Control Risk Assessment (ICRA) Tool. Infectious Disease Reports, 14(3).

Chapter 9: Environment Service in Ambulatory

Ambulatory care is defined as any care provided in a setting where individuals do not remain overnight (e.g., physician offices, dental clinics, and hospital or nonhospital-based outpatient clinics). The surfaces and devices in the ambulatory settings can be contaminated and there is increasing evidence that healthcare environment is an important source of healthcare associated infections. It is critical to ensure comprehensive environment services in the ambulatory setting.

There are many similarities between the hospitals and ambulatory facilities. However, the type of care provided at these facilities are often different. Some patients in the hospitals are more ill and require critical care wards. These can also make the roles of environmental services for hospital and ambulatory facilities different. The environment services in the ambulatory setting require different approach due to the different infrastructure, resources, and patient care area. The turnover rate of patients is higher in the ambulatory. Hence the rooms in the ambulatory care must be cleaned and disinfected after each patient, versus hospital rooms where patients remain for at least an overnight stay and often longer, even. Most hospital providers handle laundry services, whereas most ambulatory care use primarily disposable linen.

Surface Cleaning for Specific Areas in Ambulatory

Outpatient Settings

The CDC's guidelines for cleaning outpatient settings are similar to those for inpatient areas. High-touch surfaces in the patient zone (examination rooms, procedure rooms, and waiting areas) must be cleaned and disinfected with appropriate disinfectant. Floors may be cleaned with a detergent instead of a disinfectant unless contaminated with blood and body fluids.

Waste should be collected at least daily or more frequently when needed. Biohazard bin must be available in procedure rooms. There should be a cleaning schedules to meet the needs of each area being serviced.

a) Waiting areas

Ensure availability of hand hygiene stations with alcohol hand rub in the waiting and reception areas. Waiting area may also contain items such as magazines or toys. These items should be able to withstand regular cleaning with a hospital disinfectant. Items such as

magazines should be considered single use and not kept in the waiting room for multiple patients.

b) Examination Rooms

After each patient, linen or paper on the examination table must be changed or discarded, respectively. Reusable pillows, patient care equipment such as blood pressure cuffs, and horizontal surfaces must be wiped with a disinfectant. Walls and floors should be spot cleaned as needed. At the end of each day, all horizontal surfaces and the entire floor must be thoroughly cleaned and disinfected. Used suction containers, if present, must be changed, and all waste containers must be emptied or, if disposable and almost full, must be discarded.

c) Procedure Rooms

Procedure rooms are cleaned and disinfected. Blood and body fluid spills are cleaned with disinfectants that are effective against HBV, HCV, and HIV. Alcohol is not recommended for damp dusting large environmental surfaces because it dries too quickly and is flammable. At the end of each day, all surfaces and the floor should be thoroughly cleaned and disinfected. Walls should be cleaned on a routine schedule and as needed.

Clinical Laboratories

Laboratories require daily cleaning and whenever there is spill. Countertops must be decontaminated after each shift and whenever spills occur. The devices, apparatus, instruments and equipment also require cleaning and or disinfection. Cleaning schedule for both laboratory staff and the environmental staff need to be coordinated. Both biohazardous and non-biohazardous wastes must be collected at least daily or be removed for disposal more frequently. The floors and the countertops must be cleaned and disinfected daily.

Dental

The dental offices are classified by the CDC as clinical contact and environmental surfaces. Clinical contact surfaces are considered high-touch surfaces. During dental procedures it generate a lot of aerosols and spatters which is heavily contaminated by microorganisms from the mouth and dental unit waterline.

Uncovered high touch surfaces in the dental treatment area (instrument tables, dental chair, dental light, dental lines, computer keyboards, x-ray machine controls) must be disinfected with appropriate disinfectant that is effective against HBV, HCV, HIV and is tuberculocidal.

Disposable coverings on clinical contact surfaces such as lights and handles, light cure must be removed, disinfected and replace with new covers. The environmental surfaces (sinks, countertops, waste containers) must be cleaned and disinfected at least daily and whenever *visibly soiled.*

Dental Unit Waterlines Biofilm and Water Quality

Studies have demonstrated that dental unit waterlines (i.e., narrow-bore plastic tubing that carries water to the high-speed handpiece, air/water syringe, and ultrasonic scaler) can become colonized with microorganisms, including bacteria, fungi, and protozoa. The long, small-diameter tubing, low flow rates and frequent period of stagnation allow formation of biofilm. In untreated dental unit water system, it demonstrated a much higher level of bacteria than the recommended levels These include Legionella, Pseudomonas aeruginosa and nontuberculous Mycobacteria which can cause serious infections. Report on outbreak of Mycobacteria infections in children, infections with Mycobacteria and Legionella following endodontic procedures, third molar extraction and general dental work. Outbreaks has also occurred in dental practices that were using water from DUWL to irrigate teeth during pulpotomies.

Recommendations

- Use water that meets the CDC recommended limit for dental procedural water (i.e., <500 CFU/mL of heterotrophic water bacteria) for routine dental treatment.
- Every dental unit waterlines should be treated regularly with appropriate disinfectants to meet regulatory standards
- Dental unit water quality must be monitored, or tested, routinely as recommended by the equipment manufacturer. This ensures that treatments are working effectively, and the water used during dental procedures meets safety standards.
- When bacterial levels in DUWLs exceed 500 CFUs, potential next steps for practice may include shocking and /or treating the waterline, along with additional testing.
- Unused waterlines, often referred to as dead legs should be properly and effectively terminated.
- Monitoring dental unit water quality help identify performance problems or compliance with maintenance procedures and provide documentation of compliance.
- Ensure flushing of DUWLs for 20-30 seconds before the start of the day and between patients

- Dental providers should consult with the dental equipment manufacturers for appropriate methods and equipment to both maintain and monitor the quality of dental water.

Managing water quality successfully is subject to many variables. It include dental unit design characteristics, efficacy and compatibility of germicidal or cleaning products, input water quality, and staff compliance. This complexity can lead to treatment failure even with products that have shown excellent results in laboratory or controlled clinical settings. To address these concerns, ADA formerly known as OSAP believes that providing minimum baseline guidance for monitoring methods, frequency and troubleshooting problems with water quality management will help dental healthcare professionals in achieving compliances and guide manufacturers in developing a more effective directions for use.

Dialysis

Outbreaks of viral hepatitis in dialysis units have been linked with contaminated environmental surfaces (dialysis chair or bed, countertops, external surfaces of dialysis machines, scissors, hemostats, clamps, blood pressure cuffs, stethoscopes). These surfaces must be disinfected with appropriate disinfectant after each patient. Blood splatters and spills must be cleaned and disinfected immediately with effective disinfectant against HBV, HCV, HIV and *Mycobacterium tuberculosis* or with 1:100 dilution of household bleach. The dialysis machines are considered dirty or potentially contaminated once a patient is connected to the circuit. Clean all the surfaces of the machine which should also include connection ports and valves that are easy to overlook. Take precautions when cleaning to avoid personnel exposure to bloodborne pathogens. It should be disinfected according to the manufacturer's specifications. Lined waste containers with plastic bags and removed after each patient. Floors should be cleaned and disinfected at the end of each day and when visibly soiled.

Endoscopy

The physical design and workflow of endoscopy area should reduce the risk of cross contamination. Heating, ventilation and air condition (HVAC) or air-conditioning and mechanical ventilation (ACMV) should comply with the regulations and standards. Workflow should be unidirectional (move from dirty to clean) to minimize cross contamination. Reprocessing areas must have adequate space, and a separate room for decontamination and sterilisation. Appropriate airflow with negative airflow in the decontamination room and positive airflow in the clean room. The room need to be cleaned after each procedure. Eye wash station be located no more than 10 seconds from area dedicated to chemical use and

storage. Proper maintenance and testing of the eye wash unit is necessary to prevent any hazards such as infections, corrosion, blockages. The unit should be flushed regularly to reduce the development of biofilm. Ensure provision of a safe, clean environment in all preprocedural, procedural, and post procedural areas. There should be unidirectional workflow for reprocessing of the endoscopes as well as appropriate ventilation system that meet the recommended standard (temperature, negative and positive air pressure, number of air change and humidity, correct location of air inlet and air exhaust. Clear policies and procedures for reprocessing of endoscopes.

Radiology

Regular and frequent environmental cleaning. Terminal disinfection is done with appropriate disinfectant e.g., sodium hypochlorite. Blood spillages are immediately removed, cleaned and area disinfected. Specify individuals who are responsible to clean the radiological equipment.

Recommendations

1. Ensure a comprehensive hand hygiene program with suitable hand hygiene agents including hand moisturiser. They must be easily availability and accessible. **[AII]**
2. Provide cleaning schedule to meet the needs of each area for the clinical and non-clinical surfaces and equipment. Specify the frequency and timing and responsible person for each area of the facility **[BII]**
3. High-touch surfaces in the patient zone (examination rooms, procedure rooms, and waiting areas) must be cleaned and disinfected with appropriate disinfectant. **[BIII]**
4. Ensure there is a program to manage the quality of the water in the Dental Unit Waterline. This help to reduce the hypertrophic bacteria and remove the biofilm through shocking /sanitation. The waterline should be treated with appropriate disinfectant, monitored to ensure the water quality ~~i~~meets the regulations of < 500 cfu/mL. **[AII]**.

References:

1. Dancer SJ. The role of environmental cleaning in the control of hospital - acquired infection. J Hosp Infect 2009:73:378-385
2. Otter JA. Yazli S. French GL. The role played by contaminated surfaces in the transmission of healthcare associated pathogens. Infect Control Hosp Epidemiol 2011:32:687-699.
3. Chou, T. Environmental services. In Infection prevention for support services and the care environment, Chapter 109. APIC Text (2014). https://text.apic.org/toc/infection-prevention-for-support-services-and-the-care-environment/environmental-service. Assessed July 3, 2024
4. Perri, L. Dental services. In Infection prevention for practice settings and service-specific patient care areas, Chapter 54. APIC Text (2020) https://text.apic.org/toc/infection-prevention-for-practice-settings-and-service-specific-patient-care-areas/dental-services. Assessed July 3, 2024
5. Kuhar, DT. Henderson, DK, Struble, KA. Centers for Disease Control and Prevention. (2001). Updated U.S. Public Health Service guidelines for the management of occupational exposures to HBV, HCV, and HIV and recommendations for postexposure prophylaxis. MMWR; 2001:50(RR-11):1-42.
6. Kohn, WG et al., Centers for Disease Control and Prevention Guidelines for Infection Control in Dental Health Care Settings-2003. MMWR 2003;52 (RR-17) : 28-31.
7. Mills SE. Dental water quality-the scientific evidence from current CDC guidelines. Pa Dent J 2006;73:22-30.
8. Day M. Endoscopy. In Infection prevention for practice settings and service-specific patient care areas (Chapter 56). APIC Text (2024). https://text.apic.org/toc/infection-prevention-for-practice-settings-and-service-specific-patient-care-areas/endoscopy. Assessed July 4, 2024
9. Allen G. (2014). Implementing AORN recommended practices for environmental cleaning. AORNJ 2023;99(5), 570 - 582.

Chapter 10: Ambulance Cleaning

Background

Both of the surfaces and air are contaminated by organisms commonly associated with healthcare associated infection in the ambulances. Blood pressure cuff, oxygen apparatus, stretcher and patient compartment area are the most common contaminated site with MRSA and coagulase negative *Staphylococcus* (CoNS) as the most common microorganisms. Improper cleaning and disinfection can lead to ambulances becoming a source of infection affecting vulnerable patients.

Routine cleaning

High-touch surfaces including the stretcher, the blood pressure cuff, the oxygen knob, and the doorknob should be wiped with detergent or bleach after every patient transportation as soon as possible. Thorough cleaning should be performed once a day, including cleaning the patient area, wiping all surfaces, and sweeping the floor. The driver's cabin area should be cleaned and disinfected daily. It should be forbidden to bring equipment of the patient compartment area or patient's belongings to the driver's cabin. Infection prevention and control teams of healthcare institutions are encouraged to monitor the compliance of cleaning using a variety of methodologies such as fluorescent gel and direct on-site observation.

Enhanced cleaning

Enhanced cleaning should be performed after the transportation of each patient with any of the following: diarrhea or vomiting, urinary incontinence, communicable diseases transmitted through the air, emerging infectious diseases, diseases of an outbreak or a cluster comprising multiple cases, multi-drug resistant organisms (carbapenem-resistant *Enterobacterales*, carbapenem-resistant *Acinetobacter baumannii*, carbapenem-resistant *Pseudomonas aeruginosa*, MRSA, or VRE), *Candida auris*, and any other conditions with the potential to contaminate the ambulance and cause transmission. The detailed cleaning and disinfecting measures are the same for wards when facing the same scenario (please refer to the above chapters) and the local infection prevention and control team should be consulted. Nevertheless, in addition to the measures for surface cleaning, ventilation should be implemented. UV-C, chlorine dioxide, and vaporize hydrogen peroxide can be used for decontamination.

Recommendations

1. High-touch surfaces including the stretcher, the blood pressure cuff, the oxygen knob, and the doorknob should be wiped with detergent or bleach after every patient transportation as soon as possible. [AIII]

2. Thorough cleaning should be performed once a day, including cleaning the patient area, wiping all surfaces, and sweeping the floor. [AIII]

3. Enhanced cleaning should be performed after the transportation of each patient with any of the following: diarrhea or vomiting, urinary incontinence, communicable diseases transmitted through the air, emerging infectious diseases, diseases of an outbreak or a cluster comprising multiple cases, multi-drug resistant organisms (carbapenem-resistant organisms, MRSA, or VRE), *Candida auris*, and any other conditions with the potential to contaminate the ambulance and cause transmission. [AIII]

References

1. Schaps D, Joiner AP, Anderson DJ. Medical transport-associated infection: Review and commentary making a case for its legitimacy. *Infect Control Hosp Epidemiol* 2022;43:497–503.

2. Obenza A, Cruz P, Buttner M, Woodard D. Microbial contamination on ambulance surfaces: a systematic literature review. *J Hosp Infect* 2022;122:44–59.

3. Baldovin T, Amoruso I, Paganini M, Marcato C, Boscolo Cegion R, Favaro A, et al. SARS-CoV-2 Contamination of Ambulance Surfaces and Effectiveness of Routine Decontamination Procedure: A Classic Hygiene Lesson for A Novel Pathogen. *Int J Environ Res Public Health* 2022;19:13646.

Acknowledgement

We are grateful for Dr. Fu Qiao, West China Hospital, Sichuan University, for his contribution to the chapter.

Chapter 11: Staff Education

There is clear evidence that cleaning and disinfection of frequently touched surfaces reduces the risk of transmission of multiple drug resistant organisms including *C. difficile*. Healthcare settings need to standardize cleaning procedures, type of chemicals used, and establish a monitoring system to assure that the patient care equipment and environment is cleaned, disinfected and stored appropriately so that patient safety is optimized. Further, it is important that education need to be involved with all stake holders in the hospital environmental hygiene (e.g., hospital administration, leadership, nursing staff, housekeepers). Staff should be educated on the use of the chemicals and annual competencies are recommended to be required for specific disinfection and sterilization procedures. All cleaning, disinfection and sterilization processes should comply with the CDC guidelines. Given that the performance of environmental cleaning rely on human behavior, it is important to develop checklist (see Appendix) or additional mechanisms to monitor the cleaning quality of housekeepers

Staff education, thus, plays a vital role in meeting these requirements and in educating involved healthcare personnel on various infection control aspects on hospital environmental control and cleaning, particularly in view of rapid staff turnover that occurs at many resource-limited settings. Management and supervisory staff should receive training and education that also includes chain of infection, pest control, and outbreak response. Informal education during infection control and quality improvement meetings as well as during infection control walk rounds should be complemented with in-service education on hand hygiene, appropriate and early diagnosis of infections, indications for area decontamination and hospital cleaning, and isolation precautions and policies. Ongoing staff education is important due to the new research and guidelines published every year, advancements in technology, and regulatory demands. Education should be focused on the role of environmental control to limit the spread of drug-resistant pathogens. Educational campaigns, including facility-wide, unit-targeted, and informal educational interventions, to enhance adherence to infection prevention and control can decrease multidrug resistant organism (MDRO) transmission. The focus was to encourage a behavior change through improved understanding of the problem MDRO that the facility was trying to control. Whether the desired change involved hand hygiene, antimicrobial prescribing patterns, or something else, enhancing understanding and creating a culture that supported the desired behavior were viewed as essential to success. Staff should undergo competency testing

program to assess on their competency after the training to evaluate their level of understanding. The training should be repeated if a competency issue has been identified. All housekeepers are recommended to have written training and competence assessment records.

Recommendations:

1. All aspects of environmental cleaning must be supervised and performed by knowledgeable, training staff **[BII]**
2. Housekeeping must provide a training program which includes **[BII]**
    - A written curriculum.
    - A mechanism for assessing proficiency and competency.
    - Documentation of training proficiency and competency verification.
    - Orientation and continuing education.
3. Infection prevention and control education provided to staff working in Housekeeping should be developed in collaboration with Infection Prevention and Control and Occupational Health and Safety and must include: **[BII]**
    - The correct and consistent use of routine practices.
    - Hand hygiene and basic personal hygiene.
    - Signage used to designate Additional Precautions in the health care setting.
    - The appropriate use of personal protective equipment.
    - Prevention of blood and body fluid exposure, including sharps safety.
4. Housekeeping managers and supervisors must receive training and be certified. **[BII]**

References

1. Rutala, D. W. Centers for Disease Control and Prevention. Guideline for Disinfection and Sterilization in Healthcare Facilities. Weber Infection Control Practices Advisory Committee (HICPAC); 2008.

2. Spaulding EH. Chemical disinfection of medical and surgical materials. In: Lawrence C Block SS, editor. Disinfection sterilization and preservation. Philadelphia: Lea & Febiger; 1968. pp. 517–531.

3. Carling PC, Parry MF, Von Beheren SM. Identifying opportunities to enhance environmental cleaning in 23 acute care hospitals. Infect Control Hosp Epidemiol 2008;28:1-7.

4. Carling PC, Parry MM, Rupp ME, Po JL, Dick B, Von Beheren S. Improving cleaning of the environment surrounding patients in 36 acute care hospitals. Infect Control Hosp Epidemiol 2008;29:1035-1011.

5. Stoessel K and Truscott W. National Patient Safety Goal 7: Recommendations for Compliance. Infection Control Today. July 2009.

6. Siegel JD, et al. Centers for Disease Control and Prevention, National Center for Infectious Diseases. Management of Multidrug-Resistant Organisms in Healthcare Settings. 2006.

7. Best Practices for Environmental Cleaning for Prevention and Control of Infections. Available at: http://www.health.gov.on.ca/english/providers/program/infectious/diseases/ic_enviro_clean.html

Chapter 12: Occupational Health and Safety Issues Related to Housekeeping

Due to the fact that cleaning staff are working in healthcare facilities, the risk of exposure to infectious diseases exist. Hence, occupational health and safety issues include staff immunization, appropriate use of Personal Protective Equipment (PPE), staff exposures to blood and body fluids and other infection hazards, and staff safety issues such as chemical safety and ergonomic hazards.

Immunization

Appropriate immunization will include:

a) Annual influenza vaccine.

b) Hepatitis B vaccine as they may be exposed to contaminated sharps during work.

c) Measles, mumps, rubella (MMR) vaccine

d) Varicella vaccine

e) Up-to-date with COVID vaccine

Contracts with supplying agencies should include the above immunizations for contracted staff.

Personal Protective Equipment (PPE)

All cleaning personnel PPE shall be provided for with appropriate PPE, and replaced when defective or contaminated. When using novel technologies, it is recommended that manufacturer's written instructions for use be consulted and followed. Cleaning staff should wear PPE:

a) For protection from microorganisms;

b) For protection from chemicals used in cleaning; and

c) To prevent transmission of microorganisms from one patient environment to another.

Training is to be provided in the correct use, application and removal of PPE.

Using PPE to be used to prevent contact with blood, body fluids, secretions, excretions, non-intact skin or mucous membranes, should include:

a) Gloves when there is a risk of hand contact with blood, body fluids, secretions or excretions or items contaminated with these;

b) Gown if contamination of uniform or clothing is anticipated; and

c) Mask and eye protection or face shield where appropriate to protect the mucous membranes of the eyes, nose and mouth during activities involving close contact (i.e., within one metre) with patients likely to generate splashes or sprays of secretions (e.g., coughing, sneezing).

Staff Exposures

There must be written policies and procedures for the evaluation of staff (employees or contract workers) that are, or may be, exposed to blood or body fluids and other infectious hazards that include:

a) A sharps injury prevention program;

b) Timely post-exposure follow-up and prophylaxis when indicated.

Work restrictions

All healthcare settings must establish a clear expectation that HCP do not come into work when acutely ill with a probable infection (e.g., fever, diarrhea, vomiting, rash, conjunctivitis, cough). Staff members carrying on activities in a healthcare setting who develop a communicable disease may be subject to work restrictions.

Recommendations

1. Housekeeping staff must be offered appropriate immunizations. **[BII]**

2. There shall be policies and procedures in place that include a sharps injury prevention program; post-exposure prophylaxis and follow-up; work restriction program and a respiratory protection program for staff who may be required to enter an airborne infection isolation room accommodating a patient with tuberculosis. **[BII]**

Reference

1. Best Practices for Environmental Cleaning for Prevention and Control of Infections in All Health Care Settings, 3rd Edition April 2018

   https://www.publichealthontario.ca/-/media/documents/b/2018/bp-environmental-cleaning.pdf

2. Centers for Disease Control and Prevention. Infection Control in Healthcare Personnel: Infrastructure and Routine Practices for Occupational Infection Prevention and Control Services. 2019. (https://www.cdc.gov/infection-control/hcp/healthcare-personnel-infrastructureroutine-practices/index.html)

3. Infection Control in Healthcare Personnel: Epidemiology and Control of Selected Infections Transmitted Among Healthcare Personnel and Patients. Updated March 28, 2024 https://www.cdc.gov/infection-control/hcp/healthcare-personnel-epidemiology-control/index.html