AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

Environmental cleaning: emerging environmental cleaning technologies

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Background

Environmental cleaning is an essential part of standard precautions. Standard precautions are work practices that constitute the first-line approach to infection prevention and control in all healthcare settings and are recommended for the treatment and care of all patients.[1] Environmental cleaning ensures that clinical environments are safe and hygienic through the removal of dirt and microorganisms from environmental surfaces and equipment. Environmental cleaning reduces the risk of transmission from contaminated surfaces to patients and healthcare workers, and thereby reduces the risk of infection.[1,2]

An emerging cleaning technology refers to new devices or products (automatic or manually controlled) that clean the environment and/or equipment surfaces.[3,4] The information in this factsheet covers emerging cleaning technologies such as ultra violet (UV) irradiation, high-intensity narrow-spectrum (HINS), disinfectant fogging, and steam vapour.

This information complements the recommendations relating to environmental cleaning and the use of emerging cleaning technologies in the Australian Guidelines for the Prevention and Control of Infection in Healthcare. This factsheet does not address the use of products with copper, silver, triclosan, polycations or other compounds that may have some antimicrobial effect.[3]

Introduction

Healthcare-associated infections (HAIs) cause considerable morbidity and mortality for patients and are costly for the health system. HAIs are often preventable through use of standard precautions and targeted interventions that reduce the transmission risk of pathogens.[3, 4] Some pathogens are becoming increasingly more difficult to manage, and many pathogens, such as multi-resistant organisms (MROs), fungi and viruses have the potential to cause outbreaks (e.g. gastroenteritis) within the healthcare setting. As health service organisations continually work to improve infection prevention and control strategies, there is an increasing interest in the use of emerging cleaning technologies to provide more efficient cleaning practices.

While emerging cleaning technologies are increasingly being integrated into many cleaning programs, they remain expensive, have potential safety risks and require staff training before use.[3,4] Despite evidence supporting the efficacy of some of these emerging cleaning technologies in reducing the burden of pathogens on environmental surfaces, these technologies should only be used after manual cleaning with neutral detergent has been completed until evidence changes, these technologies should not replace manual environmental cleaning methods using neutral detergent and disinfectant.[3-7]

Comparison of emerging environmental cleaning technologies

When exploring emerging cleaning technologies as an adjunct to traditional environmental cleaning programs, staff should consider the objective of their use and current evidence for the effectiveness. Staff should also consider the effectiveness of the health service organisation's existing infection prevention and control strategies and assess the risk of infection within the organisation and any gaps in the organisation's existing environmental cleaning programs.

Table 1 summarises common emerging cleaning technologies, including the benefits and limitations of their use. Additional information on the use of emerging cleaning technologies is provided in the Australian Guidelines for the Prevention and Control of Infection in Healthcare.

Table 1. Summary of common emerging cleaning technologies

	Ultra Violet (UV) Irradiation	Disinfection Fogging Machines	High-Intensity Narrow Spectrum Light (HINS)	Steam Vapour
What is it?	• Free-standing machine that delivers pulses of UV light onto surfaces to kill microorganisms.[4,5,7,8]	• Free-standing machine that generates a wet or dry fog of small particles of a disinfectant solution, usually hydrogen peroxide (H_2O_2) into the air.[4-7]	• Ceiling-mounted device that emits a continuous visible UV light into the clinical environment.[10,11]	• Device that delivers high pressure dry steam (<140°C) to surfaces and vacuums dirt and water from the area that is being cleaned.[12]
How does it work?	• The UV light breaks the molecular bonds in DNA and RNA, causing damage to the cellular structure of microorganisms, and cellular death.[4,5,7,8]	• H_2O_2 kills microorganisms by releasing free radicals that oxidise the DNA, RNA and lipid membranes of cells, causing cellular death.[5,7]	• Uses a process called photodynamic inactivation, causing molecules to react with oxygen when exposed to light, leading to cellular death.[10]	• Microorganisms are killed by the high temperature of the steam.[12]
Benefits	• Non-touch, automated method of inactivation of pathogens • The device does not damage surfaces and is easy to use • A chemical free process • Delivers a pre-set level of UV light to deactivate pathogens on environmental and equipment surfaces.[4,5,7,8]	• Non-touch, automated method of disinfection • Particles of disinfectant can reach difficult-to-access surfaces of the clinical environment and equipment • Can be used on porous and non-porous surfaces • Uses a non-corrosive chemical • Delivers a pre-set measured dose or level of environmental disinfection.[5,7]	• Safe to use around patients • Wide range of antimicrobial activity • Inactivates pathogens on surfaces, equipment and in the air • Can be used continuously • Will not disrupt daily hospital routines • Easy to install onto ceilings.[10,11]	• Non-toxic, fast method of removing bioburden • No chemicals used, time and cost effective, low water consumption • Can be incorporated into routine cleaning • Equipment is portable and light weight.[7,12]
Limitations	• Only surfaces in the direct line of the UV light emitted from the device will be treated. • Not suitable for porous surfaces. • The device may need to be moved around a room several times to different locations to ensure all surfaces and equipment in a room are treated with the UV light. • The device has a long cycle time and can only be used in a vacant room.[6,8]	• The device has a long cycle time and can only be used in a vacant room. • There may be an extended down time whilst the solution dissipates before the clean room can be used. • May need more than one device to treat a large area.[4,5,7] • Only solutions that are recommended by the manufacturer should be used for disinfection fogging.[9]	• Effect on some microorganisms is dose dependent.[10,11]	• Cannot be used on electrical devices. • Not suitable for use in patient areas due to risks of burns. • May disperse water and dirt to surrounding environment. • Surfaces are damp after cleaning and require drying.[3,7,12]

	Ultra violet (UV) irradiation	Fogging or misting machines	High-Intensity Narrow Spectrum Light (HINS)	Steam Vapour
Is user training required?	• Yes	• Yes	• Minimal training required	• Yes
Work Health and Safety considerations	• UV light can cause headaches and visual disturbances (short term effect). • To prevent UV exposure to others, the room being treated must be secured to prevent people entering while the device is in operation.[4,5,7,8]	• Staff need to use PPE when handling chemicals. • H_2O_2 exposure can cause toxicity (headaches, sore throat).[9] • Rooms being treated must be securely sealed while the device is in operation to prevent fogging vapor escaping into the surrounding areas. • Times will vary for different devices. • H_2O_2 concentration levels should be monitored to ensure they remain within safe health limits.[4,5,7]	• Nil issues identified.	• Risk of scalds and burns.[7]

Suitability of emerging cleaning technologies

The use of an emerging cleaning technology may improve environment and equipment cleaning outcomes and efficiency in some settings. **Table 2** details questions that environmental cleaning and infection prevention and control staff should consider before deciding to introduce an emerging cleaning technology into an organisation's environmental cleaning program.

Table 2. Would an emerging cleaning technology be suitable for my organisation?

Question	Additional questions
Why does the health service organisation need this emerging cleaning technology?	• Does the organisation have sufficient environmental cleaning processes in place to address the risks associated with an outbreak caused by an MRO or another highly transmissible disease, such as COVID-19? • Can the risk of infection be mitigated with improvements to current cleaning programs or other interventions? • How would an emerging technology reduce the risk of HAIs, MROs or outbreaks in the healthcare organisation? Is there good evidence to support its use?
How would the health service organisation use this emerging cleaning technology?	• Who will be using the emerging cleaning technology? • Do staff need to be trained to use the emerging cleaning technology and if so, how will this happen? • Under what circumstances will the emerging cleaning technology be used? Will it form part of a regular cleaning schedule or will it only be used for outbreak management? • Can the emerging technology be used in all departments or on all equipment? • Will there be a 'down-time' after the use of the emerging cleaning technology? • How will this affect service delivery in the healthcare facility?
Does the emerging cleaning technology meet the current recommendations for environmental cleaning?	• Have the recommendations in the Australian Guidelines for the Prevention and Control of Infection in Healthcare been considered prior to selecting an emerging cleaning technology? • Is this technology approved by the Therapeutic Goods Administration (TGA)?
Can the health service organisation meet the manufacturer's instructions for the use?	• Can the healthcare organisation safely store and maintain the emerging cleaning technology and its related equipment or chemicals?
What are the establishment and ongoing costs of use of this emerging cleaning technology?	• Is the use of this emerging cleaning technology a cost effective solution? • What other costs are associated with the use of this device? For example, consider the cost related to consumables, additional equipment to use the emerging technology safely, PPE, ongoing staff training, warranties and ongoing maintenance of equipment.

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