Environmental cleaning and disinfection during COVID-19

Introduction

There is general misconception that spraying a disinfectant will not require surfaces to be cleaned first. It is not possible to disinfect unless the surfaces are clean (see definitions)

The COVID-19 pandemic has increased awareness for improving cleanliness of hands, environmental surfaces and medical devices in healthcare facilities. Driven by images on TV and social media, and compounded by the fear of becoming infected with SARS-CoV-2, the use of disinfectants has dramatically increased 1. The pandemic has also highlighted another area of concern prior to the pandemic - environmental cleaning and disinfection in healthcare facilities was inadequately taught, supervised and executed. Despite evidence-based international, national and provincial guidelines on best practices in environmental cleaning and disinfection (if in indicated), healthcare facilities compliance has been poor regarding procedures, training, monitoring and validation of cleaning, and following prescribed protocols.

Fear amongst the community and healthcare workers has resulted in a panic response to COVID-19, which has been exploited by commercial companies, marketing non-validated disinfection methods for surfaces, buildings and humans and in some instances spraying of outdoor spaces such as in taxi ranks, and open streets. At best, these systems are unnecessary; at worst are detrimental to human health, the ecosystem and environment and essentially not proven to be effective for COVID-19 containment. With no clear evidence for the use of such chemicals in the COVID-19 pandemic, extrapolation from individual studies have been quoted out of context. There is clear guidance published by the World Health Organization (WHO)2, Centers for Disease Control and Prevention (CDC)3, Pan American Health Organization 4, and the Infection Control Africa Network (ICAN)5 on the correct methods of cleaning and disinfection, mainly for healthcare facilities, to maximize benefit and minimize harm to humans. Spraying and unnecessary exposure of humans has been condemned by all these organizations. The Ministerial Advisory Committee has produced an advisory on the banning of disinfection tunnels, and chambers, yet the use of these still persist in several public spaces.

The National Public Hygiene Strategy and Implementation Plan for COVID-19, version 2, May 2020 by Environment Health, DOH including the use of spraying was reviewed (June 2020) and aligned with the latest current evidence in environmental disinfection6 but is subject to change based on new evidence.

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1 MMWR/ April 24, 2020/ Vol 69/ No 16. US Department of Health and Human Services/ CDC
4 PAHO. The use of tunnels and other technologies for disinfection of humans using chemical aspersion or UV-C light PAHO/CDE/CE/COVID-19/20-0012
6 NDOH. COVID-19 disease: Infection Prevention and Control Guidelines, version 2, May 2020
This document reviews recently published evidence including national guidelines, for cleaning and disinfection methods including the recommended chemicals, the method of delivery of disinfectants and the detrimental effects of the improper use of chemicals for healthcare and public institutions.

Definitions
A few essential definitions are shown below to clarify concepts and misuse of frequently used words, sometimes interchangeably, without a clear understanding of the meaning.

**Antiseptic**: a substance that prevents or stops the growth or action of microorganisms by inhibiting their activity or by destroying them. The term is used especially for *preparations applied topically to living tissue* such as 70% propyl, isopropyl and ethyl alcohol (ethanol) with 2% emollient, povidone iodine (no longer recommended) and chlorhexidine 2-4% w/v.

**Cleaning**: the physical or mechanical removal of foreign material (e.g., dust, soil) and organic material (e.g., blood, secretions, excretions, microorganisms). Cleaning physically removes rather than kills microorganisms. It is accomplished with water, detergents and mechanical action.

**Contact time**: the time that a disinfectant must be in contact with a surface or device to ensure that appropriate disinfection has occurred. For most disinfectants, the surface should remain wet for the required contact time.

**Contamination**: the presence of any potentially infectious agent on items such as environmental surfaces, clothing, bedding, surgical instruments or dressings, or other inanimate articles or substances including water, medications, and food.

**Detergent**: a synthetic cleansing agent that can emulsify and suspend oil. Contains surfactant or a mixture of surfactants with cleaning properties in dilute solutions to lower surface tension and aid in the removal of organic soil and oils, fats, and greases. Effective against coronaviruses.

**Decontamination**: a process for rendering medical or other devices safe for reuse on the same or another patient. It includes thorough cleaning, and disinfection or sterilization depending on the device’s heat tolerance. **Disinfection** is a part of decontamination and these two terms should not be used interchangeably.

**Disinfection**: a *thermal or chemical process* for inactivating microorganisms on inanimate objects.

- **High-level disinfection**: kills all microorganisms, with the exception of small numbers of bacterial spores. Used for endoscopes and heat labile equipment.

- **Mid-level disinfection (also intermediate-level disinfection)**: kills inactivate vegetative bacteria, including mycobacteria, most viruses, and most fungi, but might not kill bacterial spores. Used for large areas of contamination such as blood spills.

- **Low-level disinfection**: inactivates most vegetative bacteria, some fungi, and some viruses *including enveloped viruses*, in a practical contact time, but does not kill more hardy viruses (e.g. non-enveloped), bacterial genus (e.g. mycobacteria), or bacterial spores. Used for surface disinfection after cleaning.

**Disinfectants**: Chemical compounds that inactivate (i.e., kill) pathogens and other microbes and fall

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into one of three categories based on chemical formulation: low-level, mid-level, and high-level. **Disinfectants are applied only to inanimate objects.** All organic material and soil must be removed by a cleaning product before application of disinfectants. Some products combine a cleaner with a disinfectant.

**Fogging:** (fumigation, misting) Dispersing a liquid chemical disinfectant to disinfect environmental surfaces *in an enclosed space*. Fogging is sometimes indicated after an infectious patient with a highly resistant pathogen (e.g. *C difficile*), has been discharged and terminal cleaning has been completed. Fogging is to be carried out in a completely empty room with no humans, furniture or obstruction. The room is ready for use after a couple of hours, depending on the contact time. Recommended chemical for healthcare facilities is >0.5% vaporised hydrogen peroxide (WHO). ¹⁴

**Health care areas (also known as patient care areas):** patient zones and the surrounding healthcare environment within inpatient (e.g., general wards, specialized wards, patient rooms) and outpatient settings (e.g., examination areas, patient toilets). This area should remain clean and dry as possible

**Routine cleaning:** the regular cleaning (and disinfection, when indicated) of the patient area to remove organic material, minimize microbial contamination, and provide a visually clean environment. The frequency of cleaning is determined by indication but *should be at least once a day* in the absence of an outbreak.

**Terminal (discharge) cleaning:** (deep cleaning) cleaning and disinfection after the patient is discharged or transferred, and includes the entire health care area. The removal of organic material and significant reduction and elimination of microbial contamination to ensure that there is no transfer of microorganisms to the next patient. *The room can be occupied as soon as terminal cleaning is completed and ready to accept the next patient.*

**Importance of disinfecting surfaces**

It is recognized that environmental contamination plays a role in the transmission of pathogens in healthcare facilities to cause healthcare associated infections particularly with multi-drug-resistant (MDR) pathogens. During the COVID-19 pandemic, several studies have reported the presence of the virus by reverse transcriptase polymerase chain reaction or PCR – (a means of detecting viral RNA particles but does not necessarily reflect viability) on a variety of surfaces ¹⁸ ⁹ particularly in the vicinity of an infected person ¹⁰ Transmission from contaminated surfaces via hands to the mucous membranes is a possibility but the exact contribution of this route is largely unquantified for SARS-CoV-2. Studies from the UK and Germany reported that while the presence of virus was detectable, their viability (using viral culture methods) in these situations was not established. The actual survival times in healthcare and public settings vary considerably based on factors such as temperature and humidity. Given that SARS-CoV-2 is a fragile enveloped virus, which is easily killed by heat, UV, detergents, and chemicals, extensive use of disinfectants is not warranted. The process of cleaning using water and a neutral pH detergent removes 80% of organic matter and soil, which contains

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¹⁰ Chin A et al. Stability of SARS-CoV-2 in different environmental conditions *Lancet Microbe* 2020 Published Online April 2, 2020 [https://doi.org/10.1016/S2666-5247(20)30003-3](https://doi.org/10.1016/S2666-5247(20)30003-3)
microbes that may be pathogenic. The application of a disinfectant kills the small number of remaining microbes.

Healthcare facilities

In healthcare facilities including care homes and similar community institutions, environmental cleaning (and disinfection) is an essential infection prevention and control (IPC) multi-modal intervention as recommended in the WHO Core Components. Environmental cleaning and disinfection is complex and a multifaceted approach involving cleaning and disinfection (if indicated) of a physical environment surrounding the patient (patient zone). A robust environmental cleaning programme will require a multi-modal approach, which includes leadership, support from administration, supervision by IPC teams or focal person, and training of all staff involved in environmental cleaning. There must be a feedback mechanism on monitoring the processes involved. Usually, the IPC team or focal person is responsible for overseeing the environmental cleaning programme by providing advice, training, and support to the cleaning teams, irrespective of whether these are in house or outsourced companies. To be effective, environmental cleaning activities must be implemented within the overall context of the facility IPC program, and not as a standalone intervention.

A plan of frequency, method of cleaning and disinfection as well as the type of disinfection used should be in place. During the COVID-19 pandemic, the frequency of cleaning and disinfection is increased in all areas but more so in COVID-19 wards and ICUs. Care homes must ensure increased frequency of cleaning and disinfection to ensure safety of the residents and the staff.

Using a template, a number of points in the ward are marked by the inspector (these are invisible to the naked eye). The next day the points are identified using a fluorescent marker and a percentage of those no longer visible with the UV light are calculated as a percentage.

\[
\text{Number of points visible with UV light} \times 100 = \% \\
\text{Number of points marked with fluorescent marker}
\]

The disinfectants listed here are recommended as part of the environmental cleaning and disinfection programme. Fogging or fumigation is not recommended unless specified for hardy pathogens following terminal cleaning.

Public spaces

In community settings such as offices, public transportation, churches, shops, banks, and anywhere there is interaction with the public, the environmental health practitioners are responsible for advising on cleaning, disinfection and sanitation for the in-house cleaning programme. The National Public Hygiene Strategy and Implementation Plan for COVID-19, Version 2, succinctly covers a wide scope on public health. It encompasses policies and responsibilities of all departments related to public

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15 COVID-19 NATIONAL PUBLIC HYGIENE STRATEGY AND IMPLEMENTATION PLAN (draft) Version 2: May 2020
health safety including environmental cleaning, disinfection, and healthcare waste management. It includes capacity building as well as monitoring and evaluation of public health safety systems. This document is aligned with the WHO guidance on cleaning and disinfection of environmental surfaces and the National COVID-19 IPC guidelines, V2 (May 2020), and re-enforces hand hygiene, environmental cleaning and disinfection, and healthcare waste management.

There is emphasis on public awareness, cough or respiratory etiquette including the use of cloth masks, hand hygiene, and environmental cleaning and disinfection. It clearly condemns the use of spraying chemicals, fumigation tunnels, and environmental spraying.

Standard Operating Procedures (SOPs) for cleaning and disinfection of public spaces is detailed, referencing the WHO and the South African National IPC guidelines recommendations. The use of no-touch technologies such as spraying with a combination of chemicals has been described for disinfection of certain areas with recommendations of first clearing the space of humans and obstacles, adhering to the correct contact times and good ventilation.

Public interface buildings should have a structured cleaning (and disinfection) programme. In the current COVID-19 climate, increased supervised frequency of thorough cleaning and disinfection is advised. What disinfectant to use and how to use it must be clearly laid out and SOPs should be in place, which can be monitored and checked regularly by the supervisors.

Disinfecting homes of patients with COVID-19 is correctly laid out, emphasizing on wiping with a disinfectant rather than spraying.16 Workplace recommendations include increase frequency of cleaning and wiping over with a recommended disinfectant such as 1000 ppm (0.1%) chlorine or 70% alcohol for smaller spaces. Good ventilation and adhering to the correct contact time after which the facility can be opened for use, has been highlighted.

In both healthcare and community establishments, an adequate running water supply with good sanitation facilities and hygiene (WASH, WHO) as well as monitoring and evaluation are the essentials needed to support best practices in hand hygiene, environmental cleaning, and disinfection to maintain a safe environment.

Training of all those involved in cleaning, whether in house or outsourced, must be clearly defined. Responsibility of carrying out proper cleaning and disinfection must be stipulated and made accountable. In healthcare facilities, environmental cleaning usually falls under the IPC team who are responsible for monitoring and validation. In the community, the Environmental Health programme manages environmental cleaning and disinfection. Ideally, IPC and environmental health practitioners should work closely together guided by WHO recommendations17, and environmental health’s public health policy18 to determine evidence-based best practices.

18 COVID-19 NATIONAL PUBLIC HYGIENE STRATEGY AND IMPLEMENTATION PLAN (draft) Version 2: May 2020
Recommended disinfectants.
The WHO recommends the following disinfectants to be used during the COVID-19 pandemic. These have been found to be the most easily available globally, effective against SARS CoV2, and inexpensive. However, like all disinfectants they must be used according to manufacturer’s instruction in the correct concentration with the right contact time. Appropriate PPE must be worn by all those mixing and applying these chemicals. All disinfectants should be applied by wetting a cloth and systematically wiping a surface. Direct spraying onto surfaces is not recommended.

**Recommended disinfectants**
- Chlorine-
  - Surface disinfection = 1000 ppm
  - Blood spillage or large contaminated areas = 5000 ppm (0.5%)
- Alcohol: 70% ethanol without emollient
- Hydrogen peroxide: >0.5% (vaporized)

Other disinfectants or stronger concentrations of the disinfectants listed above will work but are not recommended either because of toxic residual effects to humans and the environment, or damaging surfaces.

**Toxic effects**
Disinfectants are chemicals, which have adverse side effects if not used under controlled conditions, for specific purposes. These chemicals effect the health of humans, particularly healthcare workers and the environment and also promote antimicrobial resistance. The health risks compiled by PAHO, are summarized in Table 1.

*Table 1. Health risk associated with disinfecting agents*

<table>
<thead>
<tr>
<th>Product</th>
<th>CAS</th>
<th>Presentation</th>
<th>Indication of Use</th>
<th>Health Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozone</td>
<td>10029-15-6</td>
<td>Gas</td>
<td>Air and water disinfectant</td>
<td>Inhalation at low concentrations may increase risk to health, accelerate viral or bacterial infections of the respiratory tract or exacerbate pre-existing chronic lung lesions</td>
</tr>
<tr>
<td>Hydrogen peroxide</td>
<td>7722-84-1</td>
<td>Liquid</td>
<td>Disinfectant whitener</td>
<td>Eye, nasal, dermal, throat and respiratory irritation</td>
</tr>
<tr>
<td>Sodium hypochlorite</td>
<td>7681-52-9</td>
<td>Liquid Granulated</td>
<td>Disinfectant</td>
<td>Eye irritation and dermal contact irritation. Inflammation and erosion of mucous membranes if swallowed</td>
</tr>
<tr>
<td>Hypochlorous acid</td>
<td>7790-92-3</td>
<td>Liquid</td>
<td>Disinfectant</td>
<td>Potential dermal irritation from direct exposure. Potential respiratory tract irritation and pulmonary edema from vapour inhalation</td>
</tr>
<tr>
<td>Quaternary ammonium</td>
<td>Product mix</td>
<td>Liquid by composition</td>
<td>Surfactant disinfectant</td>
<td>Dermal irritation, shortness of breath, gastrointestinal injuries in case of ingestion</td>
</tr>
<tr>
<td>Isopropyl alcohol</td>
<td>67-63-0</td>
<td>Liquid</td>
<td>Disinfectant</td>
<td>Eye, nose and throat irritation, second to direct exposure or contact with vapours</td>
</tr>
<tr>
<td>Ultraviolet rays</td>
<td>Light</td>
<td></td>
<td>Disinfection of drinking water, air, titanium implants</td>
<td>UV-induced skin erythema and keratoconjunctivitis</td>
</tr>
</tbody>
</table>


21 PAHO/CDE/ COVID-19/ 20-0012.
No-Touch Technologies

There are some no-touch technologies on the market which include systems for fogging or the use of UVC light robot as a free-standing system. There are specific indications where these technologies may be applied. These are not a substitute for a good cleaning programme and frequency followed by disinfection if indicated.

Fogging Systems.

Pressure guns and fogging machines, which are carried by sprayers, are used to distribute chemicals in a fine mist or spray. These are usually applied for spraying plants with pesticides. Now, these methods are used in the transport industry for taxis, buses, trains, and airplanes where large surfaces are required to be covered to reduce labour. The sprayers are required to wear chemical resistant personal protective equipment (PPE) to ensure safety. Often the chemicals used in these systems are not revealed and their contact times are not known therefore an assessment of toxicity is difficult. The WHO approved chemical is >5% vaporized hydrogen peroxide. Ideally, the chemical residue should be removed after the contact time to prevent contact with humans.

Steam generated to 70 °C under pressure is an excellent and safe substitute for disinfecting surfaces in large warehouses, food markets with perishable produce using a system of fogging. It is much easier to produce and less toxic to humans. If prepared according to guidelines, the steam is dry and does not leave wet patches.

Application of fogging: Although not recommended for routine use, rarely enclosed medium size spaces, which are cleared of humans in both health facilities and public spaces. If essential, fogging should be carried out at the end of the workday to give adequate contact time.

Disinfection tunnels. Another fogging or misting system is the use of continuous sprays in a disinfection tunnel or booth, which surrounds and covers people passing through it, in a fine mist. This chemical-containing mist settles on clothes, bags and skin and is carried home or the workplace. The chemicals are absorbed in the clothing and can lead to serious adverse reactions. When institutions opened, these were introduced but since then, many have been removed. However, many remain in place. The toxic effect on humans requires all tunnels to be removed forthwith.

Application: NONE

UV light systems

These are free standing UVC bulbs (254 nm wavelength) mounted on a sensor-sensitive robot, which moves across a floor space to disinfect the air and surfaces in direct contact with the UV light. While stationary UV application does work in closed systems to sterilize water and air where repeated recycling of the same air and water are carried out, it is less effective in open spaces such as ward or clinical areas.

Application: enclosed, sealed (small or medium size) spaces, which can be left exposed to the UV light for a given period of time, up to 10 to 12 hours. The space must be clean and cleared of all obstacles so that a clear “line of sight” must be established for effective disinfection to occur. For example, trucks or similar transporting goods in a closed containers that require cleaning and disinfection at the end of each trip.
The WHO does not recommend these methods for COVID-19 containment. The reasons are:

- These technologies do not add to the routine cleaning and disinfection methods already in place.
- There is no evidence that these are effective in reducing SARS-CoV-2 transmission.
- The technologies are expensive, and some are hard to maintain.
- The toxic effect on humans particularly with the chemicals used in fogging systems and UV lights has been reported. These include skin, eye and respiratory irritation and damage.

**Length of time a building should remain unoccupied**

When a person(s) is discovered to have been infected with SARS-CoV-2 in the workplace, there is a move to intensify cleaning and disinfection, and leave the premises unoccupied (shut down) for up to 4 days. This is unnecessary and does not help with reducing transmission. Only if essential such as a spillage, an area maybe cordoned off for thorough cleaning and disinfection and opened immediately afterwards.

The route of transmission of SARS-CoV-2 is via the respiratory tract. A contact is defined as someone who has been within 1m for 15 minutes or longer without a face cover. Therefore, once the contacts have been identified during a risk assessment and/or incident investigation and the proper route of management taken, the workplace can continue as before. This recommendation is based on the low risk of transmission if all the necessary daily cleaning and disinfection procedures, universal masking, hand hygiene and social distancing is already in place. Once these aspects have been confirmed, the workplace may function as normal, and all the protocols meticulously followed.

*Prolonged closure is not necessary. Two to three hours closure may be required for additional cleaning and disinfection for the allaying of fears for the workforce.*

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