

Cleaning and Disinfection of Environmental Surfaces

This article is intended to provide managers and workers in health and community care organizations with information about the types of disinfectants available for use and how they can augment facility cleaning and disinfection programs. With this, readers can make informed decisions regarding the type of cleaning and disinfection strategies they should consider for the protection of employees and patients/clients from exposure to potentially pathogenic organisms.

All health and community care workers want to be protected from exposure to organisms that can cause illness. Infection prevention and control programs implemented in health and community care facilities offer workers comprehensive protection through a number of measures such as hand hygiene, personal protective equipment, consultation with local public health officials, internal audits, and staff and visitor education. The use of disinfectants is another strategy that can be part of these programs.

It is important, however, to balance the benefits of disinfectant use against the risks it poses in terms of air quality issues, chemical exposure, and inappropriate or ineffective use. In other words, staff at all levels must determine where and when the added benefit of disinfectant use over thorough, routine cleaning alone outweighs the additional cost, risk, and administrative burden of disinfectant use.

The three-step process outlined here will help organizations to integrate disinfectant use safely and effectively into their infection control programs.

Step 1:

Research the wide range of disinfectant products available

Chlorine Disinfectants

Chlorine eliminates both enveloped viruses (e.g. Coronavirus) and non-enveloped viruses (e.g. Rotavirus). Chlorine is also effective against fungi, bacteria, and algae. The most common chlorine disinfectant is household bleach (5.25 percent sodium hypochlorite (NaClO) solution); it is cheap and readily available. It is used in concentrations ranging from 1% (1 part bleach mixed with 99 parts tap water) to 10% (1 part bleach mixed with 9 parts tap water) depending on the type of organic matter present on the surface to be disinfected.

Chlorine disinfectants can corrode metals, deteriorate fabrics, and irritate mucous membranes, eyes and skin. They are inactivated by organic materials such as feces, and therefore must be applied to clean surfaces only. They yield maximum effectiveness only after several minutes' contact with surfaces, and their effectiveness decreases in hard water and when application temperatures are below 65 degrees F.

Summary:

- wide germicidal activity
- fairly effective sporicide
- relatively nontoxic

- effective at low concentrations
- low cost
- limited activity in the presence of organic matter
- poor residual activity necessitates frequent applications
- corrosive

Iodine and Iodophor Disinfectants

Iodine and iodophors are considered low level disinfectants. These compounds can be included in time-release formulations and in soaps (e.g. surgical scrubs). Iodine and iodophors are effective against bacteria, viruses, spores, and fungi. Iodine, like chlorine, is inactivated by organic material and must be applied frequently for thorough disinfection. Iodine tinctures are corrosive, can stain fabrics, and can be very irritating to tissues. Antiseptic iodophors are not suitable for use on hard surfaces.

Summary:

- wide germicidal activity
- fairly effective sporicide; better than chlorine
- relatively nontoxic
- effective at low concentrations
- limited activity in the presence of organic matter
- poor residual activity necessitates frequent applications
- stains fabrics and equipment

Peracetic Acid

This is typically used as a high level disinfectant or sterilant for heat sensitive equipment. It provides rapid action at low temperatures and is active in the presence of organic materials. It can be corrosive and is unstable when diluted. It should not be used for environmental cleaning.

Summary:

- high level disinfectant for heat sensitive equipment
- can be corrosive
- unstable when diluted

Alcohols (isopropyl, ethyl)

Alcohols are commonly used as topical disinfectants. They are effective against Gram-positive and Gram-negative bacteria and enveloped viruses. They act quickly, do not stain, and do not leave a residue. They are not effective against bacterial spores and non-enveloped viruses, and they do not penetrate organic material. They are too expensive for general use.

Summary:

- wide germicidal activity
- non-corrosive
- fire hazard

- irritating to tissues
- limited activity in the presence of organic matter
- limited residual activity
- not effective against bacterial or fungal spores
- excellent for disinfection of external surfaces of some equipment such as thermometers and stethoscopes

Oxidizing Agents

These are most commonly available as stabilized peroxides, some of which come blended with iodophors or quaternary ammonia. Some of these products are effective against a broad range of pathogens including enveloped and non-enveloped viruses, vegetative bacteria, fungi, and bacterial spores. They can be used to disinfect equipment surfaces. In fact, a hydrogen peroxide based formulation was recommended by the Ontario Ministry of Health and Long-Term care during the SARS outbreak of 2003 for use in decontamination of equipment and vehicles.¹

Summary:

- moderate to wide germicidal activity
- moderately corrosive to aluminum, copper, brass or zinc
- limited toxicity.
- rendered ineffective in the presence of organic matter
- poor to limited residual activity
- breaks down into water and oxygen
- not all are effective against bacterial or fungal spores

Phenolic Disinfectants

Phenolics are low to intermediate level disinfectants. Phenol is commonly found in mouth washes, scrub soaps and surface disinfectants, and is the main active ingredient found in household disinfectants. Phenols are effective against bacteria (especially Gram-positive bacteria) and enveloped viruses. Phenols are not effective against spores or non-enveloped viruses. Phenols maintain their activity in the presence of organic material. Phenolic disinfectants (including cresols and pine oil) are generally safe, but may cause skin irritation with prolonged exposure. They are commercially available with added detergents to provide one-step cleaning. These products, however, leave a residual film on environmental surfaces and therefore should not be used in nurseries or on food contact surfaces.

Summary:

- wide germicidal activity
- relatively non-corrosive
- limited toxicity
- very effective in the presence of organic matter.
- typically effective as a deodorizer
- low to moderate cost.
- poor to limited residual activity.
- not sporicidal.

Quaternary Ammonium Compounds

These are low level disinfectants which contain ammonia (NH₄). Quaternary ammonium (QA) disinfectants are effective against Gram-positive and Gram-negative bacteria, and enveloped viruses. They are not effective against non-enveloped viruses, fungi, or bacterial spores. QA compounds bind to organic material including soaps so the area to be disinfected must be cleaned and rinsed free of soap. Extremely hard water also deactivates QA disinfectants. QA compounds are generally low in toxicity, but since prolonged contact can cause irritation, they should not be used to disinfect instruments.

Summary:

- wide germicidal activity
- non-corrosive
- low toxicity
- effective against vegetative bacteria, fungi and viruses;
- reduced efficiency and residual activity in the presence of organic matter
- not sporicidal
- limited effectiveness in soaps, detergents and hard water salts
- low cost
- good disinfectant for use on cleaned surfaces.

Aldehydes

Aldehydes have a wide germicidal spectrum. Glutaraldehydes are effective against bacteria, viruses, fungi, spores, and protozoa and can be used, at proper concentrations, as a high level disinfectant. They have a moderated residual activity and are effective in the presence of moderate quantities of organic material. They are extremely irritating to skin and mucous membranes.

Formaldehydes are used as sterilants rather than disinfectants. They can be highly toxic, are known to be carcinogenic, are strongly irritating, and have a pungent odour. Use them only as a last resort and then only under trained supervision in a well ventilated setting. These should not be used as environmental surface disinfectants.

Summary:

- wide germicidal activity
- sporicidal
- fungicidal
- effective against protozoa
- moderately toxic
- poses a human health risk if improperly used
- slight to moderate efficiency in presence of organic matter
- slight residual activity
- moderately expensive.

Summary of Activity of Common Environmental Disinfectants

| | Bacteria spores | Bacteria vegetative | Viruses enveloped | Viruses non-enveloped | Fungi |
|---------------------|-----------------|---------------------|-------------------|-----------------------|-------|
| Disinfectant | | | | | |
| Hypochlorites | √ | √ | √ | √ | √ |
| Iodine/iodophors | √ | √ | √ | √ | √ |
| Alcohols | | √ | √ | | |
| Oxidizing agents | √ | √ | √ | √ | √ |
| Phenolics | | √ | √ | | |
| Quaternary ammonia | | √ | √ | | |

Step 2:

Choose the disinfectant(s) that work best in your environment

Consider asking the following:

- Is the product an effective cleaner?
- How long does it take to work?
- How safe is it to use?
- Is it safe for the environment?

Disinfectant effectiveness depends on many factors. These include:

- Type of contaminating microorganism. Each disinfectant has unique antimicrobial attributes.
- Degree of contamination. This affects the time required for disinfection and the amount of chemical required.
- Amount of protein-containing material present. Protein-containing materials absorb and/or inactivate some chemical disinfectants.
- Activity in organic matter and other compounds such as soaps.
- Type of chemical. It is important to understand the mode of action in order to select the appropriate disinfectant.
- Concentration and quantity of chemical. It is important to choose the appropriate concentration of active ingredient and to use the appropriate quantity of disinfectant solution for each individual disinfection situation; follow manufacturers' directions.
- Contact time and temperature. Sufficient time and appropriate temperature, both of which depend on the degree of contamination, must be allowed for effective action of the disinfectant.
- Residual activity and effects on fabric and metal.
- pH and interactions with other compounds.

Step 3:

Write your procedures, train all staff, monitor, and evaluate

When writing your procedures, determine which areas require only cleaning and which require disinfection, based on the considerations outlined in this article. Train staff on the difference between cleaning and disinfection. Audit the disinfection and cleaning systems and make changes as needed.

Once you have chosen the cleaners and disinfectants, ensure that staff read and follow all label directions. Consider installing a dispensing system that automatically dilutes the concentrated product with water. If you have questions, contact the chemical manufacturer.

Contact your regional OSACH consultant or local public health department for assistance in setting up an infection control committee. Visit the web sites of Health Canada and the Ministry of Health and Long Term Care for more information on infection control practices.

Definitions:

Antiseptic: a chemical used to inhibit or prevent the growth of microbes on living tissue.

Cleaning: the removal of visible debris and organic matter using water, detergent and mechanical action.

Detergent: a water-soluble cleansing agent which combines with impurities and dirt to make them more soluble.

Disinfectant: a chemical used to inhibit or prevent the growth of disease-producing microorganisms.

Sanitize: reduce the number of microbes to a safe level.

Sterilize: inactivate or kill all microbes.

Bactericide: a substance which kills bacteria.

Fungicide: a substance which kills fungi.

Viricide: a substance which kills viruses.

Sporicide: a substance which kill spores of fungi or bacteria.

Biocide: a substance which kills living organisms.

Bacteriostat: anything that inhibits the growth of bacteria.

Low level disinfection: disinfection of non-critical items and environmental surfaces. Low level disinfectants will kill most vegetative bacteria, some fungi, and the enveloped viruses. It is generally considered the least effective disinfection process. It does not kill bacterial spores of *Mycobacterium tuberculosis var. bovis*, a laboratory test microorganism that is used to classify the strength of disinfectant chemicals.

Intermediate level disinfection: used in some semi-critical areas or semi-critical items. This destroys vegetative bacteria, most viruses, fungi, and *M. tuberculosis* but not bacterial spores.

High level disinfection: to destroy or decrease level of activity of bacteria (including vegetative), viruses (enveloped and non-enveloped) and fungi in critical areas and on critical items (e.g. invasive medical equipment). It will kill some (including *M. tuberculosis*) but not all bacterial spores.

Web Resources:

OSACH Resource Documents: www.osach.on.ca

Health Canada: www.hc-sc.gc.ca

Ontario Ministry of Health and Long-Term Care: www.health.gov.on.ca

Virox Technologies Inc.: Home Page: www.virox.com

Centers for Disease Control and Prevention: Sterilization or Disinfection of Patient-Care Equipment: HIV Related: www.cdc.gov/ncidod/dhqp/bp_sterilization_patient_care.html

References:

1. Ontario Ministry of Health and Long-Term Care - Emergency Health Services Branch, *Training Bulletin 103 Version 1.1: Severe Acute Respiratory Syndrome (SARS)*, (MOHLTC, March 27, 2003), page 3.

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