Surface Disinfection: What, Why, How

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Accumulated evidence collected over decades has shown that multiples types of contaminated environmental surfaces are important vehicles for healthcare-associated infections (HAIs) caused by microorganisms in hospital facilities. Clinically important pathogens capable of cross-infection by contaminated surfaces include Staphylococcus aureus, noroviruses, Clostridium difficile, and Hepatitis C virus. These and other microorganisms can survive and persist in the environment for prolonged intervals, frequently contaminate hands/gloves of health care workers, and be difficult to eliminate with cleaning and disinfection procedures (Table 1).

In dental settings, treatment areas frequently become contaminated with blood, saliva, and other body fluids during patient care. Viruses such as influenza and rhinoviruses also survive for hours to days after cross-contamination from nasal secretions, and can be passed from contaminated hands. These surfaces need to be cleaned and disinfected when disposable covers are not used. In addition to the documented risk factors described above, another consideration involves an increasing percentage of the population, whereby they have a heightened susceptibility to a variety of microorganisms that are often found in healthcare environments. Think about it - a growing segment of the population is surviving diseases and conditions which cause their immune defenses to become compromised or suppressed.

Microorganism	Persistence Duration
Staphylococcus aureus, including MRSA	7 days – 7 months
Enterococcus sp.	5 days – 4 months
Mycobacterium tuberculosis	2 days – 4 months
Escherichia coli	1.5 hours – 16 months
Clostridium difficile spores	up to 2 years
Noroviruses	8 hours – 7 days
Hepatitis B virus	>1 week (in blood)
Hepatitis C virus	16 hours – 6 weeks (in blood)
Influenza viruses	1 – 2 days

Table 1. Persistence of Selected Microbial Pathogens on Inanimate Surfaces

Thanks to life-saving scientific advances and available clinical treatment opportunities, more of these immune compromised people requiring medical care, as well as those seen in many dental practices, are living, longer, healthier lives. These include survivors of cancer(s), organ transplantation recipients, people diagnosed with diabetes, individuals living with autoimmune diseases (such as Systemic Lupus Erythematosus, Rheumatoid Arthritis), and those dependent on immunosuppressive medication regimens for other reasons, to name a few. As result they are more susceptible to infection from microorganisms can be encountered in multiple settings. With specific regard to healthcare facilities, when one considers the relatively large number of inanimate surfaces that are readily exposed to contaminated body fluids, it becomes apparent that surface disinfection constitutes a major component of an effective infection prevention program. The following article will discuss representative basic guidelines and considerations, which can assist in evaluating and selecting chemical disinfectants for professional use.

Terminology

The distinction should first be made between two fundamental terms, sterilization and disinfection. **Sterilization** is defined as the destruction or removal of all forms of life, with particular reference to microorganisms. The limiting and basic requirement for sterilization is the destruction of bacterial spores. **Disinfection** is characterized by the destruction of pathogenic and other microbial forms by physical or chemical means. Disinfection is less lethal than sterilization, because it destroys most recognized pathogenic microorganisms, but not necessarily all microbes (i.e. bacterial spores). Thus, disinfection does not ensure the margin of safety achieved with sterilization. In addition to disinfection, infection prevention guidelines also recommend use of disposable covers in certain instance; however, this area will not be considered in the present discussion.

Regulation and Registration of Commercially-Available Surface Disinfects

Each year a variety of new environmental surface disinfectant products become available for clinical use. In the United States, all disinfectants are regulated and registered with the Environmental Protection Agency (EPA). The EPA has authority to regulate these antimicrobial preparations under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), first passed in 1947. The original legislation was amended several times, most recently by the Food Quality Protection Act of 1996. Basic requirements from FIFRA include manufacturers registering each pesticide and its label with EPA before it can be available for commercial use. The EPA is charged with reviewing and approving submitted data for efficacy and appropriate application for use. Accepted methods of testing chemical formulations against specific microbial pathogens, chemical stability, and toxicity to animals and humans must be submitted by manufacturers to substantiate the product's disinfection claims. Manufacturers are also not allowed to make any product claims which have not been approved as stated on the EPA-approved label. It is important to note that while the EPA regulates disinfectants used on environmental clinical contact and housekeeping surfaces, chemical sterilants/high-level disinfectants are regulated by the Food and Drug Administration (FDA) for use with critical and semi-critical devices that are not heat sterilizable. Further clarification of the framework for these chemical antimicrobials is discussed below.

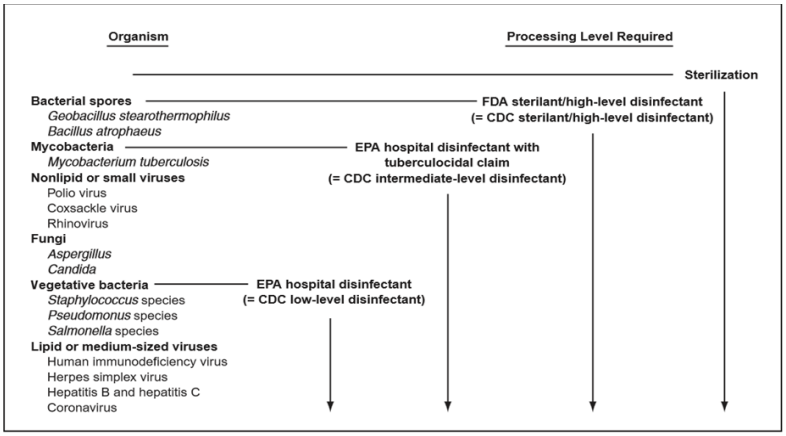
Regulatory Framework for Chemical Disinfectants and Sterilants

Chemical disinfectants and sterilants are classified by the CDC into 3 categories:

1. Low-level: an EPA-registered disinfectant without a tuberculocidal claim. These are chemicals with narrowest antimicrobial range and are also termed hospital-level disinfectants. In order to receive EPA approval, they are required to demonstrate effectiveness against 3 species of test pathogens: Staphylococcus aureus, Salmonella choleraesuis, and Pseudomonas aeruginosa. They may kill a variety of viruses and bacteria, but do not kill tubercle bacteria, a number of viruses, and many fungi.

2. **Intermediate-level**: an EPA-registered disinfectant with a tuberculocidal claim. Although they do not inactivate bacterial endospores, intermediate-level disinfectants kill many other microbial forms, including tubercle bacteria (i.e. Mycobacterium tuberculosis). M. tuberculosis presents a severe challenge to disinfectants, and is routinely used as a test organism because of its resistance. Documented tuberculocidal activity assures the user that the product is an intermediate- or high-level disinfectant, and that it will kill microorganisms currently known to be potential pathogens in dentistry.

3. High-level: FDA-approved chemical agents capable of sterilizing items, but only after prolonged immersion intervals (i.e. glutaraldehydes, hydrogen peroxide, peracetic acid). Treatment of contaminated environmental surfaces does not require use of chemical sterilants or high-level disinfection.
Major distinctions between the chemical categories are shown in Figure 1, taken from the 2003 CDC Guidelines for Infection Control in Dental Health-Care Settings.



Source: Adapted from Bond WW, Ott BJ, Franke K, McCracken JE. Effective use of liquid chemical germicides on medical devices; instrument design problems. In: Block SS, ed. Disinfection, sterilization and preservation. 4th ed. Philadelphia, PA: Lea & Gebiger, 1991:1100.

Figure 1. Decreasing order of resistance of microorganisms to germicidal chemicals (1)

Selecting a Surface Disinfectant:

Although the perfect surface disinfectant product has not yet been developed, advances in the chemistry of recent generations of formulations have resulted in products meet many of the ideal properties and offer increasingly expanded anti-microbial actions (Table 2).

Broad-spectrum of antimicrobial activity: Should have kill claims for the most prevalent healthcare pathogens
Fast-acting: Should have a rapidly lethal action on all forms of targeted microorganisms
Good cleaning properties: Should not be affected by physical factors, such as blood, saliva, and exudate
Nontoxic to users and patients
Surface compatibility: Should not compromise the integrity of fabrics, dental equipment, metallic surfaces
Residual antimicrobial effect on treated surfaces
Easy to use: Should be available in multiple forms, such as sprays and wipes, pull tops, and refills. Disinfectant wipes should also be made of a durable substrate that will not tear or dry out quickly
Acceptable odor to users and patients
Eco-friendly: Should not be able to form chemical residues which can potentially harm natural environmental systems
Economical: Cost should not be prohibitively high

Table 2. Properties of an Ideal Disinfectant

Representative Suggestions for Disinfection Selection and Use:

1. Compare properties of the disinfectant being considered to criteria for an "ideal" agent.
2. Healthcare workers should wear OSHA Bloodborne Pathogen Standard personal protective equipment (i.e. utility gloves, mask, protective eyewear, long sleeve clinic attire) when performing infection control procedures.
3. A fundamental rule to follow for surface asepsis and other infection control procedures is to "clean it first." Cleaning is the first step for sterilization or disinfection of contaminated clinical items and surfaces. Removal of visible soil and organic debris, accomplishes a reduction in both the of number microorganisms and removal of blood, saliva, tissue, and other organic material, which can interfere in the subsequent infection control procedure. Although separate cleaners and disinfectants may be used effectively, chemical agents that can accomplish both functions offer increased efficiency. Traditionally, this sequence has been described as "spray-wipe-spray." Many disinfectants are now also available as either liquid sprays or disinfectant wipes, and so the modified term used is "wipe-discard-wipe." The EPA has approved the commercial use of disinfectant wipes, which have been shown to be effective in reducing microbial counts when used as directed. Although these wipes are excellent choices to reduce aerosols created by spray disinfectants, they can potentially transfer bacteria to other surfaces is they are reused.
4. Read the label. Products must be used in strict compliance with printed instructions on the labels. As an example, some preparations are able to accomplish both cleaning and disinfection, while others require another cleaning agent to remove organic debris. Ignoring instructions can reduce a disinfectant's effectiveness.
5. For a hospital-level disinfectant with a tuberculocidal claim, the product should state on the label that it kills Mycobacterium tuberculosis.
6. After application of disinfectant on cleaned surfaces, keep surfaces wet for the recommended kill time on the label. Since approval of a tuberculocidal claim requires the most stringent testing, accomplishing that bactericidal activity infers destruction of other, less resistant pathogens included in the product's antimicrobial spectrum.

Concluding Remarks

Healthcare personnel have many available disinfectant choices. The present brief discussion focused on selected areas, aimed at assisting in the selection and appropriate use environmental surface disinfectants. In addition, the effectiveness of any spray or wipe formulation is dependent on several factors, including: 1) nature and concentrations of contaminating microorganisms; 2) antimicrobial spectrum and concentration of the active chemical(s); 3) exposure time for antimicrobial action; and 4) amount of accumulated bioburden. It is important to obtain as much relevant information as possible before purchasing a product. Hopefully, that approach will allow for decisions to be made using appropriate efficacy criteria, as well as augment infection prevention efforts of responsible clinical personnel.

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