Cleaning for Health Report 2012/2013

S.H. Dalwadi & J.H. Simmonds

This is the second edition of the Cleaning for Health Report 2011/2012.

On 9th February 2011, the World Federation of Building Service Contractors (WFBSC) resolved to make Cleaning for Health a key priority in the coming years. The Cleaning for Health project has defined the role of the cleaning industry in the promotion of public health.

Cleaning is our first defence against the ongoing threat of ósuper bugsö, influenza viruses, and more recently *E.coli* , *C.difficile*, Methicillin-resistant *Staphylococcus aureus* (MRSA) and Vancomycin-resistant *Enterococcus* (VRE) outbreaks. In healthcare settings the importance of cleaning, disinfecting and sterilizing is widely accepted and its implementation is usually strictly enforced.

However, outside the healthcare environment and within community settings such as schools, offices, retail, hotels, public transport etc; the value of cleanliness is less understood.

In this report you will find relevant information on each of the most prevalent disease causing microbes that threaten community health today and information on how to safely eliminate them from various surfaces and environments.

We provide two charts; one comparing the most commonly used disinfectants suitable for routine environmental cleaning; and the other providing important details on widespread and established community-associated infectious diseases.

As part of the written report we address important topics of concern such as; how do we know if an area or environment is clean? How do we measure cleanliness? What is an acceptable level of microbial contamination on an environmental surface?

We have also provided clarity on contentious issues such as when a detergent is sufficient to clean a particular environment or surface, and when disinfection or sterilization is required. Within this report and in the associated setting-specific guidelines which can be accessed through our website (www.cleaning-for-health.org), we have broken down environmental surfaces into two groups; noncritical surfaces and critical surfaces. Noncritical surfaces carry a low risk of infection transmission and generally can be cleaned with detergent alone. Critical surfaces however, which are often frequently touched, carry a high risk of infection and generally require low-level disinfection or sterilization.

Another controversial issue that our research has unearthed is the use of sodium hypochlorite or bleach in routine commercial cleaning. Bleach kills most microbes, including spores at high concentrations, and it is currently the most commonly used disinfectant within the cleaning industry. It works fast, effectively and is non-discriminatory between different microbes. However, cleaning contractors are reluctant to use bleach due to the health risks associated with chlorine inhalation and the long-term damage it can cause to surfaces. We have thoroughly assessed the advantages and disadvantages of using bleach and as part of the Disinfection Chart we have compared bleach alternatives.

Addressing essential criteria of reduced toxicity and increased cleaning efficiency through thorough research, Accelerated Hydrogen Peroxide (AHP) technology has proved to be a promising alternative to bleach. It can be used as an effective disinfectant for both critical and non-critical surfaces with varying concentrations. It possesses fast and effective broad spectrum antimicrobial activities against spores, mycobacteria, viruses, fungi and bacteria. The AHP formulation is also highly safe and biodegradable, along with high surface compatibility and shelf life. We have also identified steam vapour systems and microfibers as effective disinfection techniques for routine cleaning.

In addition to this, we have compiled an approximate estimation of listings of the amount of EPA registered antimicrobial products against various classes of diseases (i.e.; Norovirus, Human HIV-1, Mycobacterium, C. difficile, etc) in the form of a Product Chart. This enables us to highlight information on disease specific antimicrobial products and to recognise which antimicrobial technology is most popular (highest number of registered products) among each of the classes of diseases.

Adherence to contact times is not always strictly enforced within the cleaning industry. The contact time of a disinfectant required to kill a population of microbes should be listed on the chemical container by the manufacturer. Contact times can vary however, dependent on different factors such as microbial loading. We have explored this issue and developed recommendations.

Contamination of cleaning equipment is a significant and often overlooked impediment to cleaning procedure. If cleaning solutions, particularly those only containing detergent, are used for more than one hour the likelihood of the procedure actually spreading infectious agents around the environment is high. In this report we have suggested practices to avoid this contamination.

In this project we aim to place the WFBSC as a central source of information on cleaning for the control of infection.

Contents:

1.0 The Value of Cleaning

In the event of an outbreak of a new pandemic strain of disease, it would be very unlikely that a specific vaccine would be ready to inoculate the public during the first wave of the disease. In addition, there may not be sufficient quantities of antimicrobial medications available. Instead, governments and councils will have to focus their efforts on the prevention of transmission of the disease. This would involve rigorous cleaning and decontamination processes; not only in hospitals, but in public areas, which are vital to stemming the spread of infection.

Through our high-density living in urban areas and the increased resistance of microbes to antibiotics, the role of the cleaning industry in curtailing public health disasters has never been so important.

To reduce the risk of infection transmission within our public spaces we must combine good standards of personal hygiene such as washing our hands before we eat and covering our mouths when we cough, with good standards of environmental cleanliness to prevent the initial contamination from dirty surfaces.

2.0 WFBSC Cleaning For Health Project

The WFBSC has amassed peer-reviewed scientific data from governmental bodies and international organisations, such as the CDC[1], WHO[2], HICPAC[3], OSHA[4], HSE[5], HPA[6] and EPA among others; regarding the most effective methods to prevent the spread of infection in the community. We have identified gaps in our existing knowledge and have proposed further studies to address them.

In this report and on our website (www.cleaning-for-health.org), we provide evidence and advice to cleaning contractors and clients which they can implement into their procedures when required.

Centers for Disease Control and Prevention[1], World Health Organisation[2], Healthcare Infection Control Practices Advisory Committee[3], Occupational Safety & Health Administration[4], Health and Safety Executive[5], Health Protection Agency[6]

3.0 Introduction

This is the second edition of the Cleaning for Health Report dated April 2013. Significant changes from the first edition include:

- the use of evidence published since August 2012
- updating of some of the areas of the report covered by information from Centers for Disease Control and Prevention (CDC)
- updating associated setting-specific guidelines and Disinfection Chart on our website (www.cleaning-for-health.org)

We have, as with the second edition:

- identified current practises in achieving a scientific standard within the cleaning industry
- included thorough research on bleach alternatives with specific recommendations for the cleaning industry based on reduced toxicity, lower contact times and increased efficiency
- identified Accelerated Hydrogen Peroxide (AHP) technology as a viable bleach alternative and assessed its advantages within community settings
- introduced steam cleaning and microfibers as new disinfection techniques
- introduced a Product Chart consisting of an approximate estimation of listings of the amount of EPA registered antimicrobial products against various classes of diseases
- used qualitative evidence where appropriate

4.0 Pathogens Threatening Public Health

The emergence of disease causing pathogens is of increasing concern to the general public and infection-control professionals. Described as emerging pathogens, these can be indirectly transferrable through contact with contaminated surfaces (with the exception of Human HIV-1 virus).

Common pathogenic bacteria include *H. pylori*, *E. coli*, *C. difficile*, *Acenatobacter sp*, methicillin-resistant *S. aureus* (MRSA), multidrug-resistant *M. tuberculosis (*MRMT*),* non-tuberculosis mycobacteria (e.g., *M. chelonae*), and *S. pneumonia*.

Common pathogenic viruses include Hepatitis A virus (HAV), rotavirus, norovirus, common cold virus, influenza viruses such as H1N1 (swine flu) & H5N1 (bird flu), severe acute respiratory syndrome (SARS) coronavirus and Coxsackie A virus. The recent bird flu virus strain (H7N9) is also of increasing concern as it has been reported to infect humans via poultry-to-human transmission and is difficult to track.

Common pathogenic fungi and parasites include Aspergillus, Ringworm and *C. parvum*.

Details on the susceptibility of all emerging pathogens to chemical disinfectants and sterilizers has been studied and presented in the Pathogen Chart attached.

We are now facing novel threats to public health that have emerged from C. difficile and community-acquired MRSA (CA-MRSA) infections that were previously only contracted within healthcare settings. The CA-MRSA strain has become epidemic in many communities worldwide. The skin and soft tissue infection caused by CA-MRSA, has been seen in young and healthy individuals, indicating that the strain could be more infectious than its healthcare-associated counterpart.

5.0 Modes of Transmission:

There are several modes of transmission of these pathogens:

Droplet contact transmission: Some diseases can be transferred by infected droplets contacting surfaces of the eye, nose or mouth. Droplets containing microorganisms can be generated when an infected person coughs, sneezes or talks. Examples of diseases contracted through droplet contact transmission include SARS, the common cold, Legionnaires', Hand foot and mouth disease and MRSA.

Airborne Transmission: Some droplet nuclei (residue from evaporated droplets), or dust particles containing microorganisms can remain suspended in the air for long periods of time. These organisms can enter the upper and lower respiratory tracts. Diseases contracted through airborne transmission include chickenpox, measles, tuberculosis and aspergillosis.

Faecal-oral transmission: Microbes can enter the body through ingestion of contaminated food and water. These may multiply within the digestive system and shed from the body in faeces. Ineffective hygiene and sanitation practices result in these microbes contaminating food, water or environmental surfaces. Diseases contracted through faecal-oral transmission include *E.coli*, *Cryptosporidium, C. difficile,* hand foot and mouth disease, *H. pylori*, rotavirus and hepatitis A virus (HAV).

Direct contact transmission: This requires physical contact between an infected person and a susceptible person for the physical transfer of microbes. This may be through kissing, sexual contact or just through close contact living i.e. between individuals of the same household. Diseases contracted through direct contact transmission include Acinetobacter, *E.coli*, SARS, the common cold, ringworm and other fungal infections, scarlet fever, norovirus, hand foot and mouth disease, *H. pylori*, MRSA, H1N1 virus and hepatitis A virus (HAV). Direct physical contact between infected poultry and susceptible humans has also known to cause the transmission of viral strains such as H5N1 and H7N9. While H5N1 virus kills infected poultry, H7N9 virus transmits to humans without making the poultry sick, leading to difficulties in tracking the virus.

Indirect contact transmission: This occurs when a susceptible person comes in physical contact with contaminated surfaces via hands, and then touches their face, eyes or mouth, allowing the pathogen to enter the body and cause infection. Diseases contracted through indirect contact transmission include norovirus, *C. difficile,* MRSA, SARS*, E.coli, Cryptosporidium,* ringworm and other fungal infections, scarlet fever, hand foot and mouth disease, *rotavirus,* hepatitis A virus (HAV) *, influenza, A*cinetobacter, the common cold, *H. pylori* and tuberculosis. These microbes can survive on surfaces for extended periods of time; therefore, it is important to reduce surface contamination through cleaning and disinfection.

6.0 Achieving a Scientific Standard:

There is abundance of evidence supporting the role of environmental cleaning in public and commercial areas to control the spread of infectious diseases. Hence, it is important to integrate measurement of the cleanliness in the form of a scientific standard.

In recent years, hand-held and other inexpensive devices have been introduced in the cleaning industry that can measure both surface and aerial pathogens, providing instant measurement of cleanliness. Improvements in cleanliness measurement have been possible with the use of measuring tools and well-chosen metrics such as ATP (adenosine triphosphate) meters or particle counters.

These methods have improved function as compared to the traditional visual assessments (or ñwhite glove testsò) based under the assumption that if it looks clean, it must be clean. Pathogens are microscopic; hence a visually clean environment can still pose a health risk.

ATP meter or particle counter provides instant information on levels of contamination. These are portable devices which are easily affordable, provide accurate reading and can be used in both commercial and public settings. In this method, prior cleaning of the environmental surface is performed using a cotton swab which is then inserted into the meter and resulted are displayed within seconds on the screen.

Early predecessors of the improved technology relied on evaluating cleanliness with the help of swabs taken from environmental surfaces and subjecting them to laboratory techniques of measurement. In this method, the environmental swabs are taken in a microbiological or chemical laboratory, placed into growth culture media and evaluated for presence of pathogens. In a microbiological laboratory, the evaluation is based on counting the microscopic pathogen colony numbers and comparing them to a scientific standard which they must not exceed. In chemical (or ATP bioluminescence) method, the swab is placed in trichloroacetic acid solution followed by luminometer to measure contamination. This technology was extensively used in healthcare in the late 60s and early 70s. Despite its accuracy, this method can be quite costly and takes days to deliver results disease (Armadans et al, 2013; Burkat et al, 2010; Binnig et al, 2007; Heim et al, 2008).

The internationally specified acceptable microbial count on food-processing equipment is <5 cfu/cm^2. This could also be used in community settings on areas which pose the greatest risk to individuals such as high touch surfaces; particularly in bathrooms. This could be used to gauge the effectiveness of a certain cleaning procedure. If the microbial count exceeds this level then a review of cleaning and disinfection practices and frequencies can be conducted to improve the quality of service. A second sample could be taken after the revised cleaning procedure has been implemented to test its effectiveness.

This environmental screening ensures that resources are not wasted on areas of low infection-transmission risk, but instead attention is focussed only where it is necessary. This ñtargeted hygiene conceptò is supported by the International Scientific Forum on Home Hygiene (IFH) as a means of reducing the social and economic burden of infectious.

7.0 Detergent, Disinfectant or Sterilizer

A controversial issue within the cleaning industry has been the appropriateness of using detergents, disinfectants or sterilizers within various community settings.

We have included a brief comparison between detergents, disinfectants and sterilizers based on their cleaning function and efficiency, environmental impact, cost, and toxicity.

Detergents:

- Effective on noncritical surfaces that contribute minimally to infection transmission
- Minimal damage to environmental surfaces and no issues with disposal
- No occupational health exposure issues
- Low costs
- May be contaminated quickly

- Do not possess persistent antimicrobial activity, thereby only removing microbes rather than killing them
- Their residues can serve as food sources to microbes
- Require manual input involving rubbing and scrubbing for their full efficacy
- Good at removing organic soil such as fool spills, chemicals and other commercial wastes
- Unsuitable for cleaning potentially infective material such as blood or other body fluids
- Inefficient against bacterial spores such as that of *C. difficile*

Disinfectants:

- Effective on both noncritical and critical surfaces with varying concentrations
- Capable of significant damage and degradation of environmental surfaces and hence, have some disposal issues
- Can be toxic and pose occupational health risks
- Higher costs
- More effective than detergents in microbial load reduction
- Some newer disinfectants possess persistent antimicrobial activity
- Poor at removing organic soil particles and require prior cleaning through detergents
- Required for cleaning potentially infective material such as blood or other body fluids
- Some effective against bacterial spores such as that of *C. difficile*

Sterilizers:

- Effective on all environmental surfaces, but used mainly on critical surfaces
- Capable of significant damage and degradation of environmental surfaces and hence, have some disposal issues
- Suitable in industrial, laboratory and hospital environments, and not practical for day-to-day cleaning
- Can be highly toxic and pose occupational health risks
- Highest costs
- Most effective in microbial load reduction, as they kill all microbes including *C. difficile* spores
- Use heat, chemicals, irradiation, filtration and high pressure for eliminating microbial load
- Very effective in cleaning potentially infective material such as blood and other body fluids

8.0 Guidelines for Decontaminating Environmental Surfaces

These guidelines are suitable within office, school, retail, public transport, hotel & cruise ships, childcare, and care and nursing home settings in the event of a disease outbreak. Individual pdf documents summarising the safe and effective decontamination of each of these environments can be found through our website (www.cleaning-for-health.org).

8.1 Noncritical Surfaces

Not all areas within community settings require disinfection; cleaning with a detergent may be sufficient. Minimal risk has been associated with transmission of infectious agents to individuals through noncritical environmental surfaces such as furniture and floors, when they do not contact broken skin and/or mucous membranes.

However, detergents are prone to becoming contaminated and may further contribute the pathogen transmission process across the environmental surface. It is therefore, important to regularly use fresh solutions, at least once an hour. Detergent residues that are left exposed after cleaning may contain organic compounds which bacteria thrive in. Moist environments also favour the growth and persistence of gram-negative bacilli and fungi, therefore all areas must be thoroughly dried after cleaning.

Despite these risks, there are no studies which have found differences between infection rates when floors are cleaned with detergents rather than disinfectants. It can be concluded that routine cleaning with a detergent is sufficient to prevent disease transmission from noncritical environmental surfaces such as furniture and floors in most public spaces except those where there is frequent floor contact, such as in crèches and nurseries. In these settings, low level disinfection is recommended.

8.1.1 Flooring

Floors can become contaminated with microbes from settling airborne bacteria, or by contact with shoes, wheels and other objects. Spills of organic matter can become reservoirs for the microbes to colonize, and hence their removal is essential for maintaining a clean and safe public environment.

Cleaning floors with detergent and water tends to reduce bacterial counts by ~80%. However, the mop water becomes increasingly contaminated during this process and serves as a medium for the spreading of the microbes around the environment, and therefore should be changed for fresh detergent solutions hourly.

Using disinfectants for floor decontamination achieves a higher microbial kill than using detergents alone. However, a few hours after disinfection, the microbes usually re-establish themselves to pre-treatment levels, and hence detergent cleaning may be sufficient. In presence of organic matter, additional low-level disinfection is recommended after detergent cleaning in order to kill any microbes present in the soiling.

Hard Flooring

- Methods for cleaning non-porous floors include wet mopping and wet vacuuming, dry dusting with electrostatic materials, and spray buffing
- Floors should be vacuumed and wet mopped daily
- Methods that produce mists, aerosols or cause dispersion of dust should be avoided as these can kick up pathogen-containing dust and allergens into the atmosphere which may be inhaled
- It is advisable to equip vacuums with HEPA filters, especially for the exhaust. Bacterial and fungal contamination of filters in cleaning equipment is inevitable, and these filters should be cleaned regularly or replaced as per equipment manufacturer instructions

Carpets

- Carpets harbour more pathogens than hard floors, but no studies have shown differences between infection rates associated with the surfaces
- Those with high levels of activity in classrooms, office settings, conference rooms, shop floors and communal rooms in care homes require vacuuming daily and a full clean every six months or immediately after a spillage
- Soiled carpeting that remains damp or wet provides an ideal setting for the proliferation and persistence of gram-negative bacteria and fungi
- The soiling should be cleaned immediately. If organic matter is present it should be disinfected after removing the material mechanically with a detergent
- Carpeting that remains damp for 72 hours should be removed
- Wet vacuuming is more effective than dry cleaning at removing fungi such as aspergillosis

8.1.2 Soft Furnishings

These include curtains, chairs and pillow covers which can harbour pathogens/allergens that have settled on their surface from airborne bacteria, from contact with peopleǿs hands or clothes, or from spills of organic matter. In the event of an outbreak of disease these surfaces may require cleaning to remove harmful microbes from the environment.

- Soft furnishings that are likely to get soiled (e.g., in nursing homes, nurseries or schools) should be covered with material that is wipe-clean and impermeable. Chairs should be fully cleaned daily with a detergent. If soiling is present, then the surface will require additional disinfection after removing the organic material mechanically with a detergent.
- Laundering on a thermal disinfection cycle that achieves a temperature of 65ŬC for 10 minutes is the most effective method of decontamination.
- Soft furnishings that cannot be laundered should be steam cleaned or cleaned using a detergent solution followed by drying.
- If soiled, the fabric can be sprayed with 3% hydrogen peroxide after cleaning with a detergent.
- Allergens (e.g., dog and cat dander) have been detected in or on cloth furniture from visitorǿs clothes. Dust containing Acinetobacter, CA- MRSA, Aspergillosis and other fungi can also be found on cloth furnishing. Researchers have therefore suggested that cloth chairs should be vacuumed regularly to keep the dust and allergen levels to a minimum.
- Curtains should be commercially laundered every six months unless they are visibly soiled in which case, they should be laundered.

8.1.3 General Environmental Surfaces

- It is important to physically remove microbes and soil by wiping or scrubbing in addition to using a cleaning agent. Spraying cleaning agents should only be used if it is impossible to reach a certain area.
- Dry conditions favour the persistence of gram-positive cocci (e.g., coagulase-negative *Staphylococcus* spp.), acinetobacter, CA-MRSA, aspergillosis and other fungi in dust and on surfaces. Damp-dusting using clean cloths moistened with detergent are recommended for noncritical surfaces.
- Moist environments favour the growth and persistence of gram-negative bacilli and fungi, therefore after cleaning all surfaces must be thoroughly dried.

8.1.4 Specified Surfaces

- All parts of radiators (including between panels) should be visibly clean and free from dust, dirt, debris and spillages. They should be fully cleaned weekly.
- All parts of fans and air conditioning units including the blades/fins and the underside, should be visibly clean and free from dust, dirt and debris. They should be dusted weekly and fully cleaned annually.
- All wall fixtures such as switches, sockets or data/computer points should be visibly clean and free from dust, dirt, debris and spillages.
- Doors and door edges should be visibly clean and free from dust, dirt, debris and spillages. High touch areas such as handles and push plates should be cleaned and disinfected daily. The door should be fully cleaned weekly.
- Ventilation grilles, extractors and inlets should be visibly clean and free from dust, dirt, debris, or cobwebs. They should be dusted weekly and fully washed annually.
- Kitchen cupboards should be visibly clean and free from dust, dirt, debris, or cobwebs. They should have a full external clean weekly and full internal clean monthly.
- Unused taps or shower heads should be run at least once a week for 10minutes for Legionnairesô risk control.
- Walls and ceilings do not need to be washed more than once every 6 months with hot water and detergent unless they are visibly soiled.

8.2 Critical surfaces

These are environmental surfaces that pose a risk of disease transmission and require low-level disinfection are frequent hand-touch sites such as door handles, taps, keyboards, telephones, toys, light switches etc. These can be identified through environmental screening using a fluorescent marker. A paediatric unit seeded pieces of cauliflower mosaic virus onto a telephone and tracked its movement around the unit from hand-touch site to hand-touch site. This identified the areas that required disinfection.

The identification of high-risk areas follows the same principles as used in the food industry laid out by Hazard Analysis Critical Control Point (HACCP) as a method of infection prevention during production by eliminating risk.

8.2.1 Choosing a Disinfectant

Factors to be taken into account when choosing disinfectants include:

- Compliance with chemical safety regulations for the safety of cleaning personnel
- Material compatibility- some disinfectants can corrode or discolour certain surfaces
- Antimicrobial activity- does it have a wide antimicrobial spectrum?
- Contact times- what is the minimum exposure time a disinfectant requires for reducing microbial load by ~99.9%
- Storage and shelf life- Does it rapidly decay?
- Disposal- Are there disposal issues? Is it toxic to the environment?
- Prior cleaning- Is it effective in the presence of organic matter?
- Temperature/pH- does temperature and pH affect the disinfection process?
- Cost

- Availability
- Contamination risk- how frequently will it require preparation of fresh solutions?

8.2.2 List of suitable Disinfectants for Routine Cleaning

Below are some of the most commonly used and EPA-registered disinfectants:

- Ethyl or isopropyl alcohol (70-90%).
- Sodium hypochlorite or bleach (5.25-6.15% household bleach diluted 1:500 provides >100 ppm available chlorine)
- Phenolic germicidal detergent solution (follow product label for use-dilution)
- Iodophor germicidal detergent solution (follow product label for use-dilution)
- Quaternary ammonium germicidal detergent solution (follow product label for use-dilution).
- Hydrogen peroxide (3-7.5%) in low concentrations

For detailed information on these disinfectants see the disinfection chart attached.

Sodium Hypochlorite or Bleach

There seems to be a disparity between the use of sodium hypochlorite (bleach), recommended by government guidelines, and the avoidance of its routine use by cleaning contractors and clients.

Bleach is widely endorsed by national and international guidelines due to its wide antimicrobial spectrum consisting of varying dilutions (Concentrations of 2-500 ppm exhibiting low level disinfection, concentrations of 1000-1500 ppm for the removal of biofilms and concentrations of 1600-2500 ppm exhibiting high level disinfection and sporicidal activities).

It is fast acting, inexpensive, does not leave toxic residues, unaffected by water hardness (unlike Quaternary Ammonium Compounds) and contains minimal disposal issues. Therefore, it is highly used in hospitals and catering businesses.
However, it also comes with plenty of draw backs which prevent its use in routine cleaning:

- It can irritate mucous membranes, eyes, skin and can trigger asthmatic symptoms through prolonged exposure.
- If mixed with ammonia or acid, (e.g., other household cleaning agents) toxic chlorine gas is released, which is very harmful upon inhalation.
- It is toxic to aquatic organisms.
- It is corrosive to metals in high concentrations (>500 ppm) and will discolour fabrics.
- It is inactivated by organic matter therefore prior cleaning with a detergent is essential for full efficacy.
- Is rapidly inactivated by light and some metals, hence requires regular preparation of fresh solutions (24 hours). A bleach solution in tap water at a pH >8 stored at room temperature (23ºC) in closed, opaque plastic containers can lose up to 40%ï 50% of their free available chlorine levels over 1 month.

As mentioned earlier, low level disinfection, such as that of bleach, is only required on frequent hand-touch sites and critical surfaces. Therefore, problems associated with exposure to toxic chemicals could be avoided through rotation of staff and appropriate use of personal protective equipment. It is essential that the area being cleaned is well ventilated and a COSHH assessment must be carried out.

Due to the drawbacks, potential bleach alternatives for routine disinfection that handle issues of cost, toxicity, efficiency and sporicidal activity are ever demanding.

8.2.3 Alternatives to routine chemical disinfectants

Accelerated hydrogen peroxide (AHP)

Accelerated Hydrogen Peroxide (AHP) based technology has been developed for disinfection of both non-critical and critical environmental surfaces, and addresses various drawbacks of hydrogen peroxide (HP) such as high toxicity, relative instability and slow microbicidal action. It has been Food and Drug Administration (FDA) approved and possesses the lowest EPA toxicity category (i.e.: Category IV) amongst suitable disinfectants based on its oral, inhalation and dermal toxicities. It contains low levels of anionic and/or non-ionic surfactants, stabilizers and other excipients added to the standard HP formulation, producing effective microbicidal activity.

Some of its common features include:

- Prepared with varying concentrations- low concentration (0.5%, 1.4%) AHP for non-critical surfaces and patient care equipment, while high concentration (>2%) AHP for critical surfaces, frequent hand-touch sites and medical devices.
- Has been formulated for reuse for a distinct period of time (14-30 days depending upon the formulation). During such simulated reuse, AHP displays minimal reduction in microbicidal activity, thereby reducing the risk of spreading diseases.
- Possesses broad spectrum antimicrobial activity (sporicidal, mycobacterial, fungicidal, virucidal and bactericidal), and is hence, effective against both envelope and non-envelope recipients.
- Usually found in the form of a solution, with the exception of the sporicidal gel which is highly viscous and forms a uniform layer surrounding the target spores.
- Possesses high safety and biodegradability profile as it is free from aquatic toxicants such as non-phenyl ethoxylates (NPEs) or alkyl phenyl ethoxylates, and the levels of release in volatile organic chemicals (VOCs) are well below the detectable limits of the standard.
- Easily decomposed to oxygen and water, preventing any environmental issues by entering into sewage or wastewater systems.
- Their EPA registered contact timings vary from 30 seconds to 10 minutes, depending upon the surface, dilution and formulation used - substantially less than most EPA registered low level disinfectants.
- Free from inhalation issues and can be used in a simple cold soak application.
- Has low corrosivity and therefore, possesses high material compatibility with zero damage to mild steel, stainless steel, brass, copper, chemically resistant polymers or rubbers, anodized aluminium and various metals.
- Is non-fixative and has a good shelf life.

With an increase in environmental contamination and spread of disease carrying microbes, disinfectants with maximum antimicrobial activity, reduced toxicity and increased stability are ever demanding. AHP technology has addressed these issues and can now be considered as a potential alternative to high levels of bleach based products, aldehydes, chlorine and quaternary ammonium compounds (QUAT).

Steam Vapour Systems

Recent advancements in steam vapour technology has dramatically reduced the size of steam generators into portable devices that renders steam disinfection of environmental surfaces much more practical. They exhibit exceptional broad spectrum antimicrobial activities against both enveloped and non-enveloped species, and require nothing more than water and heat, which causes decreased toxicity and chemical irritation when used around critical surfaces, as compared to liquid chemical disinfectants. The disinfection process occurs quickly and independently of the heat retention properties of the environmental surfaces. The steam device is particularly non-hazardous when proper cleaning protocols are followed.

One of the greatest advantages of using steam vapour system is that it eliminates the risk of cross-contamination as no residual chemicals are left behind on the surface. It efficiently removes microbial load well below the EPA detection limit with average contact time of 5 seconds without producing any toxic by-products. The use of chemical disinfectants usually requires a pre-cleaning step for the removal of organic matter, which often interferes with the effectiveness of disinfection protocols. In contract, steam vapour systems are dependent on heat; therefore, the presence of organic matter does not interfere with the disinfection efficacy. However, depending on the equipment chosen, they should only be used in well-ventilated areas as accumulation of condensate could damage the internal fabric.

There are however, some fundamental problems associated with using steam for decontamination of frequent hand-touch sites and critical surfaces:

- The temperature of steam at the point of contact is high but may dissipate quickly depending upon the conductivity of exposed surfaces, leading to lack of disinfection.
- Certain microbes find habitual dampness of the environment an excellent inducement for survival.
- Super-heated steam may leave residual water on exposed surfaces and floors, increasing the risk of slips and falls.

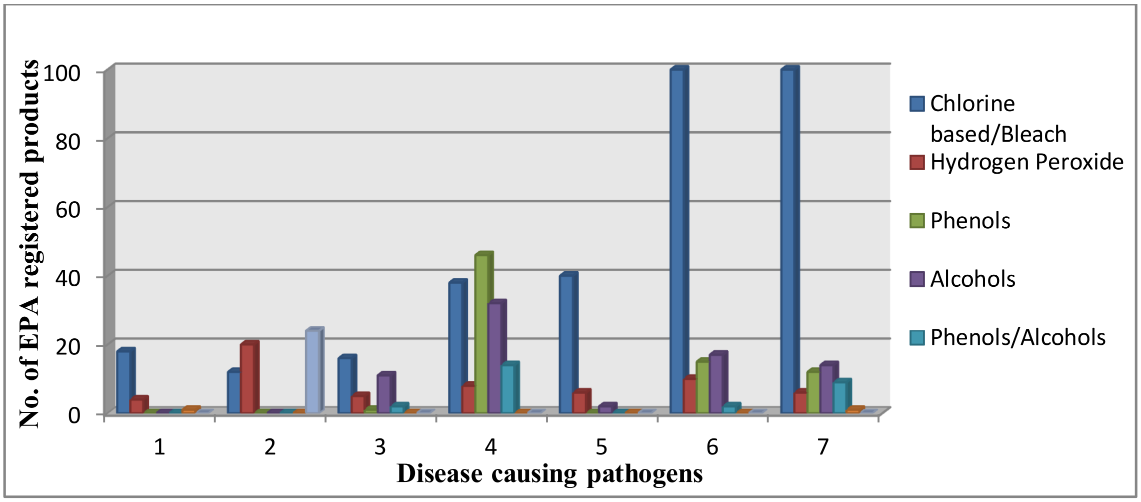
Microfibers

Researchers have recommended the use of microfiber materials to clean all surfaces including floors. Microfibers are positively charged (containing polyester and nylon) and attract negatively charged particles such as dust, liquid and pathogens. In addition, microfibers are highly dense and have 40x more surface area than a conventional, cotton-loop mop. Some grades of microfibers are split to create gripping ñhooksò that make them highly absorbent. Microfibers are mostly used dry, but in some cases can also be wet with disinfectants such as quaternary ammonium compounds. However, use of fabric softeners and chlorine based compounds such as bleach may eventually degrade the material. Cleaning must be achieved as per manufacturerõs directions.

Microfiber mops are light weight (~2 lb) as compared to cotton mops (~10 lb) (Accurate, double checked with the reference), and are more efficient in terms of reduced cleaning times, reduced staff injuries and minimal chemical usage. After usage, they require special laundering process and can withstand approximately 300 laundry cycles. Since pathogens are entrapped and not inactivated within the microfiber weave, effective laundering is essential to mitigate contamination risk of reusable microfiber cloths. This system requires rigorous training as part of implementing the new cleaning method, since improper use may lead to increased contamination and transmission of pathogens, as well as reduced product efficiency.

A study showed that the microfiber system demonstrated superior microbial removal compared to conventional string mops when used with a detergent cleaner (94% vs 68%). Microfiber pads should be regularly changed and decontaminated in an industrial washing machine with a thermal disinfection cycle that achieves a temperature of 65°C for 10 minutes. Microfiber cloths are less effective when used on old and damaged surfaces because of repeated snagging and perform best in the routine maintenance of surfaces which are not heavily soiled.

8.2.4 Variety of EPA registered products against various disease causing pathogens



Source: *Data adapted from CDC Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008. No. of EPA registered products are given for each disease causing pathogen; C. difficile spores (1), Sterilizers (2), Combined action for Mycobacterium, Hepatitis B and Human HIV01 (3), Mycobacterium tuberculosis (4), Norovirus (5), Combined action for MRSA & VRE (6) and Human HIV01 (7).*

8.2.5 Frequent Hand-Touch Sites

Frequently touched surfaces or items should be disinfected once a day. Bleach wipes have been recommended by researchers.

Here is a list of some of these surfaces listed by public setting:

- **Bathrooms:** These include taps, flushes, toilet seats, door handles and locks, sinks, all dispensers and holders, sanitary bins, wash basins, light switches, baby changing areas, shower heads, shower screens, bath tubs and waste bins.
- **Kitchens:** These include appliance buttons, cupboard handles, oven handles, drawers, countertops, eating utensils, dishes, taps, sinks, refrigerator handles, light switches, door handles and waste bins.
- **Offices:** These include desktops, computer keyboards, door handles, waste receptacles, dispensers and holders, buttons on copy machines or printers, desk drawers, telephones, railings on staircases, elevator buttons, light switches and waste bins.
- **Schools:** These include desks, toys, sport equipment, eating utensils, dishes, waste receptacles, drawers, countertops, computer keyboards, hands-on learning items, door

handles, staircase railings, lockers, playground equipment, light switches, drinking foundations and waste bins.

- **Retail and airports:** These include trolley and basket handles, check-out areas, ćchip and pinô readers, door handles (i.e. in changing rooms), railings on staircases or escalators, elevator buttons, glass food cabinets, ATMs, information desks, light switches, petrol pumps, drinking fountains and waste bins.
- **Transport systems-Trains: These include r**ailings, grab-handles, poles, door buttons, arm rests, head rests, ticket machines, barriers/gates/turnstiles, luggage storage areas, escalator and staircase railings, elevator buttons, waste bins and associated washrooms.
- **Transport systems-Buses/trams**: These include ticket machines, grab handles, poles, arm rests, head rests, stop buttons, waste bins and associated washrooms.
- **Transport systems-Airplanes**: These include overhead lockers, fold-out tables, arm rests and buttons, head rests, window shutters, overhead air-conditioning and light switches, trolley handles, door handles, waste bins and associated washrooms.
  Note: HVAC systems should be regularly cleaned from dust, debris and contamination.
- **Cruise ships/Hotels**: These include railings, door handles, arm rests, elevator buttons, desktops, computer keyboards, drawers, bedside tables, light switches, room basins, cupboard handles, restaurant bars, information desks, dispensers and holders, waste receptacles, waste bins, remote controls and associated washrooms.
- **Cleaning equipment**: ñCleaning progressò and ñCleaning safetyò sign boards, cleaning equipment and cleaner trolley wheels.

9.0 Mode of action of disinfectants

Different chemical disinfectants have varying mechanisms of targeting the microbes and killing them. Their antimicrobial activity is attributed to their ability to denature proteins, which in turn leads to the disruption of vital metabolic processes within the cell. The effectiveness of this mechanism depends upon the type of disinfectant used and its concentration. In case of steam vapour systems, the lethal temperatures of steam act as resources for disrupting the cell wall of the microbes, thereby killing them.

Usually intermediate concentrations are most efficient as opposed to high concentrations, as protein denaturation requires presence of water. Additionally, at high concentrations, disinfectants act as lethal compounds by penetrating and disrupting the cell wall, while at low concentrations, they function by inactivating enzyme systems and causing leakage of essential metabolites that ultimately lead to the cell death.

10.0 Resistance of Microbes

Decreasing order of resistance of microbes to disinfection and sterilization and the level of disinfection of sterilization.

Resistant		Level
¦	Prions (Creutzfeldt-Jakob Disease)	Prion reprocessing
¦	Bacterial Spores (*Bacillus atrophaeus*)	Sterilization
¦	Coccidia (*Cryptosporidium*)	Ź
¦	Mycobacteria (*M.tuberculosis, M.terrae*)	High
¦	Nonlipid or small viruses (polio, coxsackie)	Intermediate
¦	Fungi (*Aspergillus, Candida*)	Ź
¦	Vegetative bacteria (*S. aureus, P. aeruginosa*)	Low
Ź	Lipid or medium-sized viruses (HIV, herpes, hepatitis B)	Ź
Susceptible		

Source*: Adapted and reconstructed from CDC Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008.*

The microbicidal activity of chemical disinfectants is usually less against the viral strains as compared to the bacterial strains; attributable to the complex structures of viruses. Additionally, enveloped microbes are more susceptible to microbicidal action than their non-enveloped counterparts, due to presence of an additional outer membrane which often acts as a barrier for the uptake of disinfectants. For example, spores are resistant to disinfectants because the spore coat and cortex act as a barrier. Mycobacteria have a waxy cell wall that prevents disinfectant entry, and gram-negative bacteria possess an outer membrane that acts as a barrier for the uptake of disinfectants.

The Disinfectant Chart attached provides information on the efficacies of the most commonly used disinfectants for routine cleaning against these different microbes.

Spores are resistant against intermediate and low-level disinfectants such as quaternary ammonium compounds and alcohol based disinfectants. In fact, spore production has known to actually increase when exposed to nonchlorine-based cleaning agents. A combination of 2% glutaraldehyde, peracetic acid and *ortho*-Phthalaldehyde can reliably kill *C. difficile* spores. However, these are high level disinfectants and can be toxic, hence may not be suitable in public environments.

The elderly are particularly susceptible to acquiring *C.difficile* infection which often leads to *C. difficile*-associated diarrhoea (CDAD) and other diseases. Care home and hospice settings are therefore, advised to use sodium hypochlorite solutions at dilutions mentioned earlier to clean target areas such as bathrooms and frequent hand-touch sites.

There are currently very few EPA-registered surface disinfectants with label claims for inactivation of *C. difficile* spores. These include bleach, hydrogen peroxide and silver based disinfectants. The hydrogen peroxide based technology is an upcoming potential alternative to these chlorine based products as it addresses issues of decontamination efficiency, costs, toxicity and stability, and may be used routinely to combat against *C. difficile* spores.

11.0 Contact times

The contact time of a disinfectant is the length of time the surface needs to remain wet with the chemical to achieve inactivation of the most resistant types of microbes. Therefore strict adherence to disinfectant contact times must be followed.

A study tested whether or not contact times were met when using practices that are routinely used in facilities today- wipe once and allow the surface to air dry.
Six different disinfectants were tested: a Quaternary Ammonium Compound, a Quat-Alcohol blend, a Phenol, an Alcohol-Phenol blend, Bleach, and Accelerated Hydrogen Peroxide. The drying time was compared to the label contact time. It was found that all the tested products dried in less than 5 minute contact time with alcohol based products drying significantly faster (less than 2 minutes) than the other chemistries. Products with a label claim of 10 minutes (Quat and Phenol) all dried within 3-4 minutes with inefficiency in adequate microbial inactivation at those contact times. Bleach also had a contact time of 10 minutes, but dried at less than 3-4 minutes with marginal efficiency in adequate microbial inactivation. Accelerated Hydrogen Peroxide formulations with 1 minute and 5 minute contact times also dried within 3-4 minutes with 1 minute contact time efficiency in adequate microbial inactivation. With the exception of AHP, shorter drying times compared to the contact times of the products, led to failure in achieving their claimed disinfection activity. The contact times specified on the label of the products are therefore, often too long to be practically followed. To overcome this, more disinfectant solution could be used to extend contact for the recommended period of time, or the surface could be wiped again with the disinfectant after the initial wipe has dried.

Another factor affecting contact times is microbial load present. In highly soiled areas, the contact times increase. Therefore, prior cleaning is necessary to remove organic matter and biofilms from the surface to allow the disinfectant to achieve adequate microbial inactivation.

It is also important to ensure that all surfaces are in contact with the disinfectant. Only the surfaces directly in contact with the chemical will be disinfected, so there must be no air pockets and the surface must be completely immersed and wet for the entire disinfection contact time as stated by the manufacturer.

Ideally, products that have shortened contact times should be increasingly used and considered for disinfection. However, disinfectant manufacturers also need to obtain EPA approval for shortened contact times so these products would be used correctly and effectively in the healthcare environment.

12.0 Environmentally Safe Disinfectants

Some environmental groups advocate ́environmentally safeô products as alternatives to commercial germicides in the home-care settings. These alternatives (e.g., baking soda, vinegar, borax, liquid detergent, eucalyptus oil, grapefruit seed extract, grain alcohol, tea tree oil) are not registered with the EPA and should not be used for disinfecting because they are ineffective against S.aureus. Most environmentally safe disinfectants are also ineffective against S.Typhi and E.coli, with the exception of undiluted vinegar and eucalyptus oil. Eucalyptus oil has broad spectrum antimicrobial effects against many bacteria including mycobacterium and MSRA, viruses and fungi (including Candida), but further research and EPA approval is required before it can be commercially used.

13.0 Avoiding Contamination

High level-disinfectants and liquid chemical sterilants have not been associated with contamination and disease outbreaks, unlike low level-disinfectants and detergents. This is attributable to the fact that mop water becomes increasingly dirty during cleaning and gets contaminated when detergent and water are used. Heavy microbial contamination of wet mops and cleaning cloths can seed an environment with various microbes. Wiping hard surfaces with contaminated cloths further contaminates hands, equipment, and other surfaces. Most commonly reported disinfectants to have contaminations include chlorhexidine, quaternary ammonium compounds, phenolics, and pine oil.

It is important to constitute a few control measures in order to reduce the microbial contamination and the threat of serious infections from use of these products.

- The cleaning solutions must be regularly changed with no less often than 60-minute intervals.
- Some disinfectants should not be diluted; and those diluted, must be prepared correctly to achieve manufacturersô recommended use-dilution
- Extrinsic contamination through the point of use (ie; water used in dilutions, contaminated containers and general contamination in areas where disinfectants are prepared/used) must be avoided.
- Stock solutions of disinfectants must be stored as indicated on the product label
- Decontamination of reusable mops, cleaning cloths and other cleaning equipment must be performed subsequently, or it may lead to the overnight harbouring of pathogens.

For decontamination of reusable mops and cleaning cloths, they may be subjected to detergent washing followed by drying at 80ŬC for 2 hours, or hypochlorite (4,000 ppm) wash for 2 minutes. Care must be taken during the dry heating process as it may produce a fire hazard if the mop head contains petroleum-based products, or lint builds up within the equipment of vent hose.

14.0 Removal of Airborne Microbes

A variety of airborne microbes can be released into the air when environmental reservoirs (i.e., soil, water, dust, and decaying organic matter) are disturbed such as *Aspergillus fumigatus*. Once these materials are brought indoors by any of a number of vehicles (e.g., people, air currents, water, construction materials, and equipment); the microbes can proliferate and, serve as a source for airborne infections.

Microbes that spread through droplet contact transmission are generally transferred between individuals directly as the droplets tend to fall out of the air quickly. Therefore no extra cleaning measures are required to remove these droplets from the atmosphere.

Airborne transmission of droplet nuclei however does pose a health risk as the nuclei can remain in the air for extended periods of time.

Disinfectant spray-fog techniques for antimicrobial control are not recommended in public settings as the chemicals used can cause mucous membrane and respiratory irritation.

HVAC systems are recommended as they can remove contaminated air and minimize the risk of transmission of airborne pathogens from infected patients. HEPA filters can be fixed into HAVAC systems which are at least 99.97% efficient for removing particles.

Decreased performance of HVAC systems, filter inefficiencies, improper installation, and poor maintenance can contribute to the spread of airborne infections therefore regular maintenance is required.

Ultraviolet Germicidal Irradiation (UVGI) has shown to be effective in reducing the transmission of airborne bacterial and viral infections in military housing and classrooms, but it has only a minimal inactivating effect on fungal spores.
UV lamps can be placed inside ducts that remove air from rooms to disinfect the air before it is recirculated or they can be mounted on a wall. Maintenance of UVGI systems consists of keeping the bulbs free of dust and replacing old bulbs as necessary.

Alternatively, public settings not served by central HVAC systems can use through-the-wall or fan coil air conditioning units as the sole source of room ventilation.

15.0 Antibacterial Coating of Surfaces

There are antimicrobial coatings available for linen (curtains); furniture (lockers and bedside tables); office equipment (computers and printers); hand-touch sites (door handles and taps) and general surfaces (floors, walls and doors). Practically anything that can be impregnated or coated with microbicidal paint or chemicals could potentially be marketed as ‗antibacterial'.
Bioactive surfaces or coatings can contain heavy metals such as copper, zinc, silver or titanium, or antiseptics and biocides. There are electrostatic and inhibitory surfaces that repel microbial adhesion.

An example of this is a coating of nano-silver particles combined with titanium dioxide to form highly reactive Ti O_2 Ag particles. This invisible protective nanocoating can be applied onto a range of surfaces under low temperatures, which means that virtually all environmental surfaces could be treated.

Since frequently touched sites rapidly become recontaminated, coatings with prolonged biocidal activity might be useful for inhibiting further recontamination. However, there is little scientific evidence to support manufacturer's claims of the efficacy of these products. Also, the effectiveness of these coatings can degrade over time or in the presence of organic loading. Further research into the effectiveness of these products is required.

16.0 Conclusion

The cleaning industry has a vital role in the promotion of healthy and hygienic everyday environments within our communities. This role has become more complex and challenging within recent years due to an increase in the prevalence of multi-drug resistant organisms in non-healthcare settings and the emergence of new pandemic strains of influenza viruses.

The industry must keep up with the rapid advances in science and technology regarding effective cleaning and decontamination processes; and update its practices to match the increasing demands from society to keep our communities healthy.

We have addressed a few gaps in the past research on infection control pertaining to achieving a scientific standard within the cleaning industry. Firstly, the increased use of ATP meters or particle counters have successfully replaced the traditional visual assessments and tedious microbiological methods to assess the cleaning standards. In establishing an appropriate level of cleanliness of an environmental surface, we can determine what cleaning methods need to be revised to meet those standards.

Secondly, we have identified Accelerated Hydrogen Peroxide (AHP) as a viable bleach alternative in disinfection based on reduced toxicity, low contact times and high efficiency. It mainly prevents serious health risk associated with chlorine gas inhalation from bleach based products, as it possesses one of the lowest EPA toxicities amongst disinfectants. It can be used for both non-critical and critical environmental surfaces based on its varying concentrations. We have also identified steam vapour systems and microfibers as alternative disinfection techniques in routine cleaning. The Disinfectant Chart attached compares these products with other disinfectants currently in the market.

Lastly, the use of antibacterial coating on environmental surfaces has potential to aid cleaning practices. If these surfaces could reliably inhibit contamination they could help to sustain a higher standard of hygiene. However, the coatings currently available suffer a lack of scientific evidence supporting their efficacy to warrant their installation as standard.

For more information and resources please visit www.cleaning-for-health.org

On this site you will find a series of pdf documents which clearly explain how to safely and effectively clean and decontaminate particular environments during an outbreak of a pandemic disease within the vicinity. The environments we cover are office settings, transport systems, retail settings, childcare settings, care homes & nursing homes, and hotels & cruise ships.

17.0 Glossary

Biofilm: accumulated mass of bacteria and extracellular material that is tightly adhered to a surface and cannot be easily removed.

Cleaning: the removal of foreign material, such as soil and organic matter from surfaces. This can be accomplished manually or mechanically using water with detergents or enzymatic products.

Contact time: time a disinfectant is in direct contact with the surface or item to be disinfected. For surface disinfection, this period is framed by the application to the surface until complete drying has occurred.

Contaminated: state of having actual or potential contact with microorganisms. The term generally refers to the presence of microorganisms that could produce disease or infection.

Decontamination: according to OSHA, ñthe use of physical or chemical means to remove, inactivate, or destroy blood-borne 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 safe for handling, use, or disposalò. However, the term generally refers to all pathogenic organisms.

Detergent: cleaning agent that makes no antimicrobial claims on the label. They comprise a hydrophilic component and a lipohilic component and can be divided into four types: anionic, cationic, amphoteric, and non-ionic detergents.

Disinfection: Disinfection is the process that eliminates many or all pathogenic microorganisms on inanimate objects. Methods of disinfection involve liquid chemicals or wet pasteurisation.

- High-level disinfectants: can kill all microorganisms except large numbers of bacterial spores. Examples of these are >2.4% glutaraldehyde, 0.55% ortho-phthalaldehyde (OPA), 0.95% glutaraldehyde with 1.64% phenol/phenate, 7.35% hydrogen peroxide with 0.23% peracetic acid, 1.0% hydrogen peroxide with 0.08% peracetic acid and 7.5% hydrogen peroxide. Most of these can cause degradation to surfaces through long-term use and are highly toxic, so Personal Protective Equipment is necessary.
- Intermediate-level disinfectants: should kill mycobacteria, vegetative bacteria, most viruses, and most fungi but do not necessarily kill bacterial spores. Examples of these are sodium hypochlorite, alcohols, some phenolics, and some iodophors.
- Low-level disinfectants: can kill most vegetative bacteria, some fungi, and some viruses. Examples of these are quaternary ammonium compounds, some phenolics, and some iodophors.

Germicides: A germicide is an agent that can kill pathogenic microorganisms. The term *germicide* includes disinfectants and antiseptics.

- *Antiseptics* are germicides applied to living tissue and skin.
- *Disinfectants* are antimicrobials applied only to inanimate objects.
- Virucides, fungicides, bactericides, sporicides, and tuberculocides can kill the type of microorganism identified by the prefix. For example, a bactericide is an agent that kills bacteria.

Inanimate surface: non-living surface (e.g., floors, walls, furniture).

Inorganic and organic load: naturally occurring or artificially placed inorganic (e.g., metal salts) or organic (e.g., proteins) contaminants on a medical device before exposure to a microbicidal process.

Lipid virus: virus surrounded by an envelope of lipoprotein in addition to the usual core of nucleic acid surrounded by a coat of protein. This type of virus (e.g., HIV) is generally easily inactivated by many types of disinfectants. Also called *enveloped* or *lipophilic viruses*.

Microorganisms or microbes: animals or plants of microscopic size. This generally refers to bacteria, fungi, viruses, and bacterial spores.

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

Nonlipid viruses: generally considered more resistant to inactivation than lipid viruses. Also called nonenveloped or hydrophilic viruses.

Parts per million (ppm): common measurement for concentrations by volume of trace contaminant gases in the air (or chemicals in a liquid); 1 volume of contaminated gas per 1 million volumes of contaminated air. Parts per million = ε g/mL or mg/L.

Pathogen or infectious agent: (or a germ) is a microbe or microorganism such as a virus, bacterium, prion, or fungus that causes disease in its animal or plant host.

Sanitizer: an agent that reduces the number of bacterial contaminants to safe levels as judged by public health requirements. According to the protocol for the official sanitizer test, a sanitizer is a chemical that kills 99.999% of the specific test bacteria in 30 seconds under the conditions of the test.

Sterilization: Sterilization is the process that eliminates all forms of microbial life by physical or chemical methods.

Vegetative bacteria: bacteria that are devoid of spores and usually can be readily inactivated by many types of germicides.

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List B: EPA Registered Tuberculocide Products Effective Against *Mycobacterium tuberculosis* (PDF)
List C: EPAôs Registered Antimicrobial Products Effective Against Human HIV-1 Virus (PDF)
List D: EPAôs Registered Antimicrobial Products Effective Against Human HIV-1 and Hepatitis B Virus (PDF)
List E: EPAôs Registered Antimicrobial Products Effective Against *Mycobacterium tuberculosis* Human HIV-1 and Hepatitis B Virus (PDF)
List F: EPAôs Registered Antimicrobial Products Effective Against Hepatitis C Virus (PDF)
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List H: EPAôs Registered Antimicrobial Products Effective Against Methicillin Resistant *Staphylococcus aureus (MRSA)* and Vancomycin Resistant *Enterococcus faecalis* or *faecium* (VRE) (PDF)
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