COVID-19 Fact Sheet #5
Do's and Don'ts of Disinfectants
May 19, 2020

The information in this Fact Sheet is built on the information provided in the first four Fact Sheets. To minimize repetition, it is assumed that those were read.

Disinfection has a place on the "To Do" list of actions to prevent transmission and infection of COVID-19. At the same time, it is important not to lose sight of the fact that disinfectants can be hazardous chemicals. Many claims are being made in marketing literature. It is essential to carefully consider those claims and evaluate them using science. Let's start with some definitions:

Antiseptics – chemical substances used to inhibit or destroy microorganisms on **living tissue.** Antiseptics are considered antimicrobial drugs and are regulated by FDA. Consumer antiseptics are classified as "Washes" or "Rubs". Washes or antibacterial soaps are intended for use with water and are rinsed off after use. Antimicrobial ingredients must meet requirements for being Generally Recognized as Safe (GRAS). If not, the benefit in infection reduction must be greater than the health risk. In September 2017, FDA required the removal of 19 antimicrobials from consumer hand washes since they did not meet these requirements. Triclosan was one of the antimicrobials that was becoming very common. It was removed from washes over concerns of health effects from absorption through the skin.

Rubs or "hand sanitizers" are designed to be left on the hands. These are intended to be used **WHEN WATER IS NOT AVAILABLE.**

Cleaners – products used to remove soil from surfaces. "Soil" can be fats, proteins, grease, particulates, etc. Cleaners can contain soaps or detergents as emulsifiers, surfactants or wetting agents to help remove "soil" from environmental surfaces. Some cleaners contain enzymes to remove biofilms. Surfaces must be free of "soil" before disinfectants are applied.

Disinfectants – chemical substances that kill or irreversibly inactivate **specific microorganisms** within a given time period. Chemical disinfectants are registered and regulated by EPA under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as "antimicrobial pesticides". Disinfectants are not meant to be used on human skin, ingested or injected. EPA publishes lists of registered pesticides for various microorganisms including List N: Disinfectants for Use Against SARS-CoV-2.

Fumigants/Fogging – chemical sanitizers or disinfectants applied by fogging as a vapor or liquid aerosol. **EPA does not recommend use of fumigation or wide-area spraying to control COVID-19.** CDC recommends that you clean contaminated surfaces with liquid products, such as those provided on EPA's List N, to prevent the spread of disease. **Fumigation and wide-area spraying are not appropriate tools for cleaning contaminated surfaces.**

Germs – microorganisms, including bacteria, viruses, usually referring to those that can cause disease.

Sanitizers – chemical substances that reduce **vegetative bacteria** to an acceptable level. They are not effective against bacterial spores or viruses. Sanitizers are used primarily in the food industry.

Vegetative Bacteria – living bacterial cells. Some bacteria produce spores which creates a protective layer to help the cell survive unfavorable environments. Spores are much more difficult to kill than the vegetative bacterial cells.

The emphasis, right now, is on creating a safe work environment. Safe from COVID-19 transmission. But that should be achieved without creating health effects from the use, misuse, overuse, and extended use of disinfectants.

Case Studies

Case Study #1: Physical therapists and support staff reported headaches and feeling "woozy" after they began using disinfectant wipes at a "20-fold increase" following an infection control audit. According to the label and SDS, the product contained a quaternary ammonium disinfectant at 0.28%. The remaining ingredients at 99.72% were listed as "Other". The manufacturer refused (and are not required by EPA or OSHA) to release the identify of these "Other" trade secret ingredients despite the association of their product with symptoms in healthcare workers. Symptoms diminished when the use of surface wipes decreased.

Case Study #2: A laboratory employee left work and reported to Urgent Care with a rash and hives around her eyes. Upon investigation it was learned that she was disinfecting her safety glasses with a surface wipe containing isopropyl alcohol (IPA) and a quaternary ammonium disinfectant. Rash did not return when she switched to using IPA alone.

Case Study #3: A group of workers requested respiratory protection and industrial hygiene monitoring after being required to disinfect their work areas following contamination. Disinfection included a laboratory and office workstations using household bleach. They reported eye and throat irritation. Workers were provided with respiratory protection following medical clearance, fit testing, and training.

Case Study #4: An office worker reported a rash on the left side of her face. This appeared to be contact dermatitis and upon investigation it was learned that the cleaning service was disinfecting desktops and telephones with a quaternary ammonium disinfectant. The rash was limited to the area where she held the phone against her face. The rash resolved and did not return after halting disinfection of telephones at private desks.

These case studies took place in the past two years, prior to the outbreak of COVID-19. In each case, the disinfectants appeared to be the cause of the adverse effects.

Most Frequently Used Disinfectants

The "Active Ingredient" is the chemical substance that acts to destroy microorganisms. Most products containing disinfectants include only a very low percentage of this "Active Ingredient", often less than 1%. More than one "Active Ingredient" may be included in the formulation. This table describes potential effects that may occur from the "Active Ingredient" only. Additional effects may occur from "Other" chemicals present in the formulations including fragrances, organic solvents, dyes, emulsifiers, and aerosol propellants.

Chlorine Products

There are numerous products that contain chlorine and they have different levels of effectiveness. Chlorine has been used as a disinfectant since the cholera outbreak in London in 1850. Chorine works by damaging bacterial cell walls and virus envelopes.

Household Bleach (Sodium Hypochlorite)

Household bleach and similar products contain sodium hypochlorite, the most widely used chlorine-based disinfectant, at 4-6%. Household bleach can be diluted 1:10 with water and retain effectiveness against bacteria and viruses. Effectiveness of chlorine is largely due to the presence of hypochlorous acid.

Advantages

Effective against a broad spectrum of microorganisms, including viruses
Inexpensive
Not affected by water hardness

Disadvantages
Corrosive to metals
Effectiveness decreased by organic matter
Forms hazardous chloramines when reacting with organic matter
Unstable - solutions lose effectiveness over time. Household bleach starts to degrade at six months becoming 20% less effective every year. Bleach diluted in water (1:10) has a shelf life of only 24 hours.
Discoloration or "bleaching" of fabrics
Release of chlorine gas when mixed with ammonia or acid

Exposure Limits and Potential Health Effects
OSHA
Ceiling Limit (10-15 minute sample) of 1.0 part per million (ppm).
This concentration would not be well tolerated by individuals.
American Conference of Governmental Industrial Hygienists (ACGIH)
More realistic and updated recommended exposure limits:
8 Hour Time-weighted Average (TWA) – 0.1 ppm
Short Term Limit – 15 minutes – 0.4 ppm
Individuals may feel eye and throat irritation at 0.4 ppm.

Hypochlorous Acid
Hypochlorous acid is the most effective disinfectant in the chlorine category that is available in dilute solution. Considered to be 80 to 120 times more effective than sodium hypochlorite due to its ability to penetrate cell walls.

Advantages
Very effective against bacteria and viruses
Not corrosive
Less hazardous than other chlorine based disinfectants. (White blood cells release hypochlorous acid to kill pathogens and it is used to treat some skin disorders.)
More stable than sodium hypochlorite

Disadvantages
May leave some residue

Exposure Limits and Potential Health Effects
There are no OSHA or ACGIH exposure limits for hypochlorous acid. Products have low toxicity. When it is released by white blood cells in response to infection, it may contribute to the tissue injury associated with inflammatory response.

Chlorine Dioxide

Chlorine dioxide is used as a bleach at pulp mills and public water-treatment facilities. It has been used to decontaminate buildings following anthrax scares.

Advantages
Effective against bacteria and viruses in low concentrations

Disadvantages
Unstable - chlorine dioxide is a gas that can decompose rapidly in air so it is usually made at the location where it is used.
Sensitive to warm temperatures and sunlight and under best storage conditions, it does not last beyond 30 days
Expensive – compared to household bleach
May cause damage to plastic and other surfaces after prolonged use

Exposure Limits and Potential Health Effects
OSHA
8 Hour TWA Exposure Limit – 0.1 ppm
ACGIH
Only a Ceiling Limit of 0.1 ppm.
Respiratory irritation and skin burns may occur.

Alcohols

Ethyl and isopropyl alcohol are used in antimicrobials, for use on the skin, and in disinfectants. The alcohol must be mixed with water to be effective. The most effective formulations have 70% alcohol. The most common hand rubs contain 60% ethanol.

Note: I'd like to think that I could sit within six feet of someone and have no risk of infection as long as we were both drinking wine or Scotch. But alcoholic beverages do not make good disinfectants. Beer has alcohol content of 2-12%, wine at 12%, distilled spirits 35-50%. There are some spirits that are fortified that can reach as high as 95% - but that is a really expensive way to disinfect an environment.

Advantages
Rapidly effective against vegetative bacteria and enveloped viruses like COVID-19.
Low toxicity compared to many other disinfectants.

Disadvantages
Flammable – the flash point of 70% isopropyl alcohol is 64° F.
Vapor pressure is high enough that it is difficult to maintain the five minute recommended contact time before it evaporates.
Bacterial resistance possible - One study done at the University of Melbourne in Australia indicated bacterial resistance to 70% IPA from *Enterococcus faecium*, a common cause of hospital acquired infections.
Pidot, SJ, et.al., Increasing tolerance of hospital *Enterococcus faecium* to handwash alcohols. Sce Transl Med 2018 Aug 1; 10(452).

Exposure Limits and Potential Health Effects
Ethanol
OSHA
8 hour TWA exposure limit is high at 1000 ppm.
ACGIH
Only short term limit of 1000 ppm.
This high level would not be tolerated by most individuals.

Isopropyl Alcohol
OSHA
8 hour TWA exposure limit is 400 ppm.
ACGIH
8 hour TWA exposure limit is 200 ppm.
Short term limit of 400 ppm
Most individuals would perceive these concentrations to be too high.
Health effects can include irritation and, with extended or extensive use, central nervous system effects such as "feeling woozy" and headache.

Note: It has been tested and verified that it is not possible to absorb enough ethyl alcohol from using hand rubs to achieve a blood alcohol that would exceed the limit for driving. The breathalyzer can be inaccurate, however, if the individual administering the test has just used a hand rub containing ethyl alcohol.

Quaternary Ammonium Compounds (QACs, "Quats")

Quaternary ammonium compounds are the most common Active Ingredient on List N.
An example is: Alkyl (67% C12, 255 C14, 7% C16, 1% C8, C10, C18) Alkyl (50% C14, 40% C12, 10% C16 dimethyl benzyl ammonium chloride (0.10%)
The "alkyl" relates to structures that contain carbon. The "C" designates the carbon chain length. Carbon chains C8 to C18 are the most effective. Quats are widely used, have been around since 1917 and are effective against bacteria and enveloped viruses.

Advantages:
Not corrosive
Low vapor pressure - they do not evaporate easily so contact time can be achieved

Disadvantages:
Effectiveness reduced by organic material and hard water
May leave a residue (This may explain why the lab worker had hives after using a "Quat" to clean her safety glasses.)

Potential Health Effects
Irritation
Asthma – (This product should not be applied by spraying.)
Contact dermatitis
Reports of anaphylaxis – life-threatening allergic response
Decreased fertility in mice
V.E. Melin, et.al., Exposure to common quaternary ammonium disinfectants decreases fertility in mice. Reprod Toxicol. 2014 Dec; 50: 163–170.

Recommendations

1. Conduct a walkthrough assessment of your facility or workplace environment to identify – in a typical day – where contamination with respiratory droplets or aerosols may occur.
2. Identify which of those locations is a frequently touched surface.
3. Determine the best way to interrupt the pathway – look for alternatives to using disinfection – for the short term and the long term.
   Consider this scenario: Wiping down surfaces is typically recommended at various intervals during the work shift. Let's look at one activity: people entering the workplace – building, trailer. Let's assume they have to touch a handle or some portion of the door to enter. To really be the answer, disinfectants would have to be applied after each worker enters, waiting for the disinfectant "dwell time" – 2 to 10 minutes – before the next person enters. Disinfecting *after* workers have entered for the shift offers no protection against exposure during building entry for those entering during that time. Better to look for an alternative: leaving doors open, if feasible, for the bulk of the entry time or providing tissues for touching the door as a short term solution. Long term solution is no touch entry through various options.
4. When choosing a disinfectant product – read labels. It is sometimes assumed that "Chlorox" is synonymous with "bleach". It is not. Many products made by Chlorox Company contain no sodium hypochlorite; many contain Quats and isopropyl alcohol. "Lysol" products are also Quats as well as other disinfectants such as hydrogen peroxide.
5. If disinfectants are placed in secondary containers – ensure that they are labeled. Missing labels is always on the top ten list of "most cited" OSHA violations.
6. Provide training in the appropriate dilution (if needed) and application of the disinfectant. Follow the instructions provided on EPA's List N for approved application and dwell time.

7. Provide PPE to environmental services personnel to protect against microorganisms and, if needed, protection against the disinfectant.
8. Do not prepare "DIY" disinfectants from the recipes found online. Check with CDC website on proper preparation of bleach solutions.
9. It might be useful to perform a cost/benefit analysis. Compare the cost of disinfectants, plus labor to apply the disinfectant, balanced with implementing an option for reducing exposure.

Since it looks like a concern for preventing infection will be a priority for some time, it is important to consider strategies that would minimize the use of chemical disinfectants.

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Bessa can provide the following services:

- Facility audit for infection prevention strategies.
- Written plan for Control of Infectious Agents in the Non-healthcare Workplace
- Assistance with a response to an OSHA complaint regarding COVID-19

OSHA has allowed some leeway in compliance with other health and safety requirements such as training and exposure monitoring, there is an expectation that best efforts will be made to comply with the requirements. We can help you with that. Check the website for a list of additional services that we provide.