Disinfection

Introduction

Disinfection, sterilization, and antisepsis are all important aspects of infection control in the hospital and laboratory. It is important to understand the differences between the following definitions, because disinfection and sterilization are not interchangeable terms.

Sterilization is the use of physical or chemical processes to destroy all forms of microbial life.

Disinfection is the act of or process of reducing the amount of microbial life with the goal of obtaining a safe level (destroying pathogenic microbes).

Antisepsis is the disinfection of living tissue. The chemicals used for antisepsis are not the same as those used for disinfection.

Disinfection is one type of infection control that is widely used. For practical reasons, chemical disinfection is used in the clean-up of spills and to decontaminate surfaces. Some of these chemicals will be discussed below.

Factors Affecting Disinfection

The following are six primary variables that influence the efficacy of disinfection:

1. **Nature of the item to be disinfected**
   The rougher the surface, the longer the contact time required for disinfection.

2. **Number of microorganisms present**
   The number of microorganisms present will lengthen the time for effective disinfection to take place. In general, higher numbers of organisms require more time for disinfection.

3. **Resistance of microorganisms**
   Some microorganisms are more resistant to disinfection than others. The generally accepted order from the most resistant to the least resistant is: bacterial spores, mycobacteria, hydrophilic viruses, fungi, vegetative bacteria, lipid viruses. Disinfecting a spill with a small concentration of bacterial spores will require longer disinfection time than a large concentration of lipid viruses.

4. **Type and concentration of disinfectant used**
   Resistance of microorganisms depends on the type of disinfectant used. A particular microorganism may be more resistant to one type of disinfectant than another. For instance, alcohol (isopropyl or ethyl) is effective against vegetative bacteria and most lipophilic viruses, but is not effective against bacterial spores or most hydrophilic viruses. Many disinfectants are broad spectrum; that is, effective against all or most forms of microbial life. Some broad spectrum disinfectants include glutaraldehyde, sodium hypochlorite (bleach), and hydrogen peroxide. Non-broad spectrum disinfectants include phenolics and quaternary ammonium compounds. Alcohols lie somewhere in between these two.
   The concentration of a particular disinfectant effects disinfection. In most cases, a higher concentration increases microbial killing power and decreases time necessary for disinfection.

However, some disinfectants are not as effective in higher concentrations. Iodophors must be diluted according to the directions on the label; over-diluting or under-diluting may substantially lower the microbicidal potency. Alcohols used in concentrations above 90% are less effective because the water added to dilute the alcohol allows it to penetrate better and reach its target. Optimal concentration range is between 70 and 90%.

5. **Presence of organic material**
   The presence of organic soiling matter will compromise disinfection. Blood, blood products, bodily fluids, and feces contain significant amounts of proteins, and protein will bind and inactivate some disinfectants or slow their action. Therefore, in the presence of large amounts of protein, a higher concentration of disinfectant and longer contact time will be necessary to achieve maximal disinfection.

6. **Duration of exposure and temperature**
   Duration of exposure and temperature influences the disinfection process. The longer the duration of exposure, the higher the degree of disinfection achieved. Some disinfectants require a longer contact time to achieve killing, and some microorganisms need longer exposures to be killed. Higher temperatures increase the killing power of most disinfectants, whereas lower temperatures may slow the killing power of most disinfectants.

Disinfectant Types

Different disinfectants operate by different mechanisms, and some are more effective than others. Thus, it is not appropriate to use the various disinfectants interchangeably. The large number of chemical disinfectants that are available include alcohol, chlorine and chlorine compounds, formaldehyde, glutaraldehyde, hydrogen peroxide, iodophors, phenolics, and quaternary ammonium compounds. Effectiveness of a particular disinfectant will sometimes vary from organism to organism. For example, quaternary ammonium compounds are effective for destroying: fungi, bacteria, and lipophilic viruses (such as HIV and HBV); however, they are not effective for destroying spores. In addition, they are not generally effective for destroying *Mycobacterium tuberculosis* or hydrophilic viruses. Please call the ORCBS for the practical use of a particular disinfectant for your facility.

Bloodborne Pathogens and Tuberculosis

Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), and *Mycobacterium tuberculosis* (*M. tuberculosis*) are of concern because of potential consequences associated with infection. HIV and HBV are bloodborne; *M. tuberculosis* is an airborne infectious agent and present in respiratory secretions.

HIV and HBV are both lipophilic viruses and therefore susceptible to a variety of disinfectants.

- **Bleach solution:** A 1:10 dilution of 5.25% sodium hypochlorite (common household bleach) to water is recommended for disinfection of material potentially infected with HIV and HBV. Before disinfecting a surface after a blood spill with 1:10 solution of household bleach, one should clean the surface first because of the fact that hypochlorites and other germicides are substantially inactivated in the presence of blood.

- **Other products:** Glutaraldehyde, hydrogen peroxide (3-6%), and iodophors are also effective for destroying bloodborne pathogens. Although isopropyl alcohol and ethanol will inactivate HIV and HBV, these disinfectants evaporate rapidly so sufficient contact time may be difficult to achieve. In order to assure adequate disinfection time, the contact time should be at least 10 minutes.

Destruction of *Mycobacterium tuberculosis* presents a challenge, as many disinfectants are not effective for destroying this pathogen. Bleach is effective only in higher concentrations. Alcohols and hydrogen peroxide have varying results; quaternary ammoniums are not effective for destroying *M. tuberculosis*. Phenolics are the best tuberculocides, for they readily inactivate *M. tuberculosis*. However, when disinfecting for *M. tuberculosis*, it is very important to avoid generation of droplets or aerosols, which are the primary transmission routes.

Choosing a Disinfectant

Choosing a disinfectant should be based on the spectrum of antimicrobial activity, availability, and cost. Bleach is an effective broad spectrum disinfectant, readily available, inexpensive, and works well for spills. Although alcohols do not have the spectrum of activity that bleach has, they are readily available, economical, and excellent for everyday use. Other disinfectants have similar qualities.

Conclusion

Disinfection is a very important process in infection control. One must not only disinfect a surface after a spill, but develop a regular schedule for disinfection. Awareness of the proper technique can prevent infection and maintain a safe work environment. It is recommended that the level of disinfectant used is appropriate to the agent involved. Do not overkill.

For further reading, seek the additional references listed below:

Block, Seymour (ed.). 1991. **Disinfection, Sterilization, and Preservation.** 4th ed. Lea & Fibiger, Philadelphia.

Vesley, Donald and Lauer, James L. Decontamination, Sterilization, Disinfection and Antisepsis. **Laboratory Safety, 2nd Edition Principles and Practices.** 1995. ASM Press., Washington, D.C. pp. 219-237.