In this chapter, we will describe uses and limitations of certain germicidal chemicals and processes. A key to the prevention of healthcare-acquired infections is appropriate disinfection and sterilization of instruments and equipment (Rutala 1996). However, in order to achieve our infection prevention objectives, there are some critical points to remember. First, there is no such thing as a perfect germicide. In the selection of a germicide, we must frequently balance efficacy (the ability to destroy microbes) with safety of people and products. If a germicide is capable of destroying bacteria spores, but in the process, an expensive instrument is damaged, the approach is obviously not acceptable. One approach to protecting heat-sensitive instruments was to use ethylene oxide as a sterilizing agent. However due to environmental and occupational hazards and long cycle times, some newer, low-temperature sterilization systems have been developed. Examples of these approaches include...
hydrogen peroxide vapor, chlorine dioxide gas, ozone gas, peracetic acid liquid, mixed chemical/gas-plasma, and hydrogen peroxide gas-plasma (Favero and Bond 2001). The second consideration is examining the application and intention of the germicide. It is not necessary or desirable to achieve sterility in all instances. While surgical implants must be sterile, most environmental surfaces, like floors, need only to be clean. Even surfaces that come in contact with mucus membranes do not need to be sterile; they need to be free of disease-causing microorganisms. The key is to match the desired task with the most appropriate type of germicide. A final point is that cleaning (the removal of all foreign materials) is a critical step in either disinfection or sterilization (Rutala 1996).

CLASSIFICATION OF GERMICIDES

There are two broad classifications of germicides: antiseptics and disinfectants. Antiseptics are used on living tissue, whereas disinfectants are used on inanimate objects. Another distinction is that disinfectants used on medical equipment are regulated by the Food and Drug Administration (FDA), whereas other disinfectants are considered pesticides and regulated by the Environmental Protection Agency (EPA). Certain chemicals, such as alcohol, tincture of iodine (a mixture of alcohol and iodine), and iodophor (a chemical solution of iodine and a solubilizing agent), may be both antiseptics and disinfectants, depending on the concentration. The potential confusion from overlapping jurisdictions led the two agencies to sign a Memorandum of Understanding in which the FDA took responsibility for regulation of liquid chemicals used for high-level disinfection or sterilization, and the EPA took responsibility to regulate general purpose disinfectants. The Centers for Disease Control and Prevention (CDC) is not a regulatory body, but it does provide some guidance on the use of germicides in the prevention of nosocomial infections (CDC 2003).

Types of Disinfection

With the exception of prions (a transmissible form of an abnormal protein), bacterial spores are most difficult to kill, and vegetative bacteria and lipid viruses are easiest to kill. E.H. Spaulding proposed three levels of germicidal action: high, intermediate, and low (Favero and Bond 2001). High-level disinfectants are expected to kill vegetative bacteria, Mycobacterium tuberculosis (TB), some spores, fungi, and viruses. Intermediate-level agents kill vegetative bacteria, TB, fungi, viruses, but are not expected to kill bacterial spores. Low-level agents kill most vegetative bacteria, fungi, and lipid viruses. They will not destroy spores or non-lipid viruses, and they are sometimes less active against TB or gram negative rods such as Pseudomonas sp.

Examples of Disinfectants by Germicidal Activity

High-level disinfection is the minimum level recommended by the CDC for reprocessing semicritical instruments (CDC 2003). See the classification of devices below.
Some examples of high-level germicides are:

- 8% formaldehyde
- 2% glutaraldehyde
- 100% ethylene oxide gas (EtO)
- 10–20% stabilized hydrogen peroxide
- 58% hydrogen peroxide plasma
- 0.55% ortho-phthalaldehyde (OPA)

Some examples of intermediate-level germicides are:

- 70–90% alcohol
- 0.1–0.5% chlorine
- phenolic
- 0.01–0.007% iodophor

An example of a low-level is quaternary ammonium compounds (quats).

**Classification of Devices**

Critical devices have a substantial risk of causing an infection because they are used in procedures that enter sterile tissue or the vascular system (Favero and Bond 2001). Some examples of critical devices are surgical implants, heart-lung oxygenerators, needles, scalpels and other surgical instruments. Semicritical devices do not ordinarily penetrate body tissues but may come in contact with mucous membranes. Some examples of semicritical devices are flexible endoscopes, laryngoscopes, endotracheal tubes, other similar instruments. Noncritical devices or surfaces are expected to only touch intact skin. These devices may be subcategorized into medical equipment surfaces with routine patient contact and housekeeping surfaces with little to no patient contact. Some examples of noncritical devices or surfaces are stethoscopes, tabletops, bed railings, floors, walls, and ceilings.

**Matching Devices to Processes**

All evidence suggests that the most important issue in destroying potentially pathogenic microorganisms in instruments such as endoscopes is cleanliness and not the level of germicidal activity (Favero and Bond 2001). Thorough decontamination and cleaning must precede either sterilization or disinfection for any process to be considered reliable. The reason that cleaning is most important is that residual biofilm or other organic matter can shield microbes from the germicide. Also, the mechanical action of cleaning can remove a large number of microbial contaminants.

**Critical Items.** These devices present a high risk of infection; usually, steam sterilization is the most efficacious means of reprocessing critical instruments.
While steam is the cheapest and most effective means of achieving sterility, certain heat-labile equipment must be reprocessed using other means. The minimum level of treatment for heat-labile critical instruments is high-level disinfection, and preferably sterilization (Favero and Bond 2001). Chemical germicides that are sporicidal take much longer time to achieve sterility than steam sterilizers, in some cases, as long as 24 hours.

**Semicritical Instruments.** For heat-stable semicritical instruments, steam sterilization may be the most cost-effective means of reprocessing (Favero and Bond 2001). On the other hand, heat-labile semicritical instruments typically do not enter sterile tissue, so sterility is not required. If the instrument can not withstand long contact with a chemical germicide, high-level disinfection is sufficient. It should be noted that the primary difference between sterilization and high-level disinfection when using chemical germicides is the amount of contact time.

**Noncritical Items.** Since noncritical items offer little risk of infection, the main issue is cleanliness and not disinfection. Medical equipment surfaces may frequently become contaminated during patient procedures, so it is prudent to use low- to intermediate-level germicide on these surfaces. Housekeeping surfaces would not be expected to play a role in nosocomial infections. Some authorities suggest that to be on the safe side, even housekeeping surfaces should be disinfected (Rutala and Weber 2001b). This issue is controversial, and others believe that detergents or low-level disinfectants are appropriate (Favero and Bond 2001). The major exception is laboratory culture or blood spills. These require special precautions. The following steps are recommended to handle these types of spills:

1. Don a pair of disposable gloves
2. Remove excess fluids using absorbent materials such as paper towels
3. Dispose of the absorbent materials in a red bag
4. Use any germicide labeled as a “hospital disinfectant” to clean the area

**Characteristics of a Good Germicide**

As previously stated, there is no such thing as the perfect germicide. When selecting a germicide, consider the following issues:

- **Biocidal properties:** Will the germicide kill those organisms of concern?
- **Applicable to intended use:** Will the germicide be efficacious without harming people or the objects being disinfected?
- **Contact time:** How long does it take for the germicide to do the intended job?
- **Employee acceptance:** Will the employees find the germicide easy and safe to use, and are there any unpleasant odors or staining problems associated with its use?