APPENDIX B

ANTISEPTICS

Many chemicals qualify as antiseptics. The following antiseptics are generally available in many parts of the world:

- 60–90% alcohols (ethyl, isopropyl or "methylated spirit")
- 2–4% chlorhexidine gluconate (Hibiclens®, Hibiscrub®, Hibitane®)
- Chlorhexidine gluconate and cetrimide, various concentrations (Savlon®)
- 3% iodine; aqueous iodine and alcohol-containing (tincture of iodine) products
- 7.5–10% iodophors, various concentrations (Betadine® or Wescodyne®)
- 0.5–4% chloroxylenol (Para-chloro-metaxylenol or PCMX) various concentrations (Dettol®)
- 0.2–2% triclosan

In choosing an antiseptic, the desired characteristics (e.g., absorption and persistence) should be considered along with evidence of a given product's safety and efficacy, its acceptability to staff and, most importantly, its cost (Boyce and Pittet 2002; Larson 1995; Rutala 1996). **Table B-1** lists several recommended antiseptic solutions, their microbiologic activity and potential uses. (The grading system used in this table is excellent, good, fair, and none.)

ALCOHOL SOLUTIONS (ETHYL OR ISOPROPYL)

Note: In many countries, alcohols are available as "industrial methylated spirit," or ethyl alcohol denatured with a small amount of wood (methyl) alcohol (Harpin and Rutter 1982). Because methyl alcohol is the least effective of the alcohols, it should not be used alone as an antiseptic or disinfectant. Before using, be sure the ethyl alcohol is of adequate strength (60–90%) in locally available "spirit."

Ethyl and isopropyl alcohol (60–90%) are excellent antiseptics that are commonly available and inexpensive. Their rapid killing action makes them very effective in reducing numbers of microorganisms on skin, even under gloves. Alcohols are effective against all hepatitis viruses and HIV. They should **not** be used on mucous membranes (e.g., for vaginal preparation). (Alcohols dry and irritate mucous membranes which, in turn, promotes the growth of microorganisms.)

Alcohols are among the safest known antiseptics. A 60–70% solution of ethyl or isopropyl alcohol is effective, less drying to the skin and less expensive than higher concentrations. Because it is less drying to the skin, ethyl alcohol may be more appropriate than isopropyl alcohol for frequent use on skin (Larson 1995).

Table B-1. Antiseptics: Microbiologic Activities and Potential Uses

GROUP	ACTIVITY AGAINST BACTERIA							POTENTIAL USES			
	Gram-Positive	**Most Gram-Negative**	**TB**	**Viruses**	**Fungi**	**Endospores**	**Relative Speed of Action**	**Affected by Organic Matter**	**Surgical Scrub**	**Skin Preparation**	**Comments**
Alcohols (60–90% ethyl or isopropyl)	Excellent	Excellent	Excellent	Excellent	Excellent	None	Fast	Moderate	Yes	Yes	Not for use on mucous membranes Not good for physical cleaning of skin, no persistent activity
Chlorhexidine (2–4%) (Hibitane, Hibiscrub)	Excellent	Good	Fair	Excellent	Fair	None	Intermediate	Slight	Yes	Yes	Has good persistent effect Toxicity to ears and eyes
Iodine preparations (3%)	Excellent	Excellent	Excellent	Excellent	Good	Fair	Intermediate	Marked	No	Yes	Not for use on mucous membranes Can burn skin so remove after several minutes
Iodophors (7.5–10%) (Betadine)	Excellent	Excellent	Fair	Good	Good	None	Intermediate	Moderate	Yes	Yes	Can be used on mucous membranes
Para-chloro-metaxylenol (PCMX) (0.5–4%)	Good	Excellent	Fair	Good	Fair	Unknown	Slow	Minimal	No	Yes	Penetrates the skin and should not be used on newborns
Triclosan (0.2–2%)	Excellent	Good	Fair	Excellent	None	Unknown	Intermediate	Minimal	Yes	No	Acceptability on hands varies

Adapted from: Olmsted 1996; Boyce and Pittet 2002.

Advantages

- Rapidly kill all fungi and bacteria including mycobacteria; isopropyl alcohol kills most viruses, including HBV, HCV and HIV; ethyl alcohol kills all viruses.
- Although alcohols have no persistent killing effect, the rapid reduction of microorganisms on skin protects against regrowth of organisms, even under gloves, for several hours.
- Are relatively inexpensive and widely available throughout the world.

Disadvantages

- Need emollient (e.g., glycerin or propylene glycol) to prevent drying of skin (ethyl alcohol may be less drying than isopropyl).
- Easily inactivated by organic materials.
- Flammable (requires storage in cool, well-ventilated areas).[1]
- Will damage rubber (latex) over time.
- Not good cleaning agents.

CHLORHEXIDINE GLUCONATE (CHG)

Chlorhexidine gluconate (CHG) is an excellent antiseptic. It remains active against microorganisms on skin many hours after use (residual effect) and is safe even for use on newborn infants. Because CHG is inactivated by soap, its residual antimicrobial activity is dependent upon the concentration of CHG in the commercial product. Two to four percent chlorhexidine is the recommended concentration. New 2% aqueous formulations and 1% chlorhexidine in a waterless, alcohol-based antiseptic handrub also are effective (Larson 1995).

Advantages

- Broad spectrum of antimicrobial action.
- Persistent action on skin (chemically active for at least 6 hours).[2]
- Chemical protection (the number of microorganisms inhibited) increases with repeated use.
- Minimally affected by organic material.
- Several products available commercially, most common is in detergent base or as a waterless, alcohol-based antiseptic handrub.

Disadvantages

- Expensive and not always available.
- Action reduced or neutralized by natural soaps, by substances present in hard tap water and some hand creams.
- Not effective against tubercle bacillus, only fairly active against fungi.

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[1] Residual alcohol on hands or skin may be ignited by static electricity, so allow hands to dry thoroughly after using antiseptic handrub.

[2] For maximum effectiveness and residual activity, chlorhexidine should be used on a regular basis (at least daily).

- Cannot be used above pH of 8 because it decomposes.
- Avoid contact with eyes as it can cause conjunctivitis.

IODINE AND IODOPHOR SOLUTIONS

Three percent iodine solutions are very effective antiseptics and are available as both aqueous (Lugol) and tincture (iodine in 70% alcohol) solutions. Seven and a half percent to ten percent iodophors are solutions of iodine mixed with a carrier, a complexing agent such as polyvinyl pyrrolidone (povidone) that releases small amounts of iodine. Povidone-iodine is the most common iodophor and is available globally.

Note: Iodophors manufactured for use as antiseptics are **not** effective for disinfecting inorganic objects and surfaces. These iodine solutions have significantly less iodine than chemical disinfectants (Rutala 1996).

The amount of "free" iodine present determines the level of antimicrobial activity of iodophors (e.g., 10% povidone-iodine contains 1% available iodine, yielding a "free" iodine concentration of 1 ppm [0.0001%]) (Anderson 1989). Iodophors have a broad spectrum of activity. They kill vegetative bacteria, mycobacterium, viruses and fungi; however, they **require up to 2 minutes of contact time to release free iodine**, which is the active chemical. Once released the free iodine has rapid killing action. In addition, iodophors generally are nontoxic and nonirritating to skin and mucous membranes unless the person is allergic to iodine (Larson 1995).

Advantages

- Broad spectrum of antimicrobial action.
- Aqueous iodine preparations are inexpensive, effective and widely available.
- Iodophors are nonirritating to skin or mucous membranes (unless the person is allergic to iodine), making them ideal for vaginal use (e.g., before IUD insertion).
- Up to 3% aqueous solutions do not stain skin.

Disadvantages

- Slow to intermediate antimicrobial action.
- Iodophors have little residual effect.
- Like alcohols, iodine and iodophors are rapidly inactivated by organic materials, such as blood or sputum.
- Tincture or aqueous iodine may cause skin irritation and staining, and must be removed from skin after drying. (Use alcohol to remove the stain.)
- Absorption of free iodine through skin and mucous membranes may cause hypothyroidism in newborn infants so use should be limited (Newman 1989).
- Allergic reactions to iodine and iodophors can occur, so check patient for history of allergy (iodine and shellfish).

Note: Iodine (aqueous or tincture) must never be used on mucous membranes because of its rapid absorption and irritation to the epithelium.

Do not dilute commercially available iodophors manufactured for antisepsis (Betadine or Wescodyne) as this increases the concentration of "free" iodine that can be released and increase the degree of skin irritation.

CHLOROHEXYLENOL

Note: In commercial preparations such as Dettol, which is expensive, the antiseptic and disinfectant activity is due primarily to the alcohol content, not the chlorohexylenol. A 60–90% alcohol solution is equally effective and much less expensive.

Chlorohexylenol (para-chloro-metaxylenol or PCMX) is a halogenated derivative of xylenol that is widely available in concentrations of 0.5–4%. Chlorohexylenol destroys microorganisms by breaking down the cell wall. It has low germicidal activity (Favero 1985) compared to alcohols, iodine and iodophors and is less effective in decreasing skin flora than either CHG or iodophors (Sheena and Stiles 1982). Because it penetrates the skin, it may be toxic when applied to some areas of the body, and should not be used on newborns. Therefore, commercial products with chlorohexylenol concentrations above 4% should not be used.

Advantages

- Broad spectrum of activity.
- Only minimally affected by organic materials.
- Residual effect persists for several hours.
- Minimally affected by organic matter.

Disadvantages

- Inactivated by soaps (nonionic surfactants), making it less useful for skin preparation.
- Should not be used on newborns due to rapid absorption and potential toxicity.

TRICLOSAN

Triclosan is a colorless substance that has been incorporated into soaps as an antimicrobial agent. Concentrations from 0.2–2.0% have moderate antimicrobial activity against gram-positive cocci, mycobateria and yeast but not gram-negative bacilli, especially *P. aeruginosa* (Larson 1995). Although concern has been expressed that resistance to this agent may develop more readily than with other antiseptic agents, resistance to skin flora has not been observed in long-term clinical studies to date.

Advantages

- Broad spectrum of activity.
- Excellent persistence.
- Minimally affected by organic matter.

Disadvantages

- Not affective against *P. aeruginosa* or other gram-negative bacilli.
- Bacteriostatic (only inhibits growth).

PRODUCTS THAT SHOULD NOT BE USED AS ANTISEPTICS

Hexachlorophene (HCP)

Three percent hexachlorophene is active against gram-positive cocci such as staphylococcus, but has little or no activity against gram-negative bacteria, viruses, *Mycobacterium tuberculosis* and fungi. It is slow acting, and one wash with hexachlorophene does not reduce skin flora. Hexachlorophene has neurotoxic side effects and can penetrate the skin of premature infants. It should never be used on broken skin or mucous membranes. Also, when it is used intermittently, bacteria may grow back in large numbers between uses (rebound growth), all of which limits use (Larson 1995).

Zephiran® (benzalkonium chloride)

Zephiran is commonly used in many parts of the world as an antiseptic, but it has several distinct disadvantages:

- Solutions of benzalkonium chloride have repeatedly been shown to become contaminated by *Pseudomonas* species and other common bacteria (Block 1991).
- Solutions of benzalkonium chloride are easily inactivated by cotton gauze and other organic material and are incompatible with soap (Block 1991).
- Zephiran takes at least 10 minutes to kill HIV, the virus causing AIDS (Angle 1992). By contrast, 0.5% chlorine solution kills HIV in less than 1 minute.

Mercury Laurel or Other Mercury-Containing Compounds

Although frequently sold as antiseptics, chemicals containing mercury should be avoided because of their **high toxicity** (Block 1991):

- Skin exposure to low levels of mercury causes blister formation and contact dermatitis.
- Inhalation or ingestion of low levels of mercury affects the central nervous system (numbness, speech impairment, deafness), and higher levels (200 mg) are fatal.
- Skin contact alone can result in absorption of measurable amounts of mercury.
- Pregnant women exposed to small doses may not show toxic effects themselves. The fetus, however, may be harmed because mercury is a **potent** teratogen (causes birth defects, including cleft palate, cerebral palsy and other central nervous system abnormalities).

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