Disinfectants and antiseptics

Öner Süzer
www.onersuzer.com
osuzer@istanbul.edu.tr

Last update: 11.06.2008

Disinfectants and antiseptics

- These agents exhibit little or no selective toxicity.
- Most of them are toxic not only for microbial parasites but also for cells.
- They may be used topically to reduce microbial population in inanimate environment.

Definitions

- **Disinfectant:** A substance that kills microorganisms in the inanimate environment.
- **Antiseptic:** Substances that inhibit bacterial growth both in vitro and in vivo when applied to the surface of living tissue under suitable conditions of contact.

3/36

Table 50–2. Commonly used terms related to chemical and physical killing of microorganisms.

Antisepsis	Application of an agent to living tissue for the purpose of preventing infection
Decontamination	Destruction or marked reduction in number or activity of microorganisms
Disinfection	Chemical or physical treatment that destroys most vegetative microbes or viruses, but not spores, in or on inanimate surfaces
Sanitization	Reduction of microbial load on an inanimate surface to a level considered acceptable for public health purposes
Sterilization	A process intended to kill or remove all types of microorganisms, including spores, and usually including viruses with an acceptable low probability of survival
Pasteurization	A process that kills nonsporulating microorganisms by hot water or steam at 65–100 °C

4/36

Ideal disinfectant

Ideally disinfectants should be:

- Lethal to microorganisms in high dilution
- Noninjurious to tissues or inanimate substances
- Inexpensive
- Stable, nonstaining, odorless
- Rapid-acting even in the presence of foreign proteins, exudates or fibers.

5/36

Alcohols

- Aliphatic alcohols are antimicrobial in varying degree by denaturating protein.
- **Ethanol** in 70% concentration is bactericidal in 1-2 minutes at 30 °C but less effective at lower and higher concentration.
- **Isopropanol 90%** along with **ethanol 70%** are the most satisfactory general antiseptics for skin surfaces however they have no effect on spores.

6/36

Alcohols (continued)

- Better agents are now available for sterilizing instruments.
- Aerosols of 70% alcohol with 1 μm size droplets may be effective disinfectants for mechanical respirators.

7/36

Aldehydes

- **Formaldehyde** in concentration of 1-10% effectively kills microorganisms and their spores in 1-6 hours. It acts by combining with and precipitating protein. It is too irritating for use on tissues but widely used as a disinfectant for instruments.
- It is used in 37% formaldehyde in methyl alcohol by mass solution added to prevent polymerization.
- **Methenamine** taken orally releases formaldehyde into acidic urine.

8/36

Aldehydes (continued)

- **Glutaraldehyde** as a 2% alkaline solution in 70% isopropanol (pH 7.5-8.5) serves as a lipid disinfectant for instruments and for some prostetic materials.
- It kills viable microorganisms in 10 minutes and spores in 3-10 hours, but the solution is unstable, and tissue contact must be avoided.

9/36

Acids

- **Boric acid** 5% in water or as powder can be applied to skin lesions, but is toxic.
- Esters of benzoic acid (**parabens**) are used as antimicrobial preservatives of some drugs.

10/36

Acids (continued)

- **Acetic acid** 1% can be used in surgical dressings as a topical antimicrobial agent. 0.25-2% acetic acid is used as an antimicrobial agent, in external ear and for irrigation of lower urinary track. It is particularly effective against aerobic Gram-negative bacteria such as *Pseudomonas.*
- **Salicylic,** and **undecylenic** and other fatty acids can serve as antifungicides on the skin.

11/36

Halogens and halogen containing compounds

- **Iodine:** 1:20000 solution of iodine kills bacteria in 1 minute and spores in 15 minutes. Tincture of iodine contains 2% iodine and 2.4% sodium iodide in alcohol.
- It is the most powerful antiseptic for intact skin, but not commonly used because of serious hypersensitivity reactions, irritant effects and its staining of clothing and dressings.

12/36

Iodophores

- **Iodophores (povidine-iodine):** They are iodine complexes and release free iodine as the solution is diluted.
- Iodophores retain the activity of iodine. They kill vegetable bacteria, fungi and lipid containing viruses. They may be sporocidal upon prolonged exposure.
- Iodophores are less irritating and less likely to produce skin hypersensitivity than tincture of iodine.

13/36

Chlorine

- Chlorine is a strong oxidizing agent and universal disinfectant that is most commonly provided as a 5.25% **sodium hypochlorite** solution.
- Thus 1:10 dilution provides 5000 ppm of available chlorine; this concentration is recommended for disinfection of blood spills.

14/36

Chlorine (continued)

- Less than 5 ppm kills vegetative bacteria whereas 5000 ppm is necessary to kill the spores. It can also kill *Mycobacteria* (1000-10000 ppm) and vegetative fungal cells (100 ppm), and fungal spores (500 ppm).
- Because chlorine is inactivated by blood serum, feces and protein containing materials, surfaces, should be cleaned before use.
- Alternative chlorine-releasing compounds include **chlorine dioxide** and **chloramineT.**

15/36

Chlorhexidine

- Chlorhexidine is a cationic biguanide with very low water solubility.
- It is active against vegetative bacteria, and Mycobacteria and has moderate activity against fungi and viruses.
- It strongly absorbs to bacterial membranes causing leakage of small molecules and precipitation of cytoplasmic proteins.

16/36

Chlorhexidine (continued)

- It is most effective against Gram-positive cocci and less active against Gram-positive and Gram-negative rods.
- It has formulations 2-4%.
- Oral activity is low because of poor absorption.
- It has neurotoxicity when applied topically in middle ear surgery and neurosurgery.

17/36

Phenolics

- Phenol itself is no longer used because of its corrosive effect on tissues, its toxicity upon absorption and its carcinogenic effect.
- Derivatives which has diminished adverse effects are used such as o-phenylphenol, o-benzyl-p-chlorophenol and p-tertiary-amylphenol.
- Detergents are often added to formulations to clean and remove organic material that may decrease the activity of a phenolic compound.

18/36

Phenolics (continued)

- Phenolic compounds disrupt cell wall and membranes, precipitate proteins, and inactivate enzymes.
- They are bactericidal, fungicidal and capable of inactivating lipophilic viruses. They are not sporicidal.
- Phenolic compounds are used for hard surface decontamination in hospitals and laboratories.

19/36

Peroxygen compounds

- Hydrogen peroxide and peracetic acid have high killing activity and a broad spectrum against bacteria, spores, viruses, and fungi when used in appropriate concentration.
- 10-25% concentrations of hydrogen peroxide are sporicidal.

20/36

Peroxygen compounds (continued)

- Peracetic acid is more active than hydrogen peroxide as a bactericidal and sporicidal agent.
- Concentrations of 250-500 ppm are effective against broad range of bacteria in 5 minutes. Bacterial spores are inactivated by 500-30000 ppm.
- Only slightly increased concentrations are necessary in the presence of organic matter.
- Enteroviruses require 2000 ppm for 15-30 min. for inactivation.

21/36

Heavy metals

- Heavy metals, principally **mercury** and **silver** are rarely used as disinfectant the moment.
- **Silver sulfadiazine** slowly releases silver and is used to suppress bacterial growth in burn wounds.

22/36

Disinfectants

Table 50–1. Activities of disinfectants.

	Bacteria				Viruses		Other		
	Gram-positive	Gram-negative	Acid-fast	Spores	Lipophilic	Hydrophilic	Fungi	Amebic Cysts	Prions
Alcohols (isopropanol, ethanol)	HS	HS	S	R	S	V	—	—	R
Aldehydes (glutaraldehyde, formaldehyde)	HS	HS	MS	S (slow)	S	MS	S	—	R
Chlorhexidine gluconate	HS	MS	R	R	V	R	—	—	R
Sodium hypochlorite, chlorine dioxide	HS	HS	MS	S (pH 7.6)	S	S (at high conc)	MS	S	MS (at high conc)
Hexachlorophene	S (slow)	R	R	R	R	R	R	R	R
Povidone, iodine	HS	HS	S	S (at high conc)	S	R	S	S	R
Phenols, quaternary ammonium compounds	HS	HS	±	R	S	R	—	—	R
Strong oxidizing agents, cresols	HS	MS to R	R	R	S	R	R	R	R

Key: HS, highly susceptible; S, susceptible; MS, moderately susceptible; R, resistant; V, variable; —, no data.

23/36

Sterilants

- Pressurized steam (autoclaving) at 120 ºC for 30 minutes has been the basic method for sterilizing instruments and decontaminating materials.
- If autoclaving is not possible **ethylene oxide** is used, but this agent is explosive, mutagen and carcinogen.

24/36

Urinary antiseptics

25/36

Urinary antiseptics

- Urinary antiseptics are agents that exert antibacterial activity in the urine but have little or no systemic antibacterial effect.
- Their usefulness is limited to lower urinary tract infections, especially for prolonged suppression of bacteriuria in chonic urinary tract infections.

26/36

Nitrofurantoin I

- It is bacteriostatic and bactericidal for many Gram-positive and Gram-negative bacteria.
- *P. aeruginosa* and many strains of *Proteus* are resistant.
- Resistant mutants are rare and clinical drug resistance emerges slowly in susceptible populations.
- A reduced form of the drug is highly reactive and damages DNA. Its activity is greatly enhanced at pH 5.5 or below.

27/36

Nitrofurantoin II

- It is well absorbed after ingestion, and very rapidly metabolized and excreted.
- Thus no systematic antibacterial action is achieved.
- Average daily dose for urinary tract infection in adults is 100 mg taken four times; so concentrations of 200 μg/ml are reached in the urine.
- 100 mg once a day can prevent recurrent urinary infections.

28/36

Adverse effects

- Anorexia, nausea, vomiting.
- Neuropathies and hemolytic anemia in glucose-6-phosphate dehidrogenase deficiency.

29/36

Methenamine

- Below pH 5.5 methenamine releases formaldehyde which is antibacterial.
- Mandelate salt is taken 1 g × 4 daily
- Hippurate salt is taken 1 g × 2 daily

30/36

Methenamine (continued)

- Acidifying agents such as ascorbic acid may be given to lower urinary pH below 5.5. Sulfonamides should not be given at the same time because they form an insoluble, and inactive compound with the released formaldehyde.
- The action of methenamide is nonspecific on microorganisms.
- However organisms such as *Proteus* that make strongly alkaline urine through release of ammonia are usually resistant.

31/36

Miscellaneous antimicrobial agents

32/36

Metronidozale

- It is an antiprotozoal drug that also has potent antibacterial activity against anaerobes, including *Bacteroides* and *Clostridium* species.
- It is well absorbed after oral administration, and widely distributed in tissues.
- It can also be given IV.
- Metronidazole penetrates well into the cerebrospinal fluid, is metabolized in the liver and may accumulate in hepatic insufficiency.
- Ornidazole, tinidazole, nimorazole, and secnidazole are similar agents.

33/36

Mupirocin

- It is a natural product produced by *Pseudomonas fluorescence*. As it is rapidly inactivated, it can not reach detectable systemic levels.
- Mupirocin is active against Gram-positive cocci, particularly *Staphylococci*. It inhibits isoleucyl tRNA synthetase.
- Mupirocin is indicated for topical treatment of minor skin infections such as impetigo. Topical applications over large infected areas is not recommended.
- Mupirocin is also indicated for intranasal application for elimination of *S. aerus* carriage.

34/36

Polymyxins

- The polymyxins are a group of basic peptides active against Gram-negative bacteria.
- Except for polymyxins B and E all others are very nephrotoxic.
- They are bactericidal for many Gram-negative rods, including *Pseudomonas*.
- They act like cationic detergents and disrupt bacteria cell membranes.
- They also bind and inactivate endotoxin. Their use is restricted to topical use, because they have important unwanted effects such as neurotoxicity.

35/36

Thank you...

36/36