Sterilization & Disinfection

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Objectives

1-Define the terms sterilization, disinfectant and antiseptic.
2- Know the different methods of sterilization (physical and chemical methods).
3- Know and realizes that heat is the most important method of sterilization and its application in medical practice.
4-Know dry heat as applied in hot air oven and moist heat as applied in Autoclaves.
5- Know the principles of Autoclave function and monitoring methods of sterilization .
6- Know the importance of non heat sterilization methods and their use for sterilization of heat sensitive objects.

Objectives , cont.

7-Know the differences between antiseptics and disinfectants.
8- Know the factors affecting disinfectants and antiseptics .
9- Know the scope of function and applications of different disinfections and antiseptics in clinical practice.

Definitions

Sterilization: complete killing of all forms of microorganisms, including bacterial spores

Disinfection: killing or removing of harmful vegetative microorganisms.

Disinfectant: chemical substance used on inanimate objects . Toxic to human .

Antiseptic: disinfectant that can be safely used on living tissues.

Methods of Sterilization

1. **Physical Methods:**

   Heat *(moist heat & dry heat)*

   U.V.(ultra violet) Light

   Ionizing Radiation

2. **Chemical Methods**:

   Ethylene oxide

   Glutaraldehyde

Sterilization
Physical Methods : Heat

HEAT : Most important method ,should be used whenever possible, can be :

a-Dry heat : use temperature at 160˚C for one hour

b- Moist heat : eg. Autoclaves, use temperature at 121 for 15 minutes or 134 C for 10 minutes.

Sterilization
Physical methods:

U.V. light

- Has limited sterilizing power because of poor penetration into most materials. Generally used in irradiation of air in certain areas such as operating rooms ,virology and tuberculosis labs.

Ionizing radiation

- e.g. Gamma radiation: has greater energy than U.V. light, therefore more effective. Used mainly in industrial facilities e.g. sterilization of disposable plastic syringes, gloves, specimens, containers and Petri dishes.

Medical applications of heat methods

Dry Heat

Dry Heat- kills microorganisms by destroying their oxidative processes.

- Simplest method is exposing item to be sterilized to the naked flame e.g. Bunsen burner- for sterilizing bacteriological loops, knives, blades.
- **Hot air oven expose items to 160 ° C for 1 hour.**

Has electric element in chamber as source of heat plus a **fan** to circulate air for even distribution of heat in chamber. Oven without fan is dangerous. Used for items that are lacking water such as:

-Metals

-Glassware

-Ointment , Oil, Waxes ,Powder

Moist Heat/medical application: Autoclave

Uses hot water. Moist heat kills microorganisms by denaturating proteins.

Autoclaving : the standard sterilization method in hospitals.

The equipment is called **Autoclave** and it works under the same principle as the pressure cooker where water boils at increased atmospheric pressure ,because of increased pressure the boiling point of water is >100 ° C.

The **Autoclave** is a tough double walled chamber in which air is replaced by pure saturated steam under pressure.


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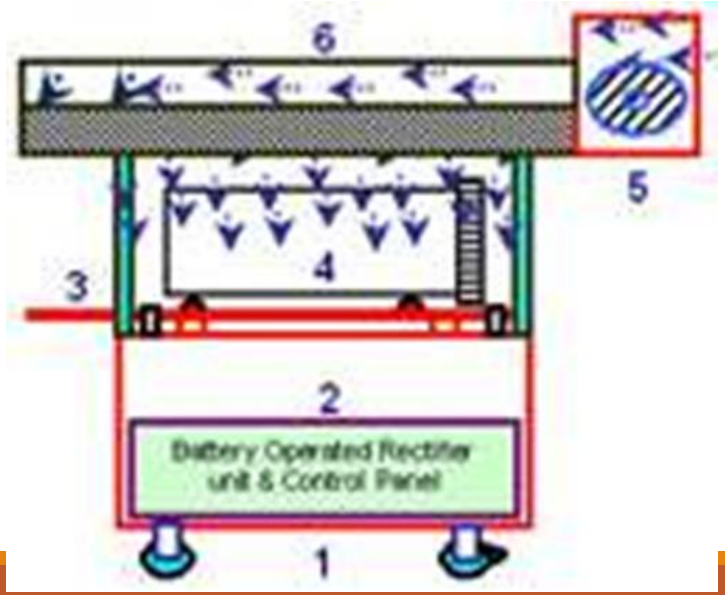
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Air in the chamber is evacuated and filled with saturated steam. The chamber is closed tightly, the steam keeps on filling into it and the pressure gradually increases. The items to be sterilized completely surrounded by **saturated steam** (**moist heat**) which on contact with the surface of material to be sterilized **condenses** to release its **latent heat** of condensation which adds to already raised temperature of steam so that eventually all the microorganisms and spores are killed.

The usual temperature achieved is 121 ° C for 15 minutes or 134 C for 10 minutes.

Advantages of Autoclaves

Temp > 100 C therefore spores killed.

Condensation of steam generates extra heat.

The condensation also allows the steam to penetrate into porous materials.

Note: Autoclavable items must be used for invasive procedures in operating room , dental equipments , and the laboratories.

Monitoring of Autoclaves

1. **Physical method:** use thermocouple to measure accurately the temperature.

2. **Chemical method :** use heat sensitive chemical that changes color at the right temperature and exposure time.

e.g. a) Autoclave tape (commonly used)

b) Browne's tube.

3. **Biological method : spore test**, a kit containing a spore bearing organism is added during the sterilization process ,then cultured later on to ensure that spores have been killed.


Sterile Surgical
Pack

Spore test
(Biological indicator)

Disinfection

Physical methods :

Filtration

Pasteurization

Chemical methods:

Antiseptics & Disinfectants

Disinfection
Physical Methods : Filtration

Use of ***membrane filter*** made of cellulose acetate or other material.

Generally removes most bacteria but viruses and some small bacteria (e.g. *Chlamydia* & *Mycoplasma*) require smaller pore sizes.

Thus filtration does not technically sterilize the items but is adequate for circumstances under which is used.

Main use: for heat labile substances e.g. sera, antibiotics. Other use: AC of certain operating theatres.

Disinfection : Physical methods

.Pasteurization

Used heat at temperatures sufficient to inactivate harmful organism in **milk** (including most viruses ,most vegetative bacteria and fungi). The temperatures of sterilization is not achieved . Two methods :

Flash method :Temp. used 74° C for 3-5 seconds.

Conventional method: temp. used 62° C for 30 minutes .

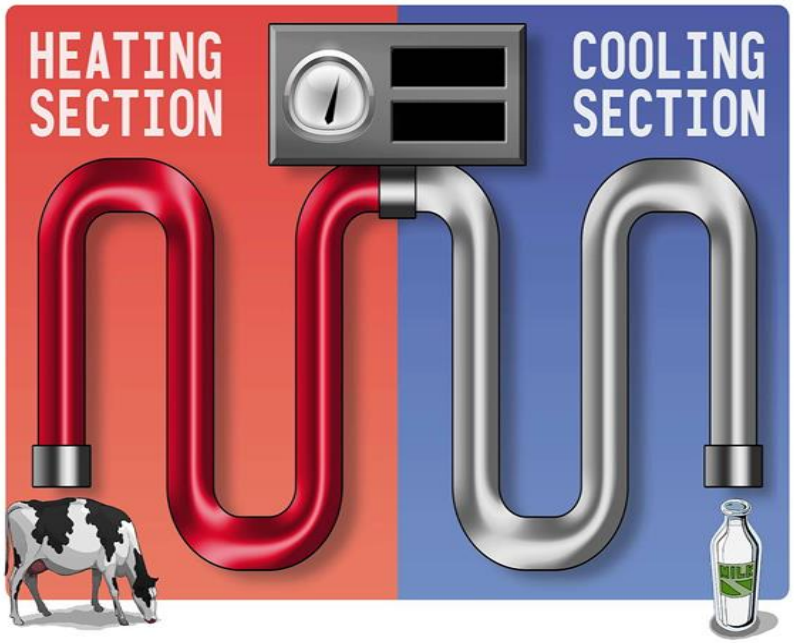
.Boiling : commonly used in domestic circumstances .Does not kill spores.

.**Electric steam sterilizers:** babies bottles.

Pasteurization of milk

To prevent transmission of the following important zoonotic diseases to human :

- **Typhoid fever**
- **Brucellosis**
- **Bovine tuberculosis**
- **Q fever**



Disinfection
Chemical methods

- **Disinfectants /Antiseptics .** Classes:

. **Alcohol:** Isopropyl alcohol (90-95%)

. **Halogens**: iodine, chlorine, hypochlorite

. **Hydrogen peroxide**

. **Phenolics** : phenol, chlorhexidine, hexachlorophene

. **Glutaraldehyde & Formaldehyde**

Glutaraldehyde is a strong chemical substances may be used to **achieve sterilization** (kill spores),used for heat sensitive items

.**Surface active compounds**: quaternary ammonium compounds

Sterilization by strong Chemicals

Useful for **heat sensitive materials** e.g. plastics and lensed endoscopes).

1**. Ethylene Oxide :** Ethylene oxide alkylates DNA molecules, inactivates microorganisms.

Temperature : 55-60° and exposure period 4-6 hours. Potentially explosive gas.

2. Activated alkaline Glutaraldehyde 2%

Immerse item in solution for about 20 minutes.

If ***Mycobacterium tuberculosis*** or **spores** present ,then immersion period is 2-3 hours.

3. Other uses: Hypochlorite at certain concentrations used for *drinking water supply ,house cleaning and disinfecting swimming pools.*

Factors influencing activity of disinfectants

1. Activity directly proportional to **temperature.**

2. Directly proportional to **concentration** an optimum concentration. After this level no advantage in further increases in concentration.

Factors influencing activity of disinfectants

3. May be inactivated by

- **Dirt**
- **Organic matter :** Proteins, Pus, Blood, Mucus and Feces**.**
- **Non organic:** Cork, Hard water and Some plastics.

4. Time : Disinfectants need time to work.

5. Range of Action : Disinfectants are not equally effective against the whole spectrum of microbes.

e.g. Chlorhexidine less active against Gram negative bacteria than Gram positive cocci.

Hypochlorite and Glutaraldehyde are more active against hepatitis viruses than most other disinfectants**.**

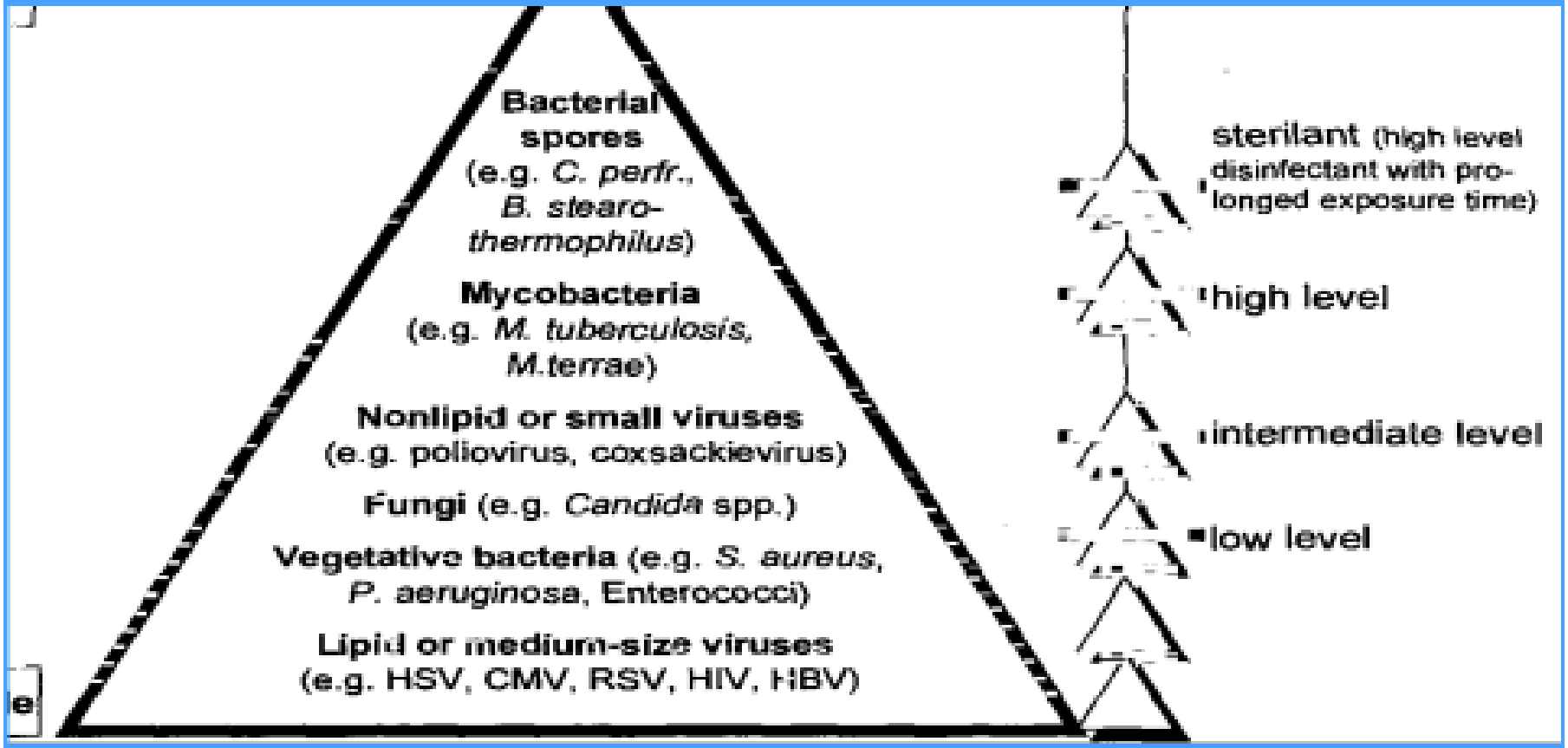
Level	uses	application	example
High-level disinfectants Kill all including spores	Used for items involved in invasive procedures but NOT withstand sterilization (critical)	Endoscopes, Surgical instruments	Moist heat Gluteraldehyde Hydrogen peroxide Chlorine dioxide Formaldehyde Peracetic acid
Intermediate-level disinfectants Kill all including mycobacterium non-enveloped viruses fungus and bacteria	Used for cleaning surface or instruments without bacterial spores and highly resilient organism (semicritical)	Laryngoscopes, Anesthesia breathing circuits...etc	Phenol compounds Alcohol Iodophor
Low-level disinfectants Enveloped viruses and bacteria	Used to treat noncritical instruments and devices, not penetrating into mucosa surfaces or sterile tissues (noncritical)	Hospital surfaces	Quaternary ammonium compounds

TABLE 3–1 Methods of Disinfection and Sterilization

METHOD	ACTIVITY LEVEL	SPECTRUM	USES/COMMENTS
Heat			
Autoclave	Sterilizing	All	General
Boiling	High	Most pathogens, some spores	General
Pasteurization	Intermediate	Vegetative bacteria	Beverages, plastic hospital equipment
Ethylene oxide gas	Sterilizing	All	Potentially explosive; aeration required
Radiation			
Ultraviolet	Sterilizing	All	Poor penetration
Ionizing	Sterilizing	All	General, food
Chemicals			
Alcohol	Intermediate	Vegetative bacteria, fungi, some viruses	
Hydrogen peroxide	High	Viruses, vegetative bacteria, fungi	Contact lenses; inactivated by organic matter
Chlorine	High	Viruses, vegetative bacteria, fungi	Water; inactivated by organic matter
Iodophors	Intermediate	Viruses, vegetative bacteria,[a] fungi	Skin disinfection; inactivated by organic matter
Phenolics	Intermediate	Some viruses, vegetative bacteria, fungi	Handwashing
Glutaraldehyde	High	All	Endoscopes, other equipment
Quaternary ammonium compounds	Low	Most bacteria and fungi, lipophilic viruses	General cleaning; inactivated by organic matter

[a]Variable results with *Mycobacterium tuberculosis*.

Disinfectant Level



Antiseptics /Disinfectants	GPC	Activity against		TB	Inactivated by		Corrosive Action
		GNB	Spores		Protein	Soap	
Phenol	++	++	–	+	–	–	+
Quaternary ammonium compounds	+	+	–	–	+	±	–
Hydrogen peroxide	++	++	+(slow)	+	+	-	-
Hypochlorite	++	++	++	+	++	–	++ or ±
Iodophor	++	++	+ (Slow)	-	+	–	–
(Hibitane) Chlorhexidine	++	+	–	–	–	–	–
70° Alcohol	++	++	–	±	++	–	–
Formaldehyde	++	++	++ (slow)	++	+	–	++
Glutaraldehyde	++	++	++	++	±	–	+

Hospital disinfection methods

Article	Disinfectant
Floors, walls	Phenolics fluids 1-2%
Surfaces tables	Hypochlorite, Alcohol
Skin	
Surgeons' hands	Chlorhexidine, Iodine alcohol
Patient skin	70% Alcohol, Iodine
Endoscopes	Glutraldehyde 2% (Cidex), subatmospheric steam
Thermometers	70% Alcohol

Soap, Water and common sense are yet the best antiseptics

William Osler

Important to know

Any instrument or item used for sterile body site should be **sterile.**

Any instrument or item used for non-sterile body site can be **disinfected**.

Reference book

Sherris **Medical Microbiology, an Introduction to Infectious Diseases.**

Latest edition, Kenneth Ryan and George Ray.

Publisher : McGraw Hill .