



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



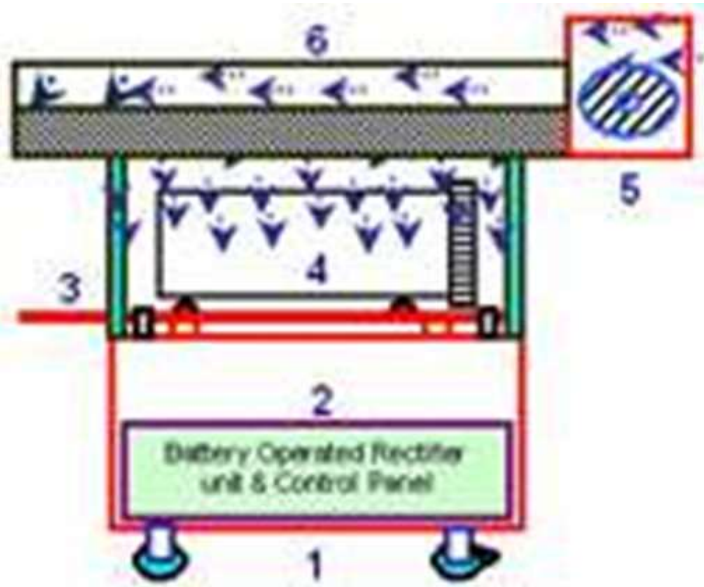
Moist Heat/medical application: Autoclave

Uses hot water. Moist heat kills microorganisms by **denaturing 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.



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 .

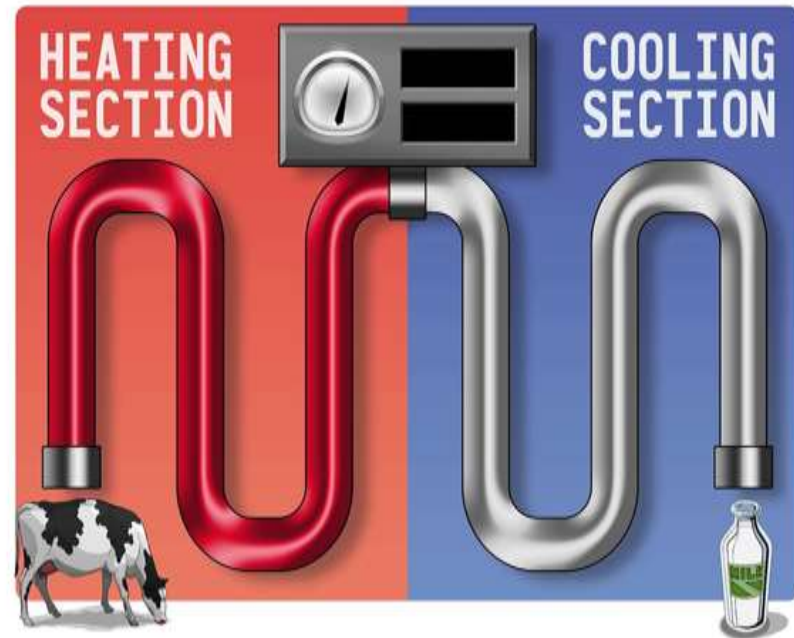
.Boiling : commonly used in domestic circumstances .Does not kill spores.

.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.

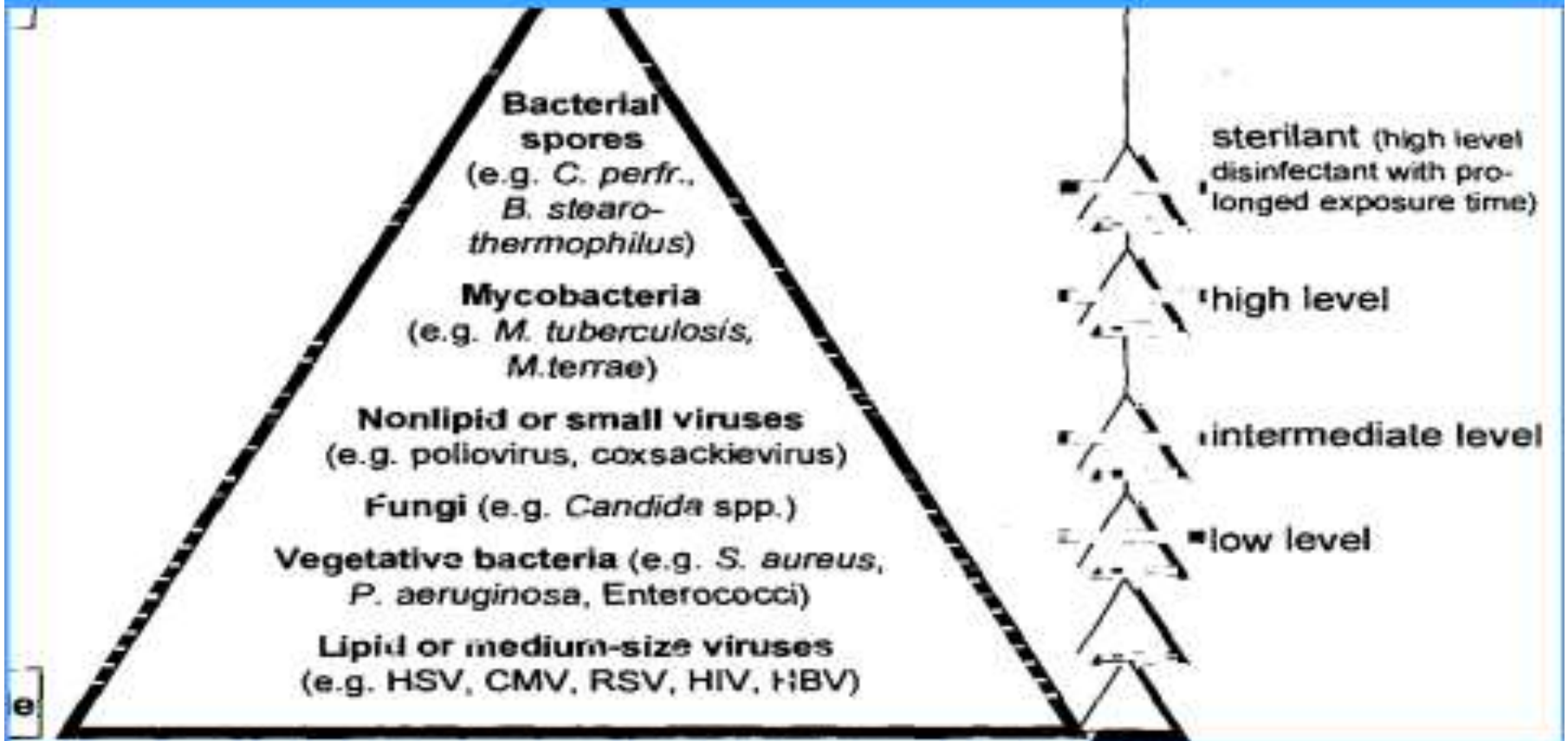
If ***Mycobacterium tuberculosis*** or **spores** present ,then immersion period is 2-3 hours.

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

1-Sterilization Monitor by physical, chemical or biological)	A-Physical	Heat	Dry Metals,Glassware,Ointment / Oils/ Waxes/Powder	160°C /60 mints
		Moist heat		121° C /15 mints or 134° C /10 mints
		Pasteurization For milk		74°C for 3-5 seconds or 62°C /30 mints
		UV Light	TB lab	254 nm waves
		Ionizing Radiation	sterilization of disposable	X- rays, gamma rays & cosmic rays
	B-Chemical (heat sensitive)	Ethylene Oxide (gas)	endoscopes	55-60°C /4-6 hours.
		Gluteraldehyde (Aldehydes)	Endoscopes anesthetic tubes	2% 20 mints –TB 2 hrs
		Filtration	For sera and antibiotics	0.22-0.24 µm pores
	2-Disinfectant	Phenolics fluids	Surfaces Surgical and neonatal units	1-2%
Gluteraldehyde		surfaces	2%	
Alcohol		Surfaces/thermometer		
3-Antiseptic	Chlorhexidine	skin	0.5%	
	Iodine (halogens)	skin	10%	
	Alcohol	skin	70%	

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

Disinfectant Level



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.
3. Dirt, Organic matters(protein, pus,blood,mucus and faeces), Non-organic matters (corks, hard water, some plastics)
4. **Time** of exposure
5. Rang of action (spectrum of activity)

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.

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

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

^aVariable results with *Mycobacterium tuberculosis*.

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	Glutaldehyde 2% (Cidex), subatmospheric steam
Thermometers	70% Alcohol

Soap, Water and common sense are yet the best antiseptics

William Osler

FIGHT GERMS BY WASHING YOUR HANDS!



1 Wet your hands



2 Soap



3 Lather and scrub - 20 sec



4 Rinse - 10 sec



5 Turn off tap



6 Dry your hands

DONT FORGET TO WASH:

- between your fingers
- under your nails
- the tops of your hands

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 .

Tutor communication

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