Sterilization and Disinfection

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STERILIZATION

- Sterilization is defined as the process by which an article, a surface or a medium is freed of all microorganisms including viruses, bacteria, their spores and fungi, both pathogenic and non-pathogenic.

Disinfection

Disinfection is a process of destruction or removal of organisms capable of giving rise to infection.

Disinfectants are capable of killing vegetative bacteria, fungi, viruses and rarely bacterial spores.

Antisepsis

Antisepsis is the destruction or inhibition of microorganisms in living tissues thereby limiting or preventing the harmful effects of infection.

A disinfectant that is applied to living tissue is referred to a an antiseptic.

Classification of Sterilization and Disinfection

1) Physical agents:

- Sunlight
- Drying
- Filtration
- Radiations

2) Chemical Agents:

- Phenols and cresols
- Halogens
- Aldehydes
- Alcohols
- Dyes
- Vapour-phase disinfectants
- Surface active disinfectants

Physical agents

1. Sunlight

- Sunlight possesses ultraviolet rays with heat rays are responsible for appreciable germicidal activity.
- These rays, however, cannot penetrate through glass, e.g. Window panes.
- This is one of the natural method of sterilization of water tanks, rivers and lakes.

2. Drying

- Water constitutes 80 % of the weight of the bacteria and is also essential for the growth of bacteria.
- Drying has deleterious effect on many bacteria. However spores are unaffected by drying.

3. Heat

- Heat is the most reliable and rapid method of sterilization.
- It can be easily controlled and unlike chemical disinfection, leaves no potential harmful residue.
- Unless the material to be sterilized is heat sensitive, this method should be preferred.

- There are 2 types of heat:

  a) Dry heat

  b) Moist heat

a) DRY HEAT:

- It is believed to kill microorganisms by causing destruction oxidation of essential cell constitutes.
- Dry heat at $100^{o}C$ for 60 minutes and $115^{o}C$ for 60 min can kill all vegetative bacteria and fungal spores respectively.
- Bacterial spores can be killed by dry heat at $160^{o}C$ for one hour or $180^{o}C$ for 20 Minutes.
- On the whole dry heat is less efficient sterilization process than moist heat.

b) Moist Heat:

- It causes denaturation and coagulation of proteins.
- When steam condenses on cooler surface, it releases its latent heat and raises the temperature of its surface.
- If spores are present, steam condenses on them and increases their water content leading to hydrolysis and breakdown of bacterial spores.

Sterilization of Dry Heat

Types:

a) Red Heat
b) Flaming
c) Incineration
d) Hot Air Oven

a) Red Heat

- Inoculating wires and loops, points of forceps and spatulas are sterilized by holding them almost vertical in a bunsen burner flame untill red hot.
- *Advantage*- sterilization is rapid and thorough.

b) Flaming

- Scalpel blades, needles, mouth of culture tubes and bottles, glass slides and coverslips are sterilized by passing the article through the bunsen flame without allowing them to become red hot.

- *Advantages:*

1) Surface sterilization is possible
2) Rapid method

c) Incineration

- This is an efficient method for rapidly destroying contaminated materials such as soiled dressings and pathological material, etc.

- *Advantage:* Can be used for loads that can be penetrated by steam.

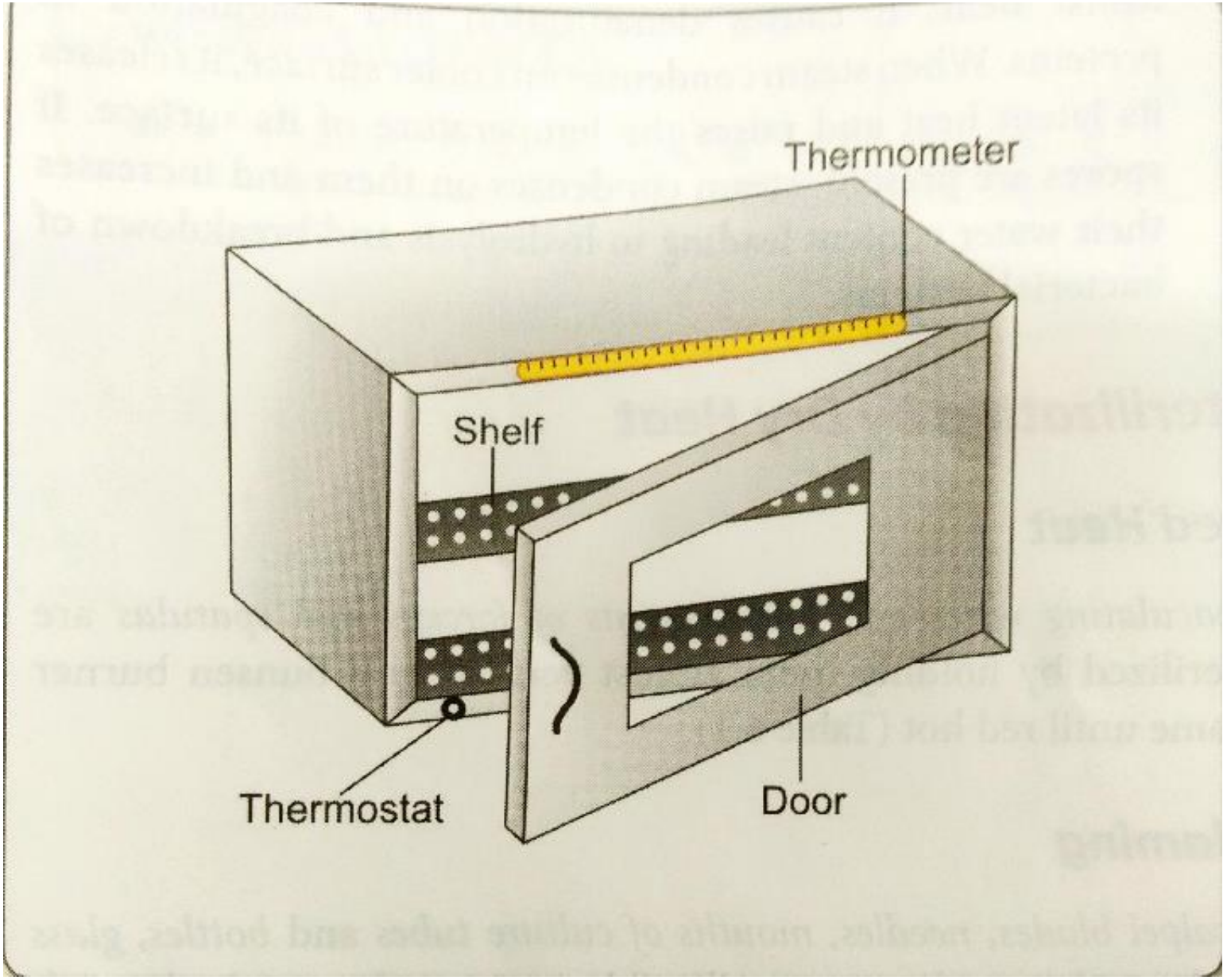
d) Hot air Oven

- It is a method of choice for sterilization of glassware e.g. test tubes, petri dishes, pipettes and flasks, metal instrumments such as forceps, scissors and scalpels.

- Sealed materials such as oils, greases, any dry powder.

- It is electrically heated & it is fitted with a thermostat that maintains the chamber air at a chosen temperature & at a fan that distributes hot air in the chamber.
- It must not be overloaded & space must be left for circulation of air through the load.

- Holding time for sterilization is 1 hour at 160^{o}C or 20 min. at 180^{o}C.
- It is timed as beginning when the thermometer first shows 160^{o}C or 180^{o}C respectively.


Thermometer
Shelf
Thermostat
Door

Sterilization by Moist Heat

It means killing the microorganisms with hot water or steam.

Moist heat is divided into 3 forms:

1. At temperatures below 100^{o}C.
2. At a temperature of 100^{o}C.
    a) Boiling water
    b) steam
3. At temperature above 100^{o}C.

A) Moist Heat at temperatures below 100^{o}C.

a) Pasteurization of milk:

- The temperature employed is either 63^{o}C for 30 min (holder method) or 72^{o}C for 20 seconds (flash method)followed by rapid cooling to 13^{o}C or lower.
- By this method non-sporing organisms such as mycobacteria Brucella and salmonella are destroyed.

- The flash method is preferable for pasteurization of milk because it is less likely to change the flavor and nutrient content and it is more effective against pathogens such as C. burnetii.

- Although pasteurization inactivates most viruses and vegetative state of bacteria & fungi, they do not kill spores & thermo resistant species.

- Therefore milk is not sterile after regular pasteurization, which explains why even unopened cartons of milk will eventually spoil on prolonged storage.

- Newer techniques have now been used to produced milk storage of 3 months. In this method, the milk is processed with ultrahigh temperature of 134^{o}C FOR 1-2 seconds.

b) **Heat-labile fluids** such as serum may be disinfected by heating at 56^{o}C for one hour. If temperature rises above 59^{o}C it will coagulate.

c) **Vaccines** prepared from non-sporing bacteria may be inactivated in water bath at 60^{o}C for one hour.

d) Household utensils & patients clothing may be disinfected by washing in water at 70^{o}C for several minutes.

B) Moist heat at a temperature pf 100^{o}C

a) **Boiling at 100^{o}C**: boiling at 100^{o}C for 10 to 30 minutes kills all vegetative bacteria & some bacterial spores. Therefore, it is not recommended for sterilization of instruments for surgical procedures.

b) **Free steam at 100^{o}C:** Steam at normal atmospheric pressure is at 100^{o}C. but, in addition, it has latent heat which on condensing on the article to be sterilized released its latent heat

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3. Koch or Arnold steam sterilizer

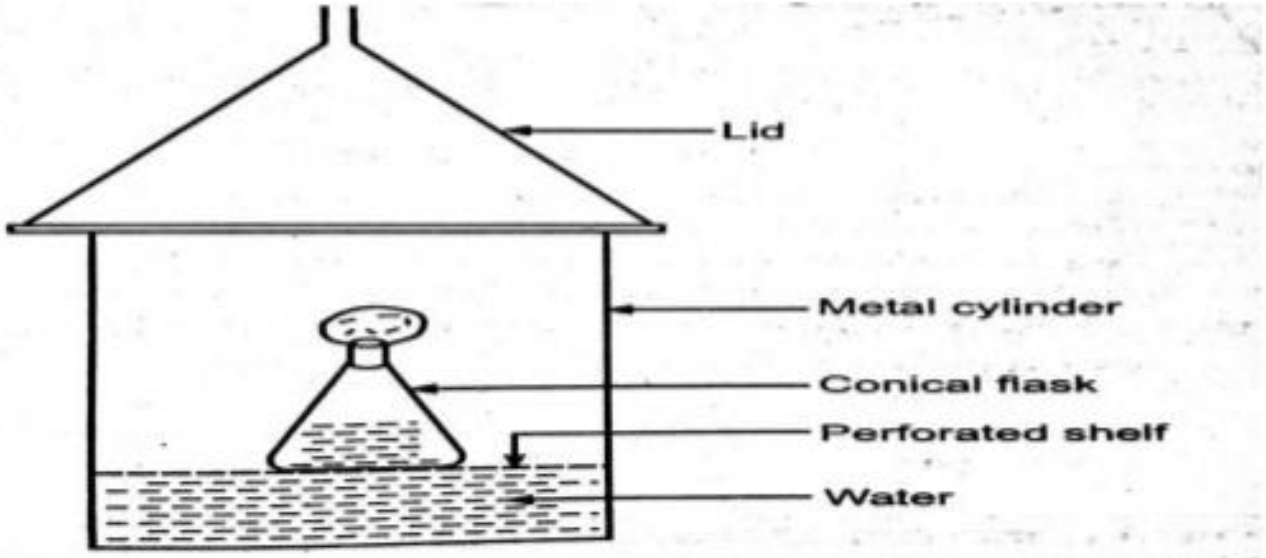


Fig. 16.2 : Steam sterilizer

3. Koch or Arnold steam sterilizer

- A Koch or Arnold steam sterilizer is usually used in industries.
- This steam sterilizer consists of a vertical metal cylinder with removable conical lid having a small opening for the escaping steam.
- Water is added on the bottom and a perforated shelf above the water level is present.
- Single exposure to steam for 90 minutes ensures complete sterilization but media containing sugar and gelatin, which may get decomposed on long heating. Hence such materials may be exposed at 100^0C for 20 minutes on three successive days. This is known as **tyndallisation or intermittent or fractional sterilization.**
- First exposure to steam kills all vegetative bacteria and at second exposure all spores germinate in a favourable medium and are killed on subsequent occasions.

c) Moist Heat at temperature above 100^{o}C.

AUTOCLAVE

- The autoclave is a equipment used to remove microorganisms (Virus, Bacteria, fungus etc.) and spores using high pressure and high temperature steam Sterilization

DEFINITION

Autoclave is a pressurized device designed to heat aqueous solutions above their boiling point at normal atmospheric pressure to achieve sterilization.

Auto ⟹ self

Clavis ⟹ self locking device

Autoclave Machine

PURPOSE OF THE AUTOCLAVE

1. To prepare materials for bacteriological cell cultures(test tubes, pipettes, Petri dishes, etc.) without contamination.

2. Prepare elements used for taking samples. (needles, tubes, containers).

3. Sterilize contaminated material.

Principle

- Boiling point of water is directly proportional to the pressure when the volume is constant.

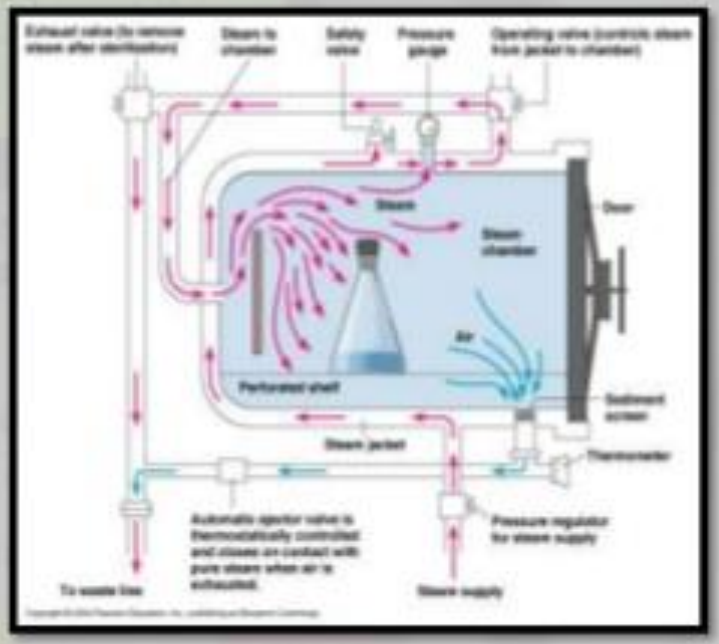
Pressure $\propto$ Temperature

- When pressure is increased in a closed vessel the temperature increases proportionately. i.e.for about 15 pounds of pressure per square inch (Psi) the temperature rises to 121°C.
- This pressure and temperature is kept constant for 20 minutes during autoclaving.
- It is sufficient to kill all the vegetative forms and spores of the organism.

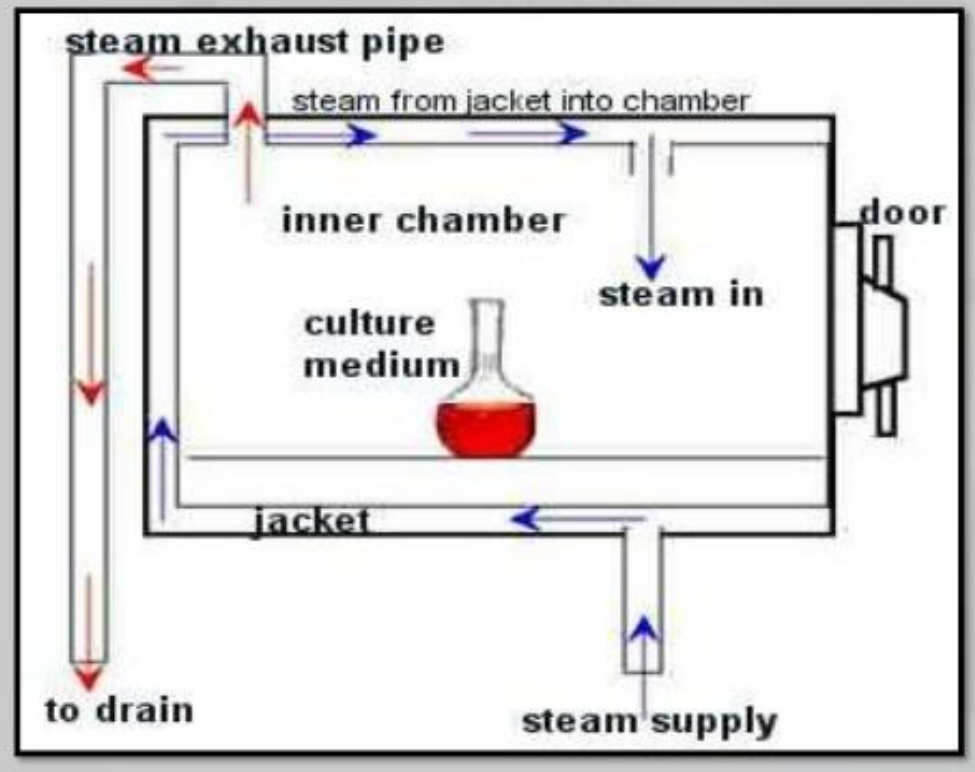
Working

- Most autoclaves contain
  - a sterilizing chamber to place articles
  - a steam jacket where steam is maintained.
- Steam flows from the steam jacket into the sterilizing chamber
- Cool air is forced out
- A special valve increases the pressure to 15 pounds/square inch above normal atmospheric pressure.

- The temperature rises to 121.5°C, and
- The superheated water molecules rapidly conduct heat into microorganisms.
- The time is reduced to 15 minutes to kill bacterial spore
- For denser objects, up to 30 minutes of exposure may be required.



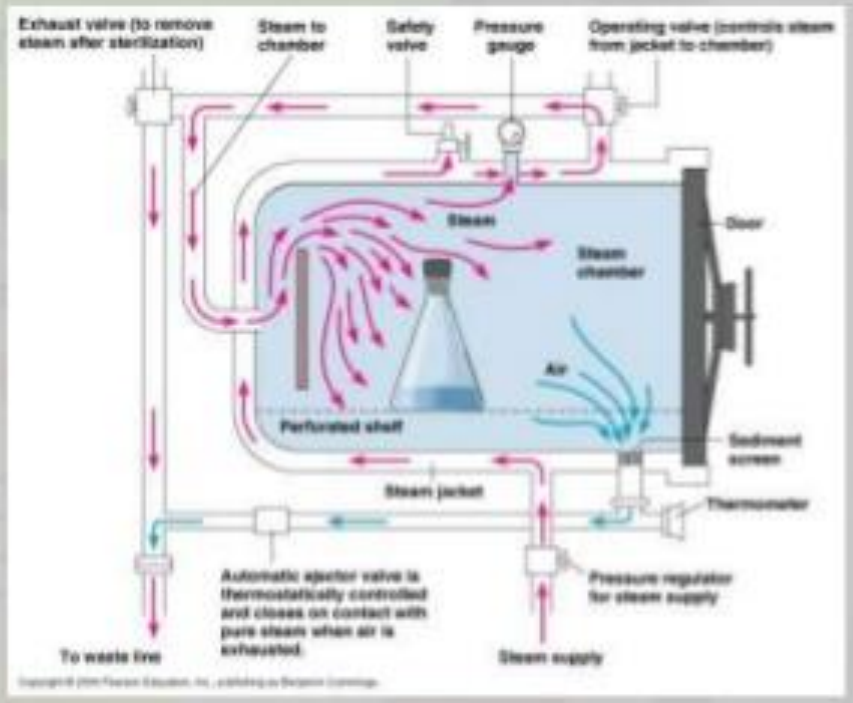
Schematic Diagram Of Autoclave



Air Removal

Various methods involved are :

- Downward displacement
- Steam pulsing
- Vacuums pumps
- Super atmospheric cycles
- Sub atmospheric cycles



TYPES OF STERILISATON

- Dry sterilisation
- Wet sterilisation

Dry Sterilization

Mechanism:

- By destructive oxidation of essential cell constituents.
- Resistant spores requires a temperature of about 160 °C for 60 minutes.
- Employed for glassware; syringes, metal instruments and paper wrapped goods.
- Used for anhydrous fats, oils and powders that are impermeable to moisture.

Wet sterilisation

Mechanism:

- By coagulating and denaturing enzymes and structural protein.
- Resistant spores generally requires 121 °C for 15-30 minutes.
- Used for the sterilization of culture media, and all other materials through which steam can penetrate.
- Moist heat is more effective than dry heat.
- Lower temperatures in a given time at a shorter duration.

C} AUTOCLAVE

- This is one of most safe and reliable method of sterilization.
- It is only effective way of sterilization.
- Autoclave kills both pathogens and their spores to achieve high effective sterilization.
- Thus it is considered as the best to sterilize surgical instruments.
- Autoclave works on the principle of pressure cooker utilizing the specific heat of steam (water vapors) to kill pathogens .

- The temperature achieved under pressure 104 degree C.
- It is capable of killing even the spores.
- The co-ordination of the temperature and time is very important in autoclaving.

Temp. in degrees	Duration of autoclaving
134-138	3 min
126-129	10 min
121-123	15 min
115-116	30 min

D} CHEMICAL STERILIZATION

- Ethylene oxide gas sterilization:

✓ ETO gas is used to sterilized items that a sensitive to heat or moisture.

✓ ETO gas kills microorganisms with spores.

✓ All plastic and rubber items

E.g. disposable syringes and needles, dialysis set, endotracheal tubes, internal pacemakers, gloves, all types of catheters, RT tubes, etc.

E} Radiation of Gamma Rays

- Gamma rays (Co60), ionizing radiation or electron beams can be used for sterilization of a wide range of articles, such as suture materials, syringes, needles catheters, dressing material etc.

F} Ozone gas sterilization

- Ozone sterilizes by oxidation.
- Oxidation is a process that destroys organic and inorganic matter.
- It penetrate into the membranes of cells and causing them to kill.
- Ozone gas sterilization provides alternative to EO gas sterilization.

G} Chemical strilants in solution

- Articles are immersed in solutions of chemicals.
- If EO gas sterilization is not available following chemicals can be used:

a) Acetic acid: it takes 20 min at room temperature of 77 degree F for sterilization.

a) Formaldehyde: 37% aqueous solution(formalin) or 8 % formaldehyde in 70% isopropyl alcohol kills microorganisms.

c) Glutaraldehyde: 2.4%, 2.5% or 3.4% kills microorganisms.

d) Hypochlorous acid: It is high level disinfectant, kills many spores on well cleaning endoscopes and other heat sensitive items.


开关
压力表

DISINFECTION

- Disinfection does not kill all microorganisms specially bacterial spores; it is less effective than sterilization.

TYPES OF DISINFECTION

1) **Chemical disinfectants:**

✓ Disinfectants are effective against microorganisms. Following disinfectant used in OT.

a) Alcohol Ethyl alcohol, isopropyl its is bactericidal agent, kills some virus, fungi.

a) Aldehyde aqueous acidic 2% glutetaldehye: kills virus, bacteria but not sporicidal but kills fungi.

C) phenol compound: 64% with 0.95 % glutaraldehyde: kills virus, bacteria, fungi, spores.

D) Halogens: Chlorine and chlorine compounds such as sodium chloride: kills virus, fungi, bacteria but limited sporocidal.

2) Physical disinfectants

a) Boiling water: minimum boiling of water for 30 min ensures disinfection of steel articles.

Boiling water can not kill spores.

b) Pasteurization: it can be used for disinfection reusable respiratory devices and anesthesia breathing circuits. (e.g. mask and bags).

c) Ultraviolet radiations:

- ✓ UV radiations kills selective vegetative bacteria, fungi, lipoprotein virus on contact in air or water.

- ✓ UV lights are used in operative rooms to decrease air born microorganisms to low levels.

Fumigation of OT

- To sterilize the operation theater formaldehyde gas(bactericidal & spermicidal) is widely employed (cost effective) for fumigation.

- Formaldehyde kills the microbes.

Steps of fumigation

- ***Step-1***: **preparation for fumigation**:

1. Thoroughly clean windows, doors, floor, walls and all washable equipments with soap and water.
2. Close windows and ventilators tightly. If any openings found in the room, seal it with cellophane tape or other material.

3. Switch off all lights, AC and other electrical items.

4. Calculate the room size in cubic feet & calculate the required amount of formaldehyde as given in step 3.

- ***Step 2:*** **precaution**

1. Adequate care must be taken by wearing cap, mask, foot cover, spectacles, etc.

2. Formaldehyde is irritant to eye and nose; and it has been recognized as a potential carcinogen.

3. For fumigating employee must be provided with the personal protective equipments.

- ***Step- 3: fumigation:***
- 1) electric boiler fumigation method:

✓ for each 1000 cu.ft 500 ml of formaldehyde(40% solution) added in 100 ml of water in an electric boiler.

✓ Switch on the boiler, leave the room and seal the door.

✓ After 45 min. switch off the boiler without entering into the room.

OR

2) Potassium permanganate method:

- ✓ For every 1000 cubic ft add 450 gm of $KMnO_4$ to 500 ml of formaldehyde (40% solution).

- ✓ Take about 5 to 8 bowels(heat resistant; place it in various locations) with equally divided parts of formaldehyde and add equally divided $KMnO_4$ to each bowl.

- ✓ This will cause auto boiling and generate fumes.

3) After the initiation of formaldehyde vapor, immediately leave the room and seal it for at least 48 hrs.

- ***Step-4***: **Neutralization :**

1. After the fumigation process neutralize the formaldehyde vapor with ammonia solution.

   on inspection or surgery day enter the OT at 7am with 150 ml of 10% ammonia (for 500 ml of the formaldehyde use i.e. for 1000 cy.ft)

2) Place the ammonia solution in the center of the room and leave it for 3 hrs to neutralize the formalin vapor.

BACILLOCID STERILIZATION

- Bacillocid rasant spray disinfectant are excellent alternative for fumigation, which should be considered if feasible as fumigation has certain major health concern.

- Bacillocid is a surface and environment disinfectant.

- It is bactericidal, virucidal, sporocidal.

- It is mopped and sprayed allowing 30 min contact time for the action.

- It has advantage over fumigation as shutting of OT for 24 hours has not required.

ROLE & RESPONSIBILITIES OF OT NURSE

- Insure preoperative checks made on accepting the pt into the department and prior to the administration of any anesthetic or surgical procedure.

- Prepare the patient psychologically, by appropriate communication and physically by placement of monitoring devices, position & assisting with IV cannulation for the planned procedures.

- Ensuring that policies and procedures are explained.
- Checking of needles, swabs, instruments, ect before and after surgery.
- Proper and correct recording and reporting.
- To ensure that correct aseptic techniques are used at all times.

- To ensure the patient is positioned safely and correctly.
- To administer medicines according to policies and procedures.
- To deliver high quality care which is clinically effective evidenced based and appropriate.
- To assess, plan, implement and evaluate care as apart of collaborative program of care.

- Maintain resources efficiently and effectively.
- Organize and priorities own workload to ensure provision of quality service.
- Work in away that minimizes risks to the health, safety and security of self and others.
- Take the appropriate action to manage an emergency.

- Identify potential risks involved in work for self and others.
- Support others in maintaining heath, safety and security.
- Correctly follow routinely maintenance, schedule and procedures.
- Accurately test equipment before procedures and identify deviations.

- Take the appropriate action if a fault can not be resolved.

- Handle the instruments correctly and safely.

- Clean and restore equipments and work areas, leaving them in a suitable condition for future use.

- Replace all articles after clening.

THANK YOU