CERTIFICATE YEAR II SEMESTER I

CLINICAL ENGINEERING TECHNOLOGY II

Code module CET 308

KENYA MEDICAL TAINING COLLEGE

OLOITOKTOK CUMPUS

FUCULTY OF REHABILITATIVE SCIENCES

MEDICAL ENGINEERING DEPARTMENT

OBJECTIVES

***The student should know and understand*:**

1. ***Maternity.***
2. ***Types of equipment's found in maternity unit.***
3. ***Know types of weighing equipment in maternity.***
4. ***Principle of operation different types of weighing scale.***
5. ***Maintenance and calibration procedures carried on baby scales.***
6. ***Different sterilization processes.***
7. ***Types of autoclaves in maternity unit.***
8. ***Parts and functions of various types of autoclaves.***
9. ***Principle of operation of various autoclaves.***
10. ***Sterilization sequence of autoclaves.***
11. ***Common problems experienced with autoclaves***
12. ***Maintenance procedures carried on autoclaves.***
13. ***Calibration procedures performed on autoclaves.***
14. ***Parts of hot air ovens.***

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CHAPTER ONE

1.0 OBJECTIVES

1. Different sterilization processes.
2. Types of autoclaves in maternity unit.
3. Parts and functions of various types of autoclaves.
4. Principle of operation of various autoclaves.
5. Sterilization sequence of autoclaves.
6. Common problems experienced with autoclaves
7. Maintenance procedures carried on autoclaves.
8. Calibration procedures performed on autoclaves.
9. Parts of hot air ovens.

1.1 STERILIZATION

- ✓ It is the complete removal or destruction of all forms of microbial life, including bacteria, viruses, fungi and spores.

1.2 What items must be sterilized?

1. **Critical items** include forceps, scalpels, scalers, surgical burs, etc.
2. **Semi-critical**- instruments are considered instruments that do not penetrate soft tissues, include mirrors, reusable impression trays, and amalgam condensers.
3. **Non-critical** items are those that only come in contact with intact skin, includes, external components of x-ray heads, bloodpressure cuffs, and pulse oximeters

- ➢ **Process:** The rate of killing of microorganisms depends upon the concentration of the killing agent and time of exposure.

$$N = 1/CT$$

N – number of survivors

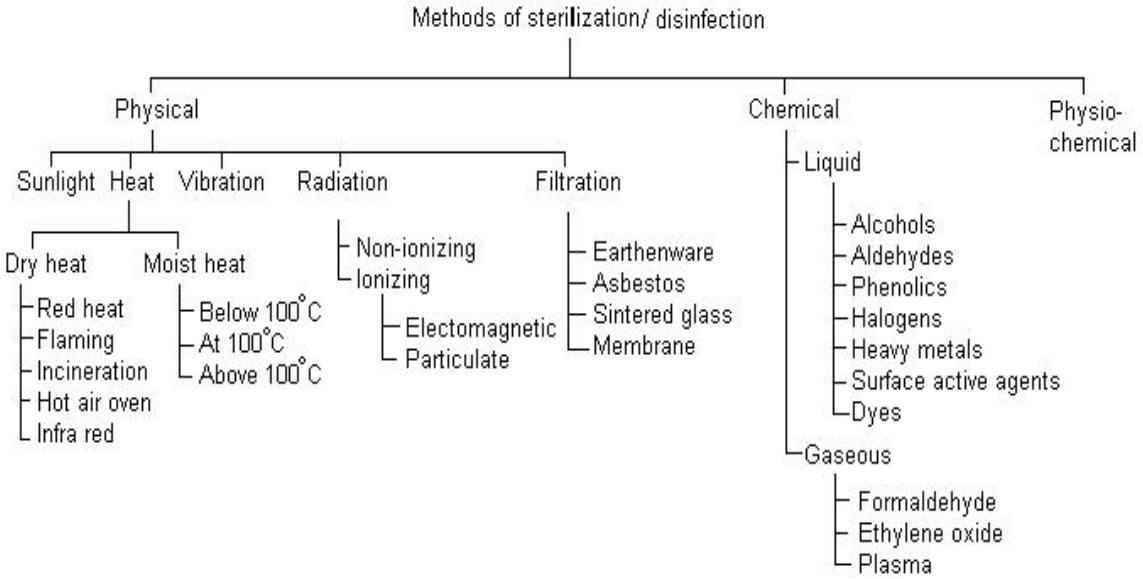
C – concentration of agent

T – time of exposure to the agent

- ✓ **Disinfection** This is the process of elimination of most pathogenic microorganisms (excluding bacterial spores) on inanimate objects. Disinfection does not attempt to remove all viable microorganisms
- ✓ **Decontamination** This is the process of removal of contaminating pathogenic microorganisms from the articles by a process of sterilization or disinfection. Also, it is the process that removes pathogenic microorganisms from an object to make it safe to handle.
- ✓ **Sanitization:** This is the process that reduces the microbial population on an object to a safe level. Also, is the process of chemical or mechanical cleansing, applicable in public health systems.
- ✓ **Cleaning** is the removal of adherent visible soil (blood, protein substance and debris), dust or other foreign material by a manual or chemical process.

Discussion *(discuss different methods of sterilization).*

1.3 Methods of Sterilization



A. Physical Method

Physical method is categorized into:

1. Sunlight.
2. Heat.
3. Vibration.
4. Radiation
5. Filtration.

1. Heat

- ✓ It can be **dry heat** and **moist heat**.
- ✓ It kills the microorganisms by **denaturation** and **coagulation** of proteins.
- ✓ Temperature required to kill microbe by dry heat more than moist heat.
- ✓ **Thermal death time** is the Minimum time required to kill a suspension of organisms at a predetermined temperature in a specified environment.

Factors affecting sterilization by heat

- ✓ Nature of heat: Moist heat is more effective.
- ✓ Temperature and time: inversely proportional.
- ✓ Number of microorganisms: More number- higher temperature or longer duration.
- ✓ Nature of microorganism: Species and strain, Spores highly resistant.
- ✓ Type of material: heavily contaminated, higher temperature/prolonged exposure.
- ✓ Certain heat sensitive articles sterilized at lower temperature.
- ✓ Presence of organic material: Organic materials (protein, sugars, oils and fats) increase the time required

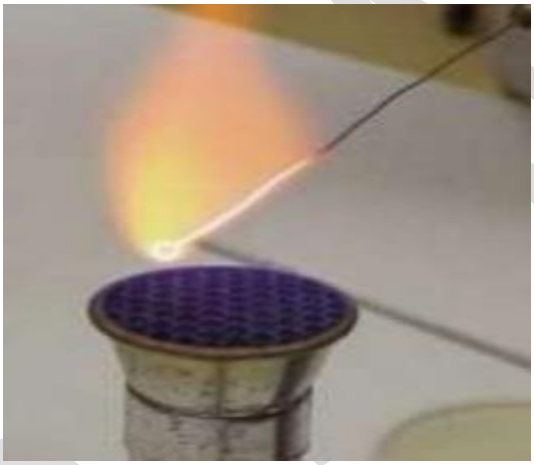
A. Dry heat

- ✓ Dry heat acts by protein denaturation and coagulation, oxidative damage and toxic effects elevated levels of electrolytes.

- ✓ Dry heat can also be used to sterilize products but is less efficient than the sterilization with steam.it takes longer time and the temperature is higher.
- ✓ Used to sterilize plastics, papers, special liquids and powders.
- ✓ Dry heat acts either by **static** air or **forced** air.

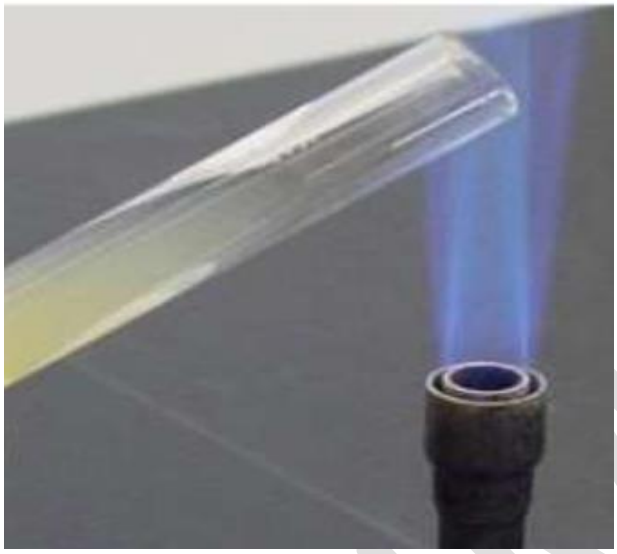
a. Read heat

- ✓ This involves holding object in Bunsen flame till they become red hot.
- ✓ Used to sterilize particles such as bacteriological loops, straight wires, tips of forceps and searing spatulas. They are held on the Bunsen flame until they become red hot.
- ✓ limited to those articles that can be heated to redness in flame.



b. Flaming

- ✓ This is a method of passing the article over a Bunsen flame but not heating it to redness.
- ✓ Used to sterilize products like scalpels, mouth of test tubes, flasks, glass slides and cover slips are passed trhough the flame a few times.



c. Incineration

- ✓ This is a method of destroying contaminated material by burning them in the incenarator.
- ✓ Used to sterilize particles such as **soiled dressings**, **animal carcasses**, **pathological**, material and bedding.
- ✓ Suitable only for those articles to be disposed.

d. Hot air oven.

- ✓ Introduced by Louis Pasteur.
- ✓ Used to sterilize **metallic instruments** (like **forceps**, **scalpels, scissors**).

  Glassware (such as **Petri dishes**, **pipettes**, **flasks**, **all-glass syringes**).

  Swabs, **oils, grease**, **petroleum jelly** and **some pharmaceutical products.**

- ✓ Unsuitable for **rubber** and **plastics**.
  - ✓ This is an electrical medical equipment which uses heated air for sterilization.they operate fom temperatures ranging from 50℃ to 300℃.
  - ✓ Air which is a poor conductor of heat is heated using electrical heaters, and because of poor heat conductivity distribution of heat throughout the chamber by a fan.
  - ✓ It is fitted with a thermostat control, temperature indicator, meshed shelves or trays.
  - ✓ **Mouths of flasks**, **test tubes** and both ends of pipettes must be plugged with **cotton**.
  - ✓ **Petri dishes** and **pipettes** wrapped in a paper.

e. Ifrared radiation.

- ✓ Bring about sterilization by generation of heat.
- ✓ The particles to be sterilized are placed in a conveyor belt and passed through a tunnel that is heated by infrared radiators to a temperature of 180℃.
- ✓ The particles are exposed to temperatures for a period of 7.5 minutes.
- ✓ Items sterilized include **metallic instruments** and **glassware**.
- ✓ Efficiency can be checked using **Browne's tube**.

Assignment

1. Name and explain various forms of dry heat sterilization.

B. moist heat/steam sterilization.

- ✓ This is done by saturated steam under pressure and can be performed at different temperatures.

a. At temperature below 100°C(pasteurization).

- ✓ It can be **holder method** which sterilizes at 60°C for 30 minutes and **flash method** which sterilizes for 72°C for 15 minutes which followed by quickly cooling to 13°C.
- ✓ Also, it includes ultra-high tempeature (UHT) which is 140°C for 15 sec and 149°C for 0.5 sec.
- ✓ Suitable for sterilizing **milk borne pathoges** like **salmonella**, **mycobacteria**, **streptococci**, **staphylococci** and **brucella**.
- ✓ Efficiency is tested by **phosphatase** test and **methylene blue** test.

Vaccine bath.

- ✓ The contaminating bacteria in a vaccine preparation can be inactivated by heating in a water bath at 60o C for one hr.
- ✓ Only vegetative **bacteria** are killed and **spores survive**.

Serum bath

- ✓ The contaminating bacteria in a **serum preparation** can be inactivated by heating in a water bath at 56ºC for one hour on several successive days.
- ✓ Proteins in the serum will coagulate at higher temperature.
- ✓ Only vegetative bacteria are killed and spores survive

Inspissation

- ✓ Egg and serum containing media (Lowenstein- Jensen's; Loeffler's serum).
- ✓ Inspissation means stiffening of protein without coagulation.
- ✓ Placed in an **inspissator** and heated at 80-85o C for 30 minutes on three successive days.
- ✓ On the first day, the vegetative bacteria would die and those spores that germinate by next day are then killed the following day.

- ✓ The process depends on germination of spores in between inspissation

b. At temperature of 100°C (boiling).

- ✓ It involves boiling of water at 100°C. It is used to kill most **vegetative bacteria** and **viruses.** It is done fot **10-20** minutes.
- ✓ Killing activivity can be enhanced by addition of 2% **sodium bicabonate.**

c. At tempeatures above 100°C.

- ✓ Also, known as **autoclaving**.
- ✓ It involves subjecting items being sterilized to high pessure steam.
- ✓ Done at temperatures of 121°C for 15 minutes and 134°C for 7 minutes.
- ✓ It is archieved by a machine called autoclave.

Advantages of steam:

- ✓ It has more penetrative power than dry air,
- ✓ It moistens the spores (moisture is essential for coagulation of proteins),
- ✓ Condensation of steam on cooler surface releases latent heat,
- ✓ Condensation of steam draws in fresh steam.
- ✓ It is cheap and nontoxic.
- ✓ It penetrates fabric.
- ✓ For all its advantages, it the method of choice for all items except those which are moisture or heat sensitive.

Parameter in Steam Sterilization

There are four parameters of importance in steam sterilization:

1. Steam
2. Pressure
3. Temperature
4. Time.

Sterilization cycle includes

1. Warming of the chamber(preheating).
2. Vacuum extraction(pre-vacuuming)
3. Pre-steam penetration time(heating)
4. Steam penetration time(steam admission)
5. Holding time(sterilization).
6. Steam exhausting(Evacuation).
7. Drying.

Discussion*(discuss various processes of sterilization of autoclaves)*

Steam Sterilization Sequences (Process) by an autoclave

i. Pre-vacuum (Air removal) phase

- ✓ the pressure is at 0 bar.
- ✓ The valve closes and the water heater starts heating and temperature rises slowly.
- ✓ The vacuum pump creates some more vacuums which suck the trapped air out of the sterilization packs.

ii. Steam admission.

- ✓ The boiling point of water is reached.
- ✓ Vacuum pump pumps switch off completely. Steam is created and admitted into the sterilization chamber. Steam gets more and creates pressure.
- ✓ The boiling point starts to shift dure to pressure and temperature rises.

iii. Sterilization phase.

- ✓ The pre-set temperature and pressure are reached and the heater is switched off.
- ✓ Sterilization begins and timer starts and the pre-set time corresponding to related temperature is (15 minutes at 121℃ or 7 minutes at 134℃) is counted down.
- ✓ Consists of holding time equilibrium time.

iv. Steam release.

- ✓ The sterilization process ends and outlet valve opens and steam is released from the sterilization chamber and condenses in a special condenser and the hot water gets back into the reservoir.

v. Drying phase.

- ✓ The temperature in the chamber decrease.
- ✓ The vacuum pump comes on and supports in the drying process by sucking the steam out of the chamber.
- ✓ Additional hater might be provided to help in drying process.

Discussion ***(name different types of autoclaves found in hospital)***

1.4 AUTOCLAVES

- ✓ An autoclave is a machine used to carry out industrial and scientific processes requiring elevated temperature and pressure in relation to ambient pressure and/or temperature.
- ✓ All steam autoclaves have a metal chamber to withstand the high pressure and the temperature. A massive door or lid which is locked during operation keeps the chamber closed. The chamber is heated by an electric heating element. In places without electricity supply autoclaves heated up by gas or fuel are common.

TYPES OF AUTOCLAVES

<u>According to operation.</u>

- ✓ **<u>Gravity displacement autoclave.</u>**
  - ➢ The hot steam enters the chamber and forces all the air through a vent.
  - ➢ It is unsuitable for autoclave bags because it creates air pockets.
  - ➢ It is generally of two types; **horizontal** and **vertical autoclave**.

Horizontal autoclave: The door/lid of this type of autoclave open outwards towards the handler. It is usually available in large sizes.

Vertical autoclave: The autoclavable material is loaded from the top side of the autoclave. It is usually available in small sizes.

- ✓ **<u>Positive pressure displacement type</u>**.
  - ➢ Steam is generated in a separate steam generator which is then passed into the autoclave.
  - ➢ It is faster as the steam can be generated within seconds.

- ✓ **<u>Negative pressure displacement type.</u>**
  - This type of autoclave contains both the **steam generator** as well as a **vacuum generator**.
  - The vacuum generator pulls out all the air from inside the autoclave while the steam generator creates steam.
  - The steam is then passed into the autoclave.
  - This is the most recommended type of autoclave as it is very accurate and achieves a high sterility assurance level.
  - This is also the most expensive type of autoclave.

<u>According to structure</u>

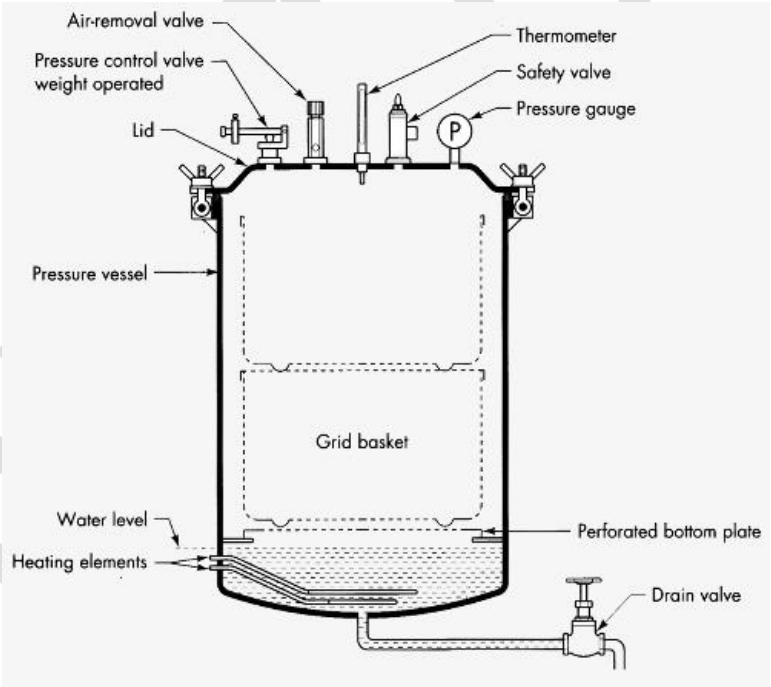
1. **pressure cooker type.**

- ✓ It is simplest autoclave with a capacity of 5-25 l.
- ✓ It is the small and portable version of a vertical autoclave.
- ✓ Sometimes integrated with heating element and sometimes doesn't have the provision of heating element.
- ✓ The pressure cooker type autoclave has a safety valve, a release valve, a pressure gauge and a thermometer.
- ✓ Very common in small hospitals.

2. **Vertical autoclave**

- ✓ The autoclavable material is loaded from the top side of the autoclave. It is usually available in small sizes.

- ✓ The vertical autoclave is a stationary top-loader with a capacity of 60 l - 100 l.
- ✓ It is often double walled with pressure gauges, thermometer, water level inspection tube and a mechanical time.
- ✓ Bigger vertical autoclaves use 3-phase installation.



Various Parts and functions.

Pressure control valve.

The pressure control valve opens when the working pressure (and thus the temperature) is reached. It works with a counter weight or a spring and can be adjusted manually.

Air-removal valve.

Is opened manually when the sterilization process is finished. It releases the steam out of the chamber. This can be done by opening a mechanical valve or by a solenoid when pushing a switch.

Thermometer or temperature gauge.

Is opened manually when the sterilization process is finished. It releases the steam out of the chamber. This can be done by opening a mechanical valve or by a solenoid when pushing a switch.

Safety valve.

The safety valve opens and releases the pressure out of the vessel if the pressure control valve fails and the pressure gets too high.

Pressure gauge.

The pressure gauge shows the pressure in the vessel but is not really needed when a thermometer is built in.

Lid and lid gasket.

A heavy lid closes the vessel airtight. The lid is sealed with a silicon gasket. The gasket has to be checked and cleaned frequently. A leaking gasket allows hot steam to escape and can create serious burns.

Pressure vessel.

The high-pressure chamber is made out of stainless steel. It contains the sterilization goods

Heating element.

The heating element (sometimes three elements for a three-phases power supply) heats up the water. It is important that it is always covered with water. A dry heating element will burn out within seconds.

Drain valve.

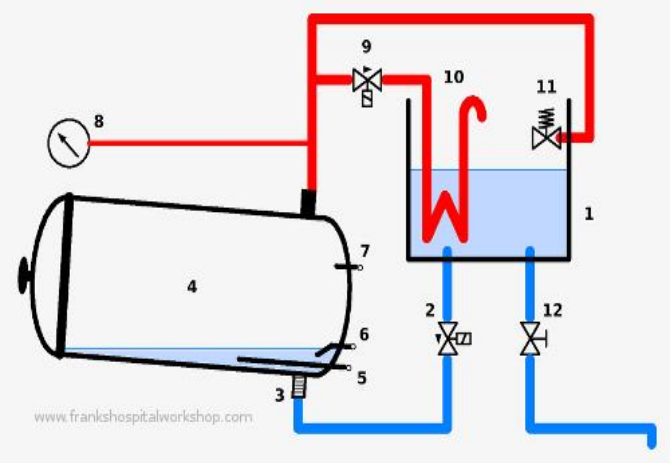
It is used to drain remaining water from the chamber after sterilization and during cleaning

3. **Horizontal autoclave**.
    - ✓ The door/lid of this type of autoclave open outwards towards the handler. It is usually available in large sizes.

4. **Table top autoclaves.**

- ✓ Table top autoclaves have a capacity of 20-80 l.
- ✓ It is found where surgical instruments are needed: E.g., in maternity wards, laboratories and at the dentist.
- ✓ Modern table-top autoclaves are a fully automatically controlled and come with a vacuum pump, drying program.
- ✓ It also has safety lock for the door and water reservoir.

Construction and operation of table top autoclave.

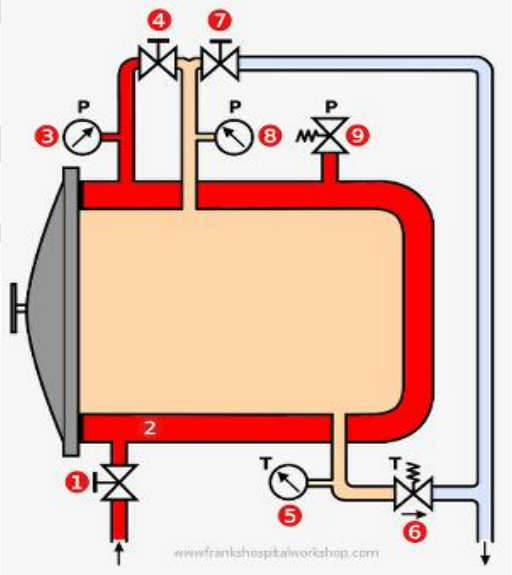


The valve **2** opens and water runs from the reservoir **1** through a filter **3** into the chamber **4**. When the water level reaches the level sensor **6** the valve closes and the heater switches on. After a while, steam is generated. The steam rises and pushes the cooler air through valve **9**and the condenser **10** out of the chamber. When the temperature reaches the boiling point (measured by the temperature sensor **7**), the outlet valve **9** closes. Then the pressure in the chamber rises (shown by the pressure gauge **8**) as well as the temperature. When the sterilization temperature is reached (sensor **7**), the heating element switches off. If the temperature control fails and the pressure gets too high, the pressure is released by safety valve **11**. For cleaning and servicing, the water can be drained by the manual valve **12**

5. Stationary autoclaves.

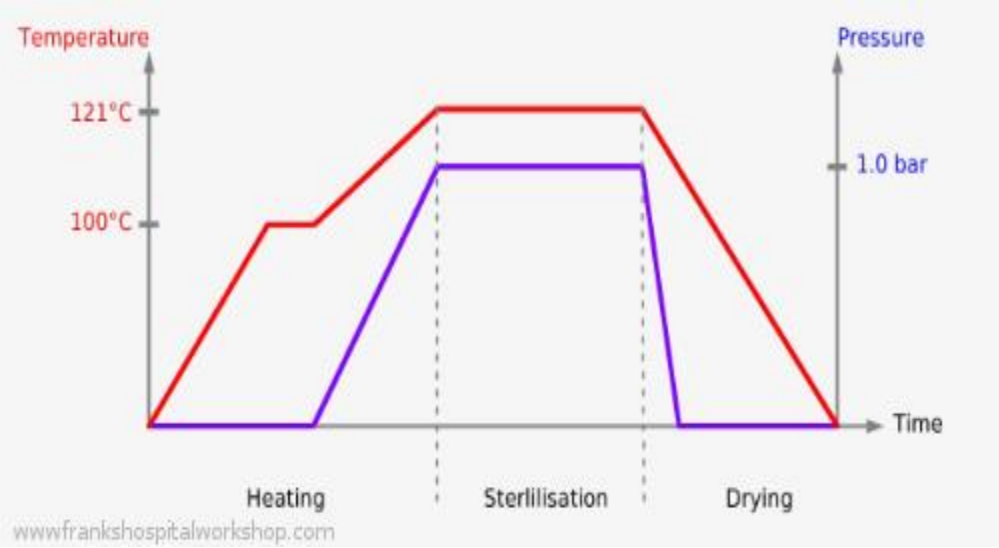
- ✓ Stationary autoclaves are big, automated or semi-automated machines, built for all sorts of purposes.
- ✓ Used to sterilize Instruments, liquids, clothes and even for waste sterilization.
- ✓ Available with capacities up to 800 l.
- ✓ Normally located in the sterile processing department (SPD) of a hospital.
- ✓ It often has two doors, a front door, rear door which are positioned between two rooms, sterile and non-sterile area.

Construction and operation of stationary autoclave.



When the inlet valve **1** is open, hot steam from the external boiler enters the jacket **2**of the autoclave. The chamber gets preheated. The pressure gauge shows **3** the jacket pressure. When valve **4** is opened, the steam gets into the chamber. The colder air escapes through the open valve **6**. The valve is a temperature controlled one-way valve. The valve closes when the steam is hot enough. Now the pressure rises until it is as high as the inlet pressure. The chamber pressure is shown by the pressure gauge **8** and the temperature by the thermometer **5**. It is placed at the bottom of the chamber, where the lowest temperature is. When the sterilization time is over, the inlet valve has to be closed and the outlet valve **7** opened. Steam escapes through the drainage pipe. The pressure and the temperature in the chamber decrease but the jacket is still under hot steam pressure. This supports drying the load. After a while the steam from the jacket can also be released by opening valve **4** or it can be kept if another load has to be sterilized. The safety valve **9** opens when the steam pressure is too high. In principle this valve is not needed because the boiler already contains one and the pressure in jacket and chamber cannot get higher than the pressure in the boiler.

Principle of operation of pressure cooker type and vertical autoclave.



ii. heating phase

- ✓ Water is heated up in the chamber.
- ✓ At 100°C steam develops and after a short time the pressure increases, the boiling point of the water rises and so does the temperature.

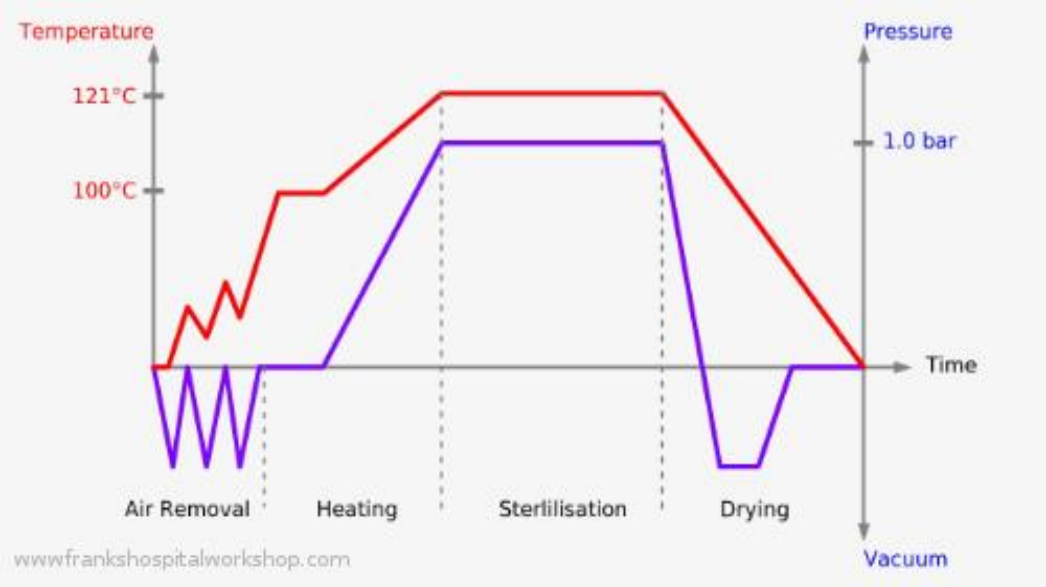
iii. sterilization phase

- ✓ Predefined pressure or temperature is reached the heating element is switched off by a **thermostat or** a **pressure switch**.
- ✓ Sterilization phase begins.
- ✓ Then the temperature drops a bit and the heating element is switched on again. In this way the temperature is kept stable.
- ✓ The timer gets started.

iv. drying phase

- ✓ After the set time the autoclave switches off completely and sterilization process is complete.
- ✓ The outlet valve opens and releases the steam.
- ✓ The sterilization goods remain a little longer in the chamber and the radiant heat from the chamber dries the items.

Principle of operation of automated autoclave (stationary/table bench autoclave).



1. **pre vacuuming** or **air removal** phase.

- ✓ The sterilizer is switched on.
- ✓ The pressure again is 0 bar.

- ✓ the vacuum pump sucks the air out of the closed chamber.
- ✓ A vacuum develops, the pressure in the chamber is negative.

2. **Heating/Steam admission.**

- ✓ The boiling point of water is reached.
- ✓ Vacuum pump pumps switch off completely. Steam is created and admitted into the sterilization chamber. Steam gets more and creates pressure.
- ✓ The boiling point starts to shift dure to pressure and temperature rises.

3. **Sterilization phase**.

- ✓ After some more minutes the pre-set temperature or pressure is reached (20 minutes at 121° or 3 minutes at 134°).
- ✓ The heater is switched off
- ✓ The sterilization period begins and the timer starts.
- ✓ A temperature or pressure sensor controls the whole process and lets the heater restart when the temperature drops.

4. **Steam release**

- ✓ The sterilization process is finished.
- ✓ The outlet valve opens and steam is released from the chamber condenses in a special condenser and the hot water gets back into the reservoir.
- ✓ The temperature in the chamber decreases

5. **Drying phase.**

- ✓ The vacuum pump supports the drying process by sucking the steam out of the chamber
- ✓ Sometimes a special chamber heater is switched on additionally in order to improve the drying process.

Group discussion

1. ***Group 1 (****discuss, draw and explain the functioning of pressure cooker autoclave****).***
2. ***Group 2 (****discuss draw and explain the functioning of vertical autoclave****).***
3. ***Group 3 (****discuss, draw and explain the functioning of table top autoclave****).***
4. ***Group 4 (****discuss, draw and explain the functioning of stationary autoclave****).***

2.4 Water quality used in sterilization.

- ✓ In principle only distilled water or de-mineralized water should be used because the water has to be pure and free of any minerals.

Effects of tap water

- ✓ water leaving deposits on the components of the autoclave and the sterilization items.
- ✓ surgical instruments getting destroyed.
- ✓ Valves and the tubing in the autoclave get blocked or damaged.
- ✓ It forms lime on heating elements which becomes thick.

In order to prevent all these problems only distilled water has to be used

- ✓ When distilled water is not available drinking water or rain water is used as alternative
- ✓ The instrument needed test the quality of water used is the **conductivity meter**.

2.5 Precautions taken when using autoclaves.

1. Make sure that the chamber is filled up with enough water.
2. Check if the door gasket is in place and the door is locked firmly before starting autoclave.
3. After sterilization make sure the autoclave is switched off.
4. Make sure that the chamber is pressure-less and cooled down before opening the door.
5. Open the door slowly, keeping head, face, and hands away from the opening.
6. Wait at least 30 seconds after opening the door before reaching or looking into the autoclave.

7. Remove solutions from the autoclave slowly and gently. Some solutions can boil over when moved.
8. Clean up any spills immediately.
9. Hospital staff should report any malfunctions or accidents immediately

Sterilization performance testes

Bowie Dick test

- ✓ This is a **performance test** done to show if:
  - **a)** The whole sterilization process was successful.
  - **b)** The packages were packed correctly.
  - **c)** The autoclave not overfilled.
- ✓ Such a test is performed with indicator strips or tape
- ✓ According to the international standards Bowie-Dick-test has to be done every day by the autoclave operator.
- ✓ For this purpose, a **test strip** is placed in the center of the load and the sterilization cycle is started. After sterilization a color change indicates whether the sterilizer works correctly or not. The test strip is supposed to change colour from **yellow** to **black.**
- ✓ A failed test can be the result of a **defect autoclave** or, and this is more likely, of an overfilled or wrongly packed autoclave.
- ✓ Bowie-dick test is the most preferable way in sterilization testing because:
  1. It is easy to use. It can provide multiple convinient package testing of multiple cycles.
  2. It provides immidiatevisual evidence of inadequate air removal or air leak.
  3. It easy to validate
  4. Provides easy documentation.
  5. It cheap.
- ✓ **In addition to the daily Bowie-Dick-test, a more precise test with biological indicators should be done twice a year. These indicators have to be sent for analyzing to a certified laboratory.**

Chemical indicators

- ✓ This are paper strips, tubes containing granules or fluids that change colour at a particular temperature.
- ✓ Most are not influenced by the time at which the temperature is maintained. They should not be the only means of testing sterility.

They are used inside the packs or outside the packs todistinguish sterile from unsterilized items.

biological indicators

- ✓ This are standardized preparations of **bacterial spores** (the most resistant form of microorganisms). They are placed among the equipment.
- ✓ After sterilization, the spores are placed in a suitable growth medium and incubated at

the proper temperature. No growth should be observed. Bacillus stearothermophilus whose spores are among the most resistant to heat, are commonly used.

✓ Expiration date and proper storage of the biological indicator is important to avoid false negative tests.

2.6 Daily check by the user.

1. Remove and clean the outlet sieve under running water.
2. Clean the chamber using a cloth. Do not use abrasive cleansers or steel wool, as these will scratch the surface and increase corrosion.
3. Clean the trays or baskets with multi-purpose cleaner and a cloth.
4. Clean the door or lid gaskets with a cloth and check for defects.
5. Do a performance test by using indicator strips (Bowie-dick test).

2.7 Weakly checks by the user.

1. Flush the chamber drain to keep it free of residues.
2. Remove the outlet sieve. Pour 1 litre of multi-purpose cleaner and hot water down the drain with a funnel. Rinse drains with 1 litre of hot water. Clean the sieve with multi-purpose cleaner and put it back into place.

3. Do a performance test by using indicator strips.

Discuss *(name various problems during usage of autoclaves).*

1.8 Common problems experienced during usage

1. **Wet material after sterilization**

This is brought up due to:

- **a.** Overloading.
- **b.** the air-release valve was not opened completely.
- **c.** the door was not briefly opened after sterilization

2. **Door locked after power outage**

   This is coursed by**:**

   - ✓ electronically controlled autoclaves reset due to power failure.

<u>suggestions to prevent problems during usage of autoclaves</u>

- **i.** Use only distilled water. Never use tap water.
- **ii.** Use towels to separate instruments and absorb moisture if needed.
- **iii.** Hinged instruments must be autoclaved in the open position.
- **iv.** No sharp instruments should be allowed to touch other instruments.
- **v.** Do not over-pack the autoclave. Otherwise, steam does not get everywhere.
- **vi.** Make a daily performance test.

2.9 Technical problems experienced by autoclaves

1. **Error code.**

- ✓ It is displayed by the microprocessor in case of any fault of the autoclave**.**
- ✓ Always identified by the help of service manual.

2. **Burnt-out heating element.**

- ✓ Coursed by the lime covering out the heating element.
- ✓ Blocked water supply.

- ✓ Water level sensor delivering wrong signal due to dirt.

3. **Leaking gasket**.

- ✓ This is bought about by the gasket getting hard over time.

4. **Black or burned relay contacts.**

- ✓ This is due to shot circuiting.

5. **Wet material after sterilization.**

Discussion ***(name various maintenance procedures carried on autoclaves)***

2.10 Repair and maintenance procedure of autoclaves.

MAINTAINANCE PROCEDURE.

1. Fill sterilizer with distilled water.
2. Place temperature sensor for external thermometer in the center of the chamber.
3. Perform a test run at 121°.
4. Check the temperatures inside the chamber. If it is lower than 121°C, do a calibration.
5. Check the display of the internal thermometer. Adjust it if necessary.
6. Check the function of the safety valve. Pull a few times with long pliers or a screwdriver when the chamber is under pressure. Be careful, hot steam will come out.
7. Monitor the sterilization time with a stop watch, your watch or your mobile phone.
8. Do a visual check for leakages from inside and outside.

- ✓ Let the autoclave cool down and then continue:

9. Clean chamber, heating element and rinse the drainage.
10. Clean or exchange the drainage filter and the air filter.
11. Check door gasket for damages.
12. Lubricate gaskets with silicon oil.
13. Visual check for leakages: chamber, door, piping, valves, water reservoir.
14. Check electrical connections.
15. Check the electronic board for cold solder points and water damages.
16. Check contacts of relays.

17. Make a final test run at 134°C.
18. Do a calibration for the temperature display if needed.
19. Replace cover
20. Drain the water and clean the autoclave from outside with soap water.
21. Fill out the maintenance protocol

2.11 Cleaning procedure of autoclave

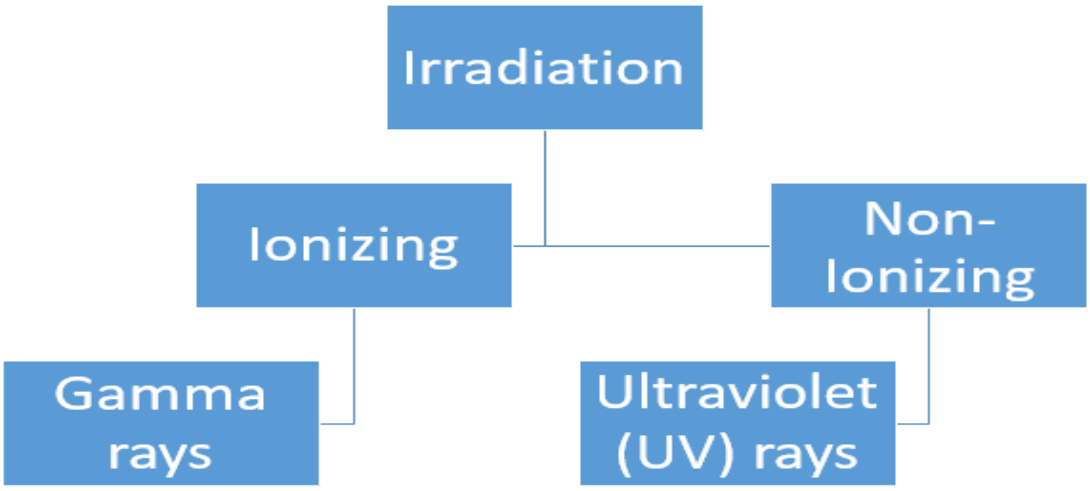
1. Drain the water from the reservoir. Clean the reservoir with a sponge and distilled water or with a soap solution if needed.
2. Remove the water filter (between reservoir and chamber). Rinse it under running water in reverse direction.
3. Remove also the water outlet filter which is found at the bottom of the chamber. Rinse this filter under running water.
4. The air inlet filter for ventilating the chamber after sterilization has to be replaced once a year.

B. RADIATION

Two types of radiation are used,

1. **Ionizing-** are of two types **paticulate** and **electromagnetic rays.**

2. **Non-ionizing**. Are Rays of wavelength longer than the visible light. like Microbicidal wavelength of UV rays lie in the range of 200-280 nm. This UV rays are produced by **high- pressure mercury vapor lamp**



C. FILTATION.

- ✓ It does not kill microbes but separates them out.
- ✓ Membrane filters of pore sizes between 0.2-o.45 µm.
- ✓ Used to remove particles fom solutions that cant be autoclaves like serum, antibiotic solutions, sugar solutions, urea solution.
- ✓ Aided by using either positive or negative pressure using vacuum pumps.

Types of filters used.

1. **Earthenware filters**: these include**:** ***Pasteur-chamberland filter, berkefeld filter and mandler filter.***
2. Asbestos filters.
3. Sintered glass filters.
4. Membrane filters.
5. Air filters.

D. SONIC AND AULTRASONIC VIBRATIONS

- ✓ It involves the use of sound waves of frequency >20,000 cycle/second to kill bacteria and exposing them for 1 hour.

- ✓ High frequency sound disrupts cells.
- ✓ Used to clean and disinfect instruments as well as to reduce microbial load.

E. CHEMICAL METHODS OF DISINFECTION.

- ✓ Disinfectants are chemicals that destroy pathogenic bacterial from inanimate surfaces.
- ✓ Chemicals that sterilize are called **chemisterilants**.

Characteristics of chemical used as disinfectant.

- ✓ Should have wide spectrum of activity
- ✓ Should be able to destroy microbes within practical period of time
- ✓ Should be active in the presence of organic matter
- ✓ Should make effective contact and be wettable
- ✓ Should be active in any pH
- ✓ Should be stable
- ✓ Should have long shelf life
- ✓ Should be speedy
- ✓ Should have high penetrating power
- ✓ Should be non-toxic, non-allergenic, non-irritative or non-corrosive
- ✓ Should not have bad odour
- ✓ Should not leave non-volatile residue or stain
- ✓ Efficacy should not be lost on reasonable dilution
- ✓ Should not be expensive and must be available easily

Assignment

1. Define the following terms:

a. Sterilization.
b. Disinfection
c. Decontamination.
d. Sanitization.

2. Name and explain various types of dry heat sterilization.
3. Draw and explain sterilization graph sequence for vertical autoclave

and stationary autoclave.

4. Name at least five maintenance procedures carried on autoclaves.
5. Explain the calibrations carried on autoclaves.

F. GASESOUS STERILIZATION

Ethylene Oxide Sterilization

- ✓ Ethylene oxide (ETO) is used to sterilize medical products that cannot be steam sterilized.
- ✓ ETO is a colorless gas that is **flammable** and **explosive**; however, mixtures of ETO (**10-12%**) with **carbon dioxide** or **the fluoridated hydrocarbons** reduce the risk. But Because of implications of the effect of the halocarbons on the ozone layer, restrictions are emerging.
- ✓ The effectiveness of ETO sterilization is influenced by four essential parameters like:
    - Gas concentration: 450mg to 1200 mg/l.
    - Temperature: 29°C to 65°C.
    - Humidity: 45% to 85%,
    - Exposure time: 2 to 5 hours.
- ✓ Within certain limitations, an increase in gas concentration and temperature may shorten the time necessary for achieving sterilization. The total cycle time is three to six hours.

Symptoms associated with ETO exposure:

1. Irritation of eyes, upper respiratory passages.
2. Peculiar “taste”.
3. Headache, nausea, vomiting.
4. Dyspnea, cyanosis, pulmonary edema, unsteadiness, EKG abnormalities.
5. Dermal irritation, or burns if direct contact.
6. Elevated lymphocytes, decreased Hgb.
7. High number of chromosomal aberrations

CHAPTER TWO

BOILER

1: **Definition**

Boiler is Medical equipment used for high level disinfection of instruments.

2: **Types**

1: Fixed (Electrical)

2: Portable (Electrical or Non-electrical)

Table top or Portable type

3: **Parts (Electrical)**

1. Body
2. Lid with handle
3. Chamber
4. Slotted equipment tray with carrying handle
5. Heating element
6. Cable with top plug
7. Drainage tap
8. Rubber stand
9. On and Off Switch

4: **Accessories**

1. Source of heat – Charcoal gas/stove
2. In case of non-electrical – timer

5. Preparation

1. Put the boiler on Table or firm leveled surface.
2. Ensure that the Boiler is clean in and outside.
3. Ensure that the Instruments to be sterilized are clean.
4. Pack the instruments properly in the boiler well immersed in water.
5. Close the Lid properly.

Operation

1. Switch on the power or put on the source of heat.
2. Regulate the temperature knob to 100^{o} C.
3. When the water starts boiling time for 20minutes
4. Don"t add instruments or water in the middle of procedure.

Care

Immediate Care

1. After twenty minutes switch off the power and unplug
2. Drain out water from the boiler, if you have nowhere to put your instruments, leave them inside.
3. Use sterile cheatle forceps to remove the instruments.

Routine Care

1. Daily cleaning of the Boiler
2. Change water daily or more than once a day if necessary

3. Check for the functionality of the equipment and report any fault to the Immediate upervisor.

Discussion ***(explain the various components of a boiler)***