



# DISINFECTION

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# Terminology

- **Sepsis:** Bacterial contamination.
- **Asepsis:** Absence of significant contamination.
- **Antisepsis:** Chemical destruction of vegetative pathogens on living tissue.
- **Sanitization:** Lowering microbial counts on eating and Drinking utensils to safe level.

# Terminology

- **Bactericidal:** Chemical agents capable of killing bacteria.
- **Virucidal:** Chemical agents capable of killing virus.
- **Fungicidal:** Chemical agents capable of killing Fungi.
- **Sporicidal:** Chemical agents capable of killing Spores.
- **Bacteriostatic:** Chemical agents that inhibit the growth of bacteria but do not necessarily kill them.

# Introduction of Disinfectants

- **Disinfection** is the process of destruction or removal of micro-organisms and reducing them to the level not harmful to health.
- Disinfection generally kills the sensitive vegetative cells but not heat resistant endospores.
- Disinfection does not necessarily kill all microorganisms but reduces them to a level acceptable for a defined purpose. (British standards)

- If the object is inanimate (lifeless), such as working area, dishes, benches, etc. the chemical agent is known as **disinfectants**.
- However if the object is animate(living)
- such as human body tissue, the chemical is known as **antiseptic**.
- Disinfectants are usually bacteriocidal but occasionally they may be bacteriostatic.

# Types of disinfections

## 1. Concurrent disinfection

-M.O are destroyed as soon as they are released from the body and further spread of the disease is stopped.

Eg- disinfection of urine, faces, vomitus, contaminated linen, clothes, dressings, gloves, aprons, hands throughout the course of illness

## 2. Terminal disinfection

It consists of the application of disincentive measures after the patient has been removed by death or shifted to another hospital or has ceased to be a source of infection. It is considered adequate enough along with the proper airing and exposure to sunlight.

## 3. Precurrent or prophylactic disinfection

-Achieved by disinfection of water using chlorine, pasteurization of milk and washing of hands .

# LEVELS OF DISINFECTION:

- HIGH:

Kills all the organisms except high number of Spores, Prions – Eg. Aldehydes, ethyleneoxide

- INTERMEDIATE:

Kills Mycobacteria, most viruses and bacteria, fungi but not spores – Eg. Iodine, ethanol, chlorine

- LOW:

Kills some viruses and bacteria but not mycobacteria, spores – Eg. Quarterly ammonium compounds, mercurials.

# An ideal disinfectant should:

- Have a wide spectrum of activity
- Be active in the presence of organic matter
- Have speedy action
- High penetrating power
- Be stable
- Not be toxic
- Not corrosive
- Inexpensive
- Not affected by the physical factors
- Odourless
- **Surface compatibility**

# Classification of disinfectants

## 1. Physical agents

a. Sunlight

b. Burning

c. Hot air

d. Boiling

e. Autoclaving

f. Radiation

# 1. Sunlight

- Appreciable bactericidal activity, plays imp role in spontaneous sterilization.
- U.V light is lethal to bacteria and viruses
- Articles like linen, bedding and furniture may be disinfected by exposure to sunlight for several hours.

# 2. Burning-

Burning and particularly incineration are excellent methods of disinfection.

Applicable for contaminated dressings, rags and swabs

### 3. Hot air-

Hot air sterilization is done by using hot air oven where temp. can be raised up to 160-180 degree celcius.

-useful for sterilization of glass wares, glass syringes, swabs, dressings, and sharp instruments

### 4. Boiling-

Boiling provides temp. above 90 degree celcius along with atmospheres of steam.

Suitable for sterilization of small instruments like syringe, needle , globes and swabs.

Addition of 2% sod.bicarbonate to water promotes sterilization.

## 5. Autoclaving-

It works on the principle of moist heat sterilization. Sterilization by steam under pressure is carried out at a temp between 108-147 degree celcius.

## 6. Radiation

Gamma radiation is widely used radiation

Used in the sterilization of bandages, dressings, catguts, swabs, catheters, syringes, culture, plates etc.



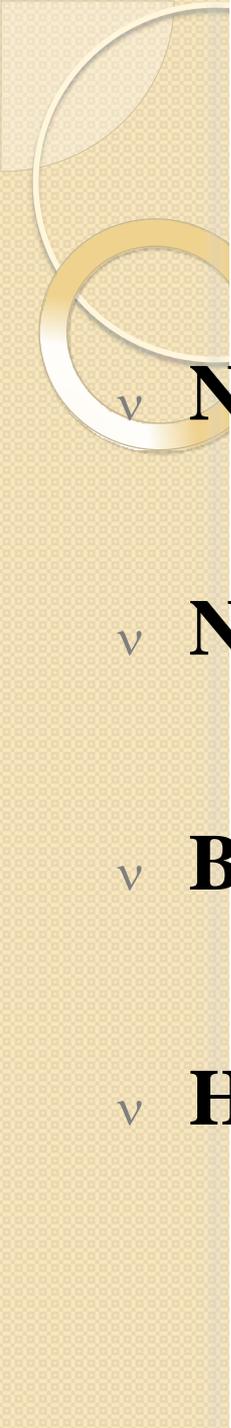
## **2. Chemical *agents***

1. Alcohols: Ethyl, isopropyl, methyl
2. Aldehydes: Formaldehyde, Glutaraldehyde
3. Dyes
4. Halogens
5. Phenols
6. Gases: Ethylene oxide, Formaldehyde, Beta propiolactone.
7. Surface active agents

# Properties of an ideal disinfectant or antiseptic

**It should**

- ✓ **Have wide spectrum of activity**
- ✓ **Act in the presence of organic matter**
- ✓ **Have high penetrating power**
- ✓ **Be stable and effective in acidic and alkaline conditions**



v **Not be corrosive**

v **Not be toxic and irritant**

v **Be safe, easy to use and cost effective**

v **Have long shelf life**

# ALCOHOLS:

- Ethyl alcohol
- Methyl alcohol
- Isopropyl alcohol
  
- Bactericidal, tuberculocidal, fungicidal, virucidal. Do not act on spores
- Optimum concentration is 60 – 90 %
- Mechanism of action: denaturation of proteins

- **Microbicidal activity:**

<b>Pseudomonas</b>	<b>10 sec</b>	<b>30 – 100%</b>
<b>E.coli, S.typhi</b>	<b>10 sec</b>	<b>40 – 100 %</b>
<b>S.aureus, Strep. pyogenes</b>	<b>10 sec</b>	<b>60 – 95%</b>

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- Ethyl alcohol (60 – 80%) is virucidal for all lipophilic viruses and hydrophilic viruses except hepatitis A and polio virus
  - Isopropanol is active against all lipophilic viruses.
  - 70% ethanol is active against cryptococcus, blastomyces, coccidioides
  - 20% isopropanol is used for killed cysts of acanthamoeba

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- Uses:
    - Oral thermometers
    - Scissors
    - Stethoscopes

### Disadvantages:

As they lack sporicidal action, they are not recommended for equipments and surgical materials. They damage the lensed instruments and tonometer tips. Methyl alcohol is toxic and not used nowadays.

# CAVI WIPES:



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- Low alcohol (17% isopropanol) surface disinfectants:
    - non abrasive towelettes
    - easy to use
    - ideal for operating rooms, surgical centres,  
neonatal centres
    - saves time and convenient

# ALDEHYDES:

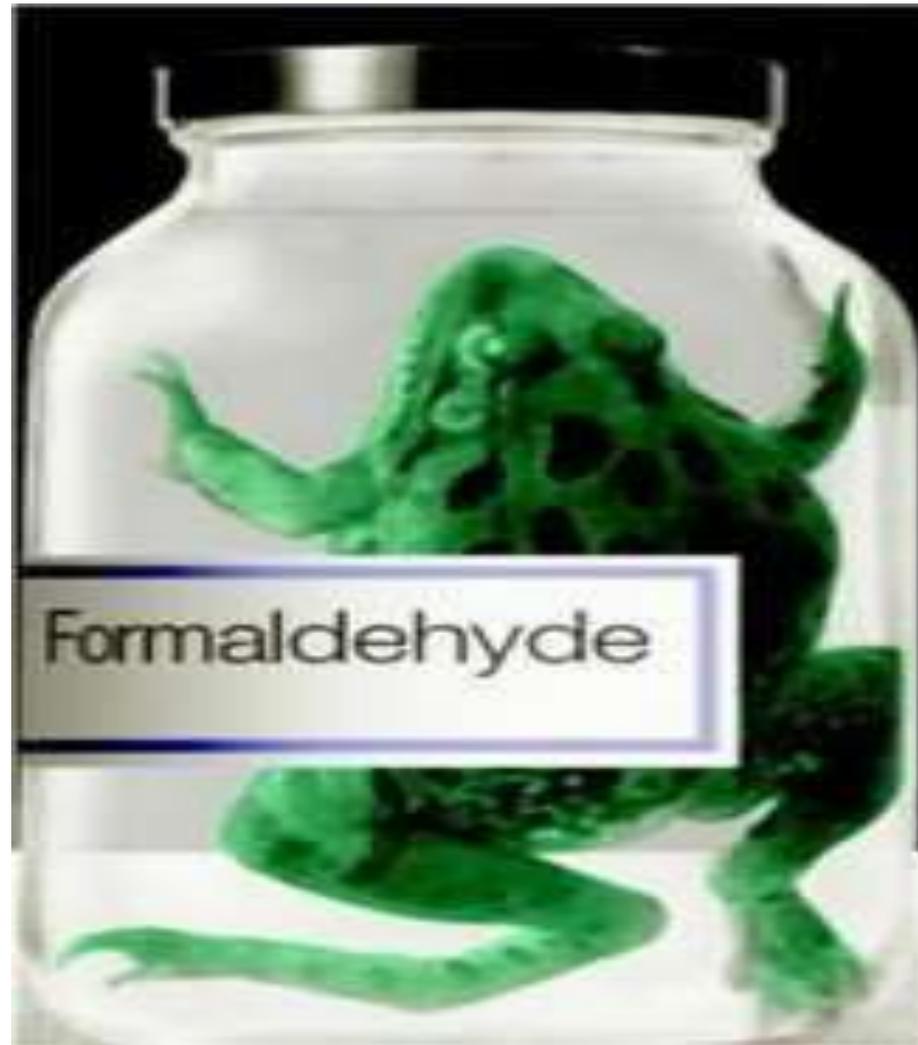
- Formaldehyde
- Glutaraldehyde
- Ortho – phthalaldehyde

# Formaldehyde/Formalin

Highly toxic and irritating gas which precipitates and destroys protein.

- Bactericidal, sporicidal, virucidal
- Used to preserve specimens
- For destroying anthrax spores in hair and wool
- 10% formalin containing 0.5% sodium tetraborate is used to clean metal instruments.

# Formalin:



# Glutaraldehyde:

- High level disinfectant & chemical sterilant
- In aqueous solutions – not sporicidal
- if activated by using alkalinising agents to change the pH to 7.5 to 8.5 becomes sporicidal
- ITS ACTION AND USES ARE SIMILAR TO FORMALDEHYDE.

- Effective against tubercle bacilli , fungi, virus
- Less toxic and irritant to eyes and skin.
- It has no deleterious effect on the cement or lenses of instruments such as cytoscope and bronchoscope.
- Used for sterilization of corrugated rubber , anesthetic tubes, and face masks, plastic endotracheal tube, metal instruments and polythene tubes.

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- Disadvantage of activation:

Once activated the shelf life of glutaraldehyde is only 14 days and after that polymerisation of the glutaraldehyde molecules takes place and it blocks the active aldehyde groups.

To overcome the above problem:

Glutaraldehyde phenol sodium phenate or stabilised alkaline glutaraldehyde can be used.



- **Mechanism of action:**

Alkylation of sulfhydryl, hydroxyl, carboxyl and amino groups of microorganisms which alter the RNA, DNA and protein synthesis

- > 2% aqueous solution of glutaraldehyde buffered to alkaline pH with sodium bicarbonate kills:

<b>Vegetative bacteria</b>	<b>&lt;2 min</b>
<b>TB, Fungi, Viruses</b>	<b>&lt; 10 min</b>
<b>Bacillus, Clostridial, spores</b>	<b>3 hours</b>



- **Uses:**

Endoscopes, Spirometry, Dialyzers, Transducers  
, Anaesthesia equipments , Plastic trocars.

Advantage: non corrosive

Disadvantage:

- If not properly cleansed- colitis occurs in endoscopy patients
- In eye equipments – keratopathy
- Health care workers with chronic exposure – dermatitis, asthma and rhinitis

# Endoscope:



# Glutaraldehyde disposal:

- If glutaraldehyde disposal is restricted through the sanitary sewer system, sodium bisulfate can be used to neutralise glutaraldehyde and make it safer for disposal

## TRADE NAMES:

cidex, Asep, clinicide, totacide, triocide

# Ortho-phthalaldehyde:

- High level disinfectant
- Superior than glutaraldehyde
- Excellent stability over wide range of pH
- Not irritant
- No need of activation

## DYES:

aniline and acridine dyes are extensively used as skin and wound antiseptic. They are bacteriostatic in high dilution but are not so effective as bactericidal agents.

### Aniline dyes

- Brilliant green, malachite green, crystal violet
- more active against gram positive than gram -ve , effective as bacteriostatic due to their reaction with the acidic group in the cell.
- non toxic, non irritant
- inactivated by organic material (pus)

### Acridine dyes

- Proflavine, acriflavine, euflavine, aminacrine
- active against gram positive
- very little affected by organic matter
- Useful as antiseptic against wound,
- They impair the DNA complex of the organism and thus kill or destroys the reproductive capacity of the cell.

# HALOGENS:

- Bactericidal, virucidal and sporicidal

## CHLORINE:

- used as chlorine tablets for disinfection of water
- sodium hypochlorite for disinfection of equipment soiled with blood
- Bleaching powder, sodium hypochlorite and halazone have been used for disinfection of water supplies, swimming pools and in the food and dairy industry.
- The organic chloramines are used for dressing of wounds.



# Hypochlorites:

- Readily inactivated by organic material
- Corrosive to metals and textiles
- Should not be mixed with acids, as they emit toxic amounts of chlorine gas
- Very active against bacteria, viruses including HIV and HBV
- Trade names: chlorox, domestos, diversol BX, milton

# Iodine:

- Iodine is more sporicidal than chlorine
- Iodine in alcoholic solution of 1-2% one of the most effective antiseptic but it stains the skin and occasionally produces sensitivity reaction.
- It is bactericidal with moderate activity against spores, tubercle bacilli and no. of viruses.
- Used in aqueous and alcoholic solution as skin disinfectant
- Eg. Povidone iodine (betadine) preparations- effective as iodine and nonirritant and does not satins the skin.

- Iodophores:

Organic compounds that slow the release of iodine. Steadily supplies the iodine over long periods, increases the penetration, more active.



# Phenols: (carbolic acid)

- Obtained by distillation of coal tar between the temp. of 170-270degree celcius.
- Mechanism of action:  
Protoplasmic poison – penetrates the cell wall and precipitates the cell proteins.

Cresol- all purpose coal tar disinfectant.

. 3-10 times more effective than phenol.

. 5-10% cresol- disinfection of urine and faeces.

cresol(50TO60%)soap= saponified cresol or lysol

## **BIGUANIDE Chlorohexidine(HIBITANE)**

~ **Less irritant and toxic to skin.**

~ **Commonly used as a skin disinfectant**

~ **Less active against Gram negative bacteria.**



Chloroxylenol or dettol – nontoxic antiseptic , used in 5% concentration for disinfection of instruments and plastic equipments.



**Phenol.  
liquefact.**

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- Active against bacteria, mycobacteria but little activity against endospores, viruses
  - Will not inactivate HIV within 30min
  - Resistant to inactivation by organic matter
  - Activity reduced in alkaline pH
  - Useful to disinfect environmental surfaces
  - Names: Clearsol, hycolin, stericol, lysol, dettol

# Phenolics – disadvantage :

- Phenolics in nurseries causes hyperbilirubinemia in infants.
- If phenolics are used to terminally clean infant bassinets and incubators, the surfaces should be rinsed thoroughly with water and dried before reuse of infant bassinets and incubators

# Gas:

- **Ethylene Oxide :**

- Widely used for re -sterilizing ‘packaged heat sensitive devices’ like sharp knives and blades.

It is non-corrosive and safe for most plastic and polyethylene materials. It is the preferred method for sterilizing **heat labile tubings, vitrectomy cutters, cryoprobes, light pipes, laser probes, diathermy leads, cannulated instruments like endoscopes**



- Ethylene oxide sterilisation:  
cold cycle -  $37 \pm 5^{\circ}\text{C}$   
Warm cycle –  $54 \pm 5^{\circ}\text{C}$

In these cycles, the relative humidity is maintained at 40 to 50% and ethylene oxide concentration is kept at 700mg/litre.

Testing of ethylene oxide steriliser:

**Bacillus subtilis subsp niger**

# Hydrogen peroxide:

- Bactericidal, virucidal – 1 minute
- sporicidal, fungicidal – 5 minutes
- Mechanism of action:
  - Targets cell wall, cytoplasm
- Works by producing destructive hydroxyl free radicals that can attack membrane lipids, DNA.

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- **Hydrogen Peroxide** which must be diluted to a 6% solution, is less expensive . The 3% H<sub>2</sub>O<sub>2</sub> solutions used as antiseptics, however, should not be used as a disinfectant.
  - For disinfecting soft contact lenses, tonometer biprisms, ventilators, fabrics, endoscopes.

# Disadvantages:

- $\text{H}_2\text{O}_2$  soaked tonometer tip caused corneal damage.
- Gastrointestinal endoscopy unit rinsing with 3%  $\text{H}_2\text{O}_2$  caused enteritis & pseudomembranous colitis.



## **FORMALDEHYDE FUMIGATION :**

Commonly used to sterilize the OT.

**Requirement (*For an area of 1000 cubic feet*)**

- 500 ml of 40% formaldehyde in one liter of water
- Stove or hot plate for heating formalin
- 300 ml of 10% Ammonia



- **Procedure**

- Close all doors & windows air tight and switch off fans and A.C.
- Heat formalin solution till boiling dry
- Leave the OT unentered over night
- Enter the OT next day morning with 300ml of ammonia
- Keep the ammonia solution for 2-3 hrs to neutralize formalin vapours
- Open the OT to start surgery
- Advised fumigation at weekly intervals



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- **Mode of Action**
  - Formaldehyde inactivates microorganisms by alkylating the aminoacid and sulfhydryl groups of proteins and ring nitrogen atoms of purine bases.
  - **Disadvantages**
  - It acts as a potential carcinogen
  - Toxic
  - Irritant

## **Duration:**

- In case of any construction in O.T. → 48 hrs
- In case of infected cases → 24hr
- For routine clean cases → 12 hrs.
- Alternatively 250 ml of formalin and 3000 ml of tap water are put into a machine (auto mist) and time is set for 2 hrs. The mist is circulated for 2hrs inside the closed room.

# Commercially available disinfectant

- **Bacciloid rasant**
- A newer and effective compound in environmental decontamination with very good cost/benefit ratio, good material compatibility, excellent cleaning properties . It is a Formaldehyde-free disinfectant cleaner with low use concentration.
- Active ingredients:
  - Glutaral 100 mg/g, benzyl-C12-18-alkyldimethylammonium chlorides 60 mg/ g, didecyldimethylammonium chloride 60 mg/g.



- **Aldekol**

A new method of fumigation has been evolved using 'Aldekol', a mixture containing 6% formaldehyde, 6% glutaraldehyde and 5% benzalkonium 120 chloride



- **Advantages**

- - Provides complete asepsis within 30 to 60 minutes.
- - Cleaning with detergent or carbolic acid not required.
- - Formalin fumigation not required.
- - Shutdown of O.T. for 24 hrs not required.

# Surface active agents:

- Substances that alter the energy relationship at interfaces, producing a reduction of surface or interfacial tension.
- Classification:
  - anionic, cationic, non-ionic and amphoteric

- Mechanism of action:

CATIONIC act on the phosphate groups of the cell membrane and enter the cell.

- Common compounds:

Acetyl trimethyl ammonium bromide (cetavlon) ,Benzalkonium chloride

.SAVLON=

CETAVLON+CHLOROHEXIDINE

USED as an all purpose antiseptic and for the disinfection of clinical thermometer and plastic appliances.

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- ✓ **Soaps and sodium lauryl sulfate are anionic compounds.** Soaps prepared from saturated fatty acids are more effective against gram negative bacilli while those prepared from unsaturated acids have greater action against gram positive.
  - ✓ **Nonionic detergents** are not ionized. However these substances **do not possess significant anti-microbial activity.**
  - ✓ **Amphoteric compounds** have the detergent properties of anionic surfactants combined with disinfectant properties of cationic surfactants. Eg: Tego compounds.

Thank you.....

