

Microbial control

Antimicrobial agent

Definition

The following terms are commonly employed in connection with antimicrobial agents and their uses

Biocide

A general term describing a chemical agent usually of broad spectrum that inactivates microorganisms

Bacteriostatics

A specific term referring to the property by which a biocide is able to inhibit bacterial multiplication; multiplication resumes upon removal of agent

Bactericidal

A specific term referring to the property by which a biocide is able to kill bacteria, bactericidal action differs from bacteriostatic only in being irreversible the killed organism can no longer reproduce even after being removed from contact with agent

Sterilization

A physical or chemical process that completely destroys or removes all microbial life including spores, e.g. incineration, certain gases, exposure to ionizing radiation, some liquid chemicals and filtration.

Pasteurization

Is the use of heat at a temperature sufficient to inactivate important pathogenic organisms in liquid such as water or milk, but at a temperature below that needed to insure sterilization, for example heating milk at 74°C for 3

to 5 seconds or 65c for 30 minutes kills, most pathogenic bacteria that may present without alters its quality, spores are not killed

Disinfectant

Products or biocides used to kill microorganism on inanimate objects or surfaces, it can be sporostatic but are not necessary sporicidal

Septic

Characterized by the presence of pathogenic microbes in living tissue

Antiseptic

A biocide or product that destroys or inhibits the growth of microorganism in or on living tissue e.g. skin, vaginal tract (to reduce the number normal flora and pathogenic contaminant)

Aseptic

Characterized by the absence of pathogenic microbes

Preservation

The prevention of multiplication of microorganism in formulated product including pharmaceutical

Physical agent

Heat

Application of heat is the simplest means of sterilization. A temperature of 100°C will kill all but spore forms of bacteria within 2-3 minutes in laboratory scale; culture a temperature of 121°C for 15 minutes will kill spores by steam e.g. autoclave (steam moisturized)

Flash autoclave which is widely used in operating room often use saturated steam at a temperature of 134°C for 3 minutes, air removed before and after the sterilization cycle so that metal instrument may be available rapidly.

For sterilization of material that remains dry circulating the hot air electrical oven are available since heat is less effective on dry material 160°C-170°C for one hour or more, sterilization through carbonization.

Quality control of autoclave*

Gas:

A number of articles particularly certain plastic and lensed instruments that are damaged or destroyed by autoclaving can be sterilized with ethylene oxide,

Ethylene oxide is inflammable and potentially explosive gas. 10% of this gas along with carbon dioxide at 50 to 60°C for 4 to 6 hours under controlled conditions of humidity. Aeration done after sterilization to remove the gas

It is dangerous to use care must be taken

But it is effective for sterilizing heat labile device such as artificial heart valve.

Ultraviolet light

In the wavelength 240 to 280 nm is absorbed by nucleic acids and causes genetic damage including the formation of the thymidine dimmers, it is limited by its poor ability to penetration., it is used for sterilization of air like in critical hospital sites and in the laboratory, it can cause skin and eye damage so protection should be taken.

Ionizing radiation

Carries far greater energy than uv light. It causes direct damage to DNA and produces toxic free radicals and hydrogen peroxides from water within the microbial cells. Cathode rays and gamma rays from cobalt -60 are widely used in industrial processes including the sterilization of many disposable surgical supplies such as gloves plastic syringes, specimens containers, some foodstuffs,

Killed organism may remain morphologically intact and stainable

Filtration

Both live and dead organism can be removed from liquid by positive or negative pressure filtration. Membrane filters usually composed of cellulose esters (cellulose acetate) are commercially available with porosity 0.005 to 1 μm . For removal of bacteria a pore size of 0.2 μm is effective because filters act not only mechanically but electrostatic adsorption of particles to their surface. Filtration is used for sterilization of large volumes of fluid especially those containing heat labile component such as serum. L for inanimate surface

Pasteurization (refer to previous definition)

Disinfection and decontamination

Chemical disinfectant causes death of pathogenic vegetative bacteria. Most are general protoplasmic poisons and are not currently used in the treatment of infection other than very superficial lesion, have been replaced by antimicrobial agent

E.g.

- Quaternary ammonium compounds
- Alcohol
- Iodophors

All reduces the superficial flora and can eliminate contaminating pathogenic bacterial from skin surface

Phenol only inanimate Surfaces

Alcohol

the alcohol (ethyl alcohol, isopropyl alcohol and n-propanol) are protein denaturants that rapidly kill vegetative bacteria when applied as aqueous solution in the range of 70-90% alcohol. They are in active against bacterial spores and many viruses. Alcohol requires some water for antibacterial effectiveness.*

Halogens

Iodine is an effective disinfectant that acts by iodinating or oxidizing essential components of the microbial cell. It is used as tincture of 2% iodine in 50% alcohol. It is killing more rapidly and sensitivity react effectively than alcohol alone, it has the disadvantages of sometimes

causing hypersensitivity reaction and of staining materials with witch com in contact.

Iodophores, causes less kin staining used before surgery. Although less allergic than inorganic iodine preparation, also idophores should not be used on a patients with history of iodine sensitivity.

Chlorine is highly effective oxidizing agent, it is lethal to microbes. It exists as a (hypochlorous acid in aqueous solution that dissociate to yield free chlorine over a wide pH range, particularly under slight acidic conditions). Less than one part million, chlorine is lethal within seconds to most vegetative bacteria, and it inactivates most viruses. it is used sterilizing drinking water and in chlorination of water in swimming pools. It reacts very rapidly with protein and many other organic compound and its activity is lost quickly in the presence of organic material.

Surface active compound

Surfactant

Compound with hydrophobic and hydrophilic groups that attach to and solubilize various compounds or alter their properties. **Anionic detergent** such as soaps are highly effective cleansers, but have little direct antibacterial effect probably because of there charge is similar to that of most microorganisms. There action on lipid of bacterial cell membrane.

Cationic detergent particular quaternary amonium compound such as benzalkoniunm chloride, are highly bactericidal in the absence contaminating organic matter.

Quaternary ammonium compounds e.g.

These compounds have two regions in their molecular structure one a water repellent (hydrophobic) group and the other a water attracting (hydrophilic) group. Are useful antiseptic of clinical purpose e.g. preoperative disinfection of unbroken skin as well as for cleaning of hard surfaces they are sporicidal they inhibit the outgrowth of spores but not the actual germination process

Are also mycobacteriostatic and have an effect on lipid

Phenolics

Phenol: One of the first effective disinfectants was the primary agent employed by Lister in this antiseptic surgical procedure. It is a potent protein denaturant and bactericidal agent. Substitution in the ring structure of phenol have substantially improved activity and have provided a range of phenols and cresols that are the most effective environmental decontaminants available for use in hospital hygiene. It is too toxic to skin and tissues, they are the active ingredient in many mouth wash and on throat preparations.

Hexachlorophene: is primarily bacteriostatic, incorporated into a soap, it is skin decontaminant with effect against normal flora and gram positive bacteria.

Chlorohexidine: it replaced the previous disinfectant as routine hand and skin disinfectant and for other optical application it is great bactericidal without its toxicity it act on gram negative and positive bacteria.

both Causes toxicity to skin but the chlorohexidine is less toxicity

Glutaraldehyde and formalaldehyed

Both are alkalyating agent highly lethal to essential all microorganism. Formalaldehyed gas is allergenic, unpleasant, and it is vapor defective environmental decontaminate the laboratory, rooms that have such bacillus anthrax.

Glutaraldehyde is effective sterilizing agent for apparatus that cannot be heat treated, such as some lensed instrument and equipment for respiration therapy.

Heavy metal derivatives

Silver sulfadiazine a combination of two antibacterial agent Ag^+ and sulfadiazine has a broad spectrum of activity binding to cell component such as DNA may be responsible for its inhibitory properties

Peroxogens

Hydrogen peroxides has broad spectrum activity against viruses bacteria yeasts and bacterial spores, sporicidal activity require higher concentration (10-30%) of H_2O_2 and longer contact items

Vapor phase sterilant

Heat resistant medical device and surgical supplies can be effectively sterilized by vapor phase system employing ethylien oxide formal aldehyde hydrogen peroxide

Chemotherapeutic agent the natures and modes of action of these

Antimicrobial agents

Antibiotics

Naturally occurring or synthetic organic compounds which inhibit or destroy selective bacteria, generally at low concentration

Antimicrobial agents:

Clinically effective antimicrobial agents all exhibit selective toxicity toward the parasite rather than the host, a characteristic that differentiates them from the disinfectant.

Selective toxicity is explained by action on microbial process or structure that differs from those of mammalian cells. e.g. Some of agents act on the cell wall synthesis, Some antimicrobial agent as penicillin are essentially non toxic to host, unless hypersensitivity has developed. Aminoglycosides have a much therapeutic index which have a certain toxicity to host so monitoring the dose and blood levels.

Bactericidal

Bacteriostatics

Fungicidal fungistatic

The basic measurement of the virto activity of an antimicrobial agenst against an organism is minimum inhibitory concentration (MIC) or minimum bactericidal concentration (MBC)

MIC: is the least a mount that prevents the growth of the organism under standarediezed conditions

There are three sources of antimicrobial agents: the true antibiotics are of biological origin and probably play an important part in microbial ecology in the natural environment. Penicilline for example is produced by several mold of the genus *Penicillium* where cephalocyporein brought from other mold.

The largest source of antibiotics were derived from the genus *Streptomyces*, streptomycin tetracycline, chloramphenicol, erythromycin a few antibiotics derived from bacteria of the genus *Bacillus*

The true chemotherapeutic agents are chemically synthesized antimicrobial agent

Sulfonamides for example were discovered as results of routine screening of aniline dyes

Third source of new antimicrobial agents is molecular manipulation of previously discovered antibiotics or chemotherapeutics

Antimicrobial agent, terms

- Antimicrobial agent
- Chemotherapy
- Spectrum

Spectrum: the range of activity of each antimicrobial, it used to describe the genera and species against which it has been shown

narrow spectrum agents: e.g. benzyl penicillin is highly active against enteric gram negative bacilli

broad spectrum e.g. that inhibit a wide range of gram positive and gram negative bacteria including some obligate intracellular organism

bacterial resistant to antimicrobics may caused by :

There are multiple mechanism of bacterial resistance to antimicrobics,

1. altered antimicrobial uptake secondary to diminished permeability of the cell envelope or active efflux of the antimicrobial agent
2. Diminishing affinity to or absence of a specific antimicrobial target site.
3. ability of organism to bypass a blocked metabolic pathway(plasmids), which can determine resistance to several different antimicrobis. Some
4. synthesis of substances that binds antimicrobial and protect its target
5. production by the organism of an enzymes that inactivate the antimicrobial

Innate resistance inherited to the microbial species

Acquired resistance is usually by mutation or genetic exchange

Many resistance genes are grouped on plasmid (R plasmids)

Synergistic if its effect is greater than the sum of the effects of its component e.g. penicillin and aminoglycosides may kill enterococcus far more effectively than would either acting alone

Antagonistic combination one antimicrobial, usually that with the least important properties partially prevents the second from expressing its activity

Advantages of uses combination prevents expression of resistant mutants

Action of antimicrobial agents

- Acting against cell wall e.g. β -lactam (penicillins, cephalosporines) ..
- Glycopeptide antimicrobial two agents, vancomycin and teicoplanin,
- Antimicrobial acting on the outer and cytoplasmic membranes : the polymyxins
- Inhibitors of protein synthesis at the ribosomal level (aminoglycoside – aminocyclitol antibiotics)
- Inhibitors of nucleic acid synthesis and replication : the quinolones
- Metabolic inhibitors folate inhibitors

