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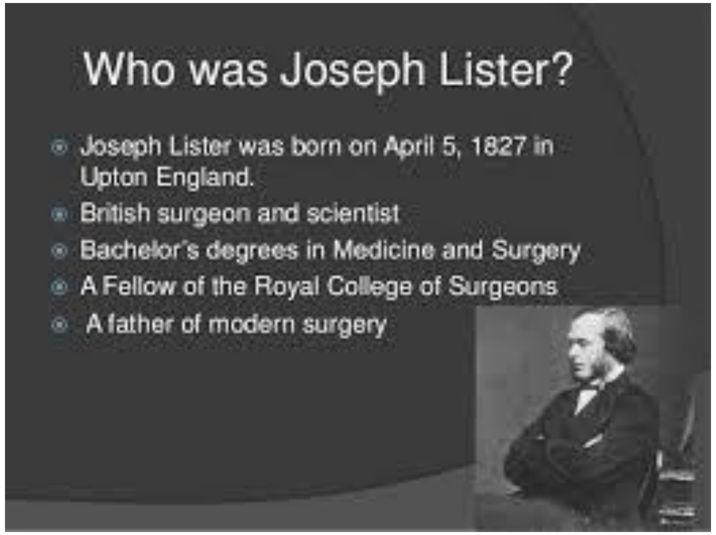
Control of microbial growth

Introduction

- Microorganisms are agents of contamination, infection and decay
- Therefore; it is necessary to remove them from materials and the operating areas
- In early civilisation, people practised salting, pickling, smoking and exposure to sunlight
- In the mid of 1800 a British surgeon developed an aseptic technique to prevent contamination of surgical wounds after nosocomial infections (a disease originating in a hospital) caused death in 10% of surgeries.
- In addition, 25% of mothers delivering in hospitals died due to infection



Sterilisation

The process of destruction or removal of all microorganisms including their spores

It should

- Completely remove all kinds of microbes (bacteria, mycobacteria, viruses and fungi) by physical or chemical methods
- Be effective to kill bacterial spores

Sterilant: material or method that usually used to remove or kill all microbes

Cleaning: a process which removes visible contamination but does not mean to destroy all microorganisms. This cleaning is necessary to effective disinfection or sterilisation

Asepsis: A term used to describe methods, which prevent contamination of wounds and other sites by ensuring that only sterile object and fluids come into contact with them

Antisepsis: a procedure or application of an antiseptic solution or an agent which inhibit the growth of microorganisms, while remaining in contact with them

Disinfection: a process that **reduces** the number of viable microorganisms to an acceptable level, however; it may not be able to inactivate some viruses and bacterial spores

Sanitization: a process that reduces microbial population on an object to a safe level

Decontamination: a process that removes the pathogenic microorganisms from an object to make it safe to handle

To achieve a proper sterilisation of any instrument:

- Pre-sterilisation cleaning
- Sterilisation process
- Aseptic storage

Pre-sterilisation cleaning

- Removal of the organic materials, blood and saliva, which provide protective barrier for microorganisms and prevent its destruction
- This can be achieved by: manual, ultrasonic and mechanical washing

Manual cleaning

- Simplest and cheapest method but it is time consuming and difficult to achieve
- Heavy duty gloves and glasses must be worn to protect from needle prick and to protect eyes
- Soaps and detergents are usually used

Ultrasonic cleaning

- It is conversion of electrical energy into vibratory sound waves, which pass through a soap solution containing the instruments
- Used mainly for burs, bone files, bone cutter, artery forceps and saw… etc

Mechanical washing

- High pressure jets of water with or without a detergent which remove debris from the small instruments such as burs

Methods of control

- Physical and chemical
- Physical includes heat, irradiation, filtration and mechanical removal
- Chemical control involves the use of antimicrobial chemicals

Factors influence the effectiveness of antimicrobial treatment

1- Number of microbes: the more the microbes present the more time it takes to eliminate population

2- Types of microbes: endospores are very difficult to be destroyed. Vegetative pathogens vary in susceptibility to different methods of microbial control

3- Environmental influences: presence of organic material such as blood, saliva etc. tend to inhibit antimicrobials

4- Time of exposure: is more effective at longer time. In heat treatment, the longer exposure compensates for lower temperature.

Factors affecting efficacy

Nature of site: stability, porosity and chemical nature

Microorganism: degree of resistance, spores, viral envelope, protozoan cysts

Environmental conditions: acidity (pH), temperature, presence of organic material

Physical methods of microbial control

Heat

- Kills microorganisms by degenerating their enzymes and other proteins.
- Heat resistance varies widely among microbes
- Fast, reliable and inexpensive
- Does not produce potential toxic substances

Types of heat control:

- Moist heat
- Dry heat
- Pasteurization

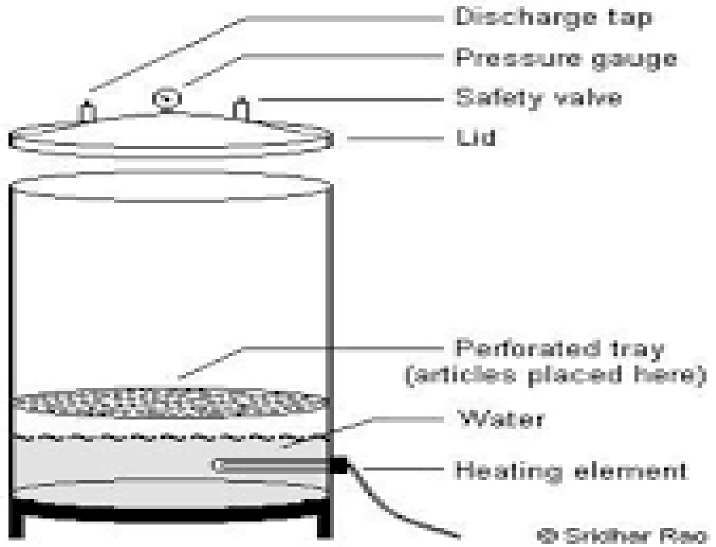
Moist heat: kills microorganisms by coagulating their proteins

Boiling: heat to 100^{o}C or more will kill vegetative forms of bacterial pathogens.

- Most pathogens can be killed within 10 minutes or less
- Endospores and viruses cannot be killed that quickly
- In general: moist heat is much more effective than dry heat

Autoclave: is a chamber which filled with hot steam under pressure. It is a preferred method of a sterilisation, unless a material is going to be damaged by heat, moisture or high pressure.

- The steam temperature reaches 121^{o}C at a twice atmospheric pressure
- All organisms and endospores are killed within 15 minutes



Dry heat

- Direct flaming: used to sterilise inoculating loops and needles. They should be heated until it has a red glow
- Incineration: effective way to sterilise disposable items (paper cups, dressing) and biological waste
- Hot air sterilisation: place in the oven, which required 2 hours at 160-170^{o}C for sterilisation
- However; moist heat is more effective than dry heat

- Killing is due to dehydration, oxidation of microorganisms and protein denaturation

Irradiation

Used for sterilisation, by killing or inactivate microorganisms, it is two types

1- Ionizing radiation such as X-rays, gamma rays and high speed electrons

2- Non-ionising radiation such as ultraviolet light and infrared light

1-Ionising radiation

- X-rays, gamma rays and cosmic rays are highly lethal to DNA and other vital constituents
- They have high penetration power
- There is no considerable increase in temperature
- Therefore; it is referred to as cold sterilisation
- Commercial factories use gamma radiation for sterilising plastics, syringes, swabs and catheters

Non-ionising radiation

There are two types

A- Ultraviolet (UV): is considered as germicidal at a wavelength of 2537 Angstroms. UV destroy microorganism's DNA

Used mainly for air and water purification in the hospitals

B- Infrared: is most commonly used to purify air, such as in the operating room. It is effective, although has no penetrating ability

Chemical methods

- There is no available chemical solution to sterilise instruments through immersed them in it
- There is a risk of producing tissue damage if some residual solution is carried over into the wound, while it is being used

Mechanism of action of chemical disinfectants

1- Cell membrane injury
2- Coagulation and denaturation
3- Interactions with functional groups of proteins

1- Aldehyde compounds

A. Formaldehyde: a broad-spectrum antimicrobial agent, used for disinfection, has limited sporicidal activity. It is hazardsubstance, inflammable and irritant to the eye, skin and respiratory tract

B. Glutaraldehyde: It is solution of 2% glutaraldehyde, required immersion of 20 mins for disinfection and 6-10 hours of immersion for sterilisation
- It is a high level disinfectant

2- Alcohols

- Act as denaturising bacterial proteins
- Solutions of 70% ethanol which are more effective than higher concentrations. The presence of water can speed up the process of protein denaturation

3- Iodophor compounds

- Many studies have shown that iodophor compounds are the most effective antiseptics.
- These compounds are effective against most bacteria, spores, viruses and fungi
- Most commonly used as surface disinfectants along with hypochlorite

4- Biguanide

The most commonly used biguanide compound is **chlorhexidine**

- Powerful non- irritating antiseptic that disrupts bacterial cell membrane
- It persists on skin for long period of time and that is why it is extensively used for surgical scrubbing, neonatal bath, mouth wash and general skin anti-septic

5- Hydrogen peroxide

- Oxidizing properties allow it to destroy wide range of pathogens
- Biggest advantage is short cycle time
- Used in 35% to 90% concentration

References

- Clinical Periodontology and Implant Dentistry By Jan Lindhe
- Colour Atlas of Dental Medicine and Periodontology