

Sterilization Disinfection

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...Your Taxes at Work...

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Sterilization

- = the complete removal or destruction of all forms of microbial life
 - bacteria,
 - viruses,
 - fungi
 - spores
- Probabilistic notion
 - No absolute assurance that there is 0 microorganism
 - Sterility assurance level (SAL) used as measure of sterility
 - SAL = probability of survival of a microorganism after sterilization process
 - Expressed as \log_{10} (probability of survival)
 - SAL of 6 = < 1 chance in a million (10^{-6}) that a particular item is contaminated
 - SAL = 6 acceptable for critical item.

Disinfection

- Process that eliminates defined pathogens
- Not all microbial forms
- Main difference with sterilization = the lack of sporocidal activity
- Categorized into 3 levels:
 - High,
 - Intermediate
 - Low:

Resistance of Microorganisms

Sterilization

Spores
bacterial, fungal

Bacillus stearothermophilus
Bacillus subtilis
Clostridium sporogenes

High Level Disinfection

Mycobacteria, TB bacilli

Intermediate Disinfection

Hydrophilic viruses

Polio, Coxsackie, Rhino

Low Disinfection

Vegetative fungi & bacteria
Lipophilic viruses

Trichophyton, Cryptococcus, Candida
Pseudomonas, Staphylococcus, Salmonella
HSV, CMV, RSV, HBV, HIV

Other Stuff

- **Cleaning** = the removal of adherent visible soil (blood, protein substance and debris), dust or other foreign material by manual or chemical process
- **Sanitizing** = process that reduces microbial population on object to a safe level
- **Decontamination** = process that removes pathogenic microorganisms from an object to make it safe to handle

Other Stuff

- **Antiseptics = chemicals to prevent growth or destroy**
 - Used on living tissues
 - Regulated by FDA
- **Disinfectants = chemicals used for disinfection**
 - Used for objects
 - Regulated by EPA
- **AOAC (Association of Official Analytical Chemists) tests are used on antiseptics and disinfectants.**

What needs to be

- Sterilized
- Disinfected
- At which level ?

Spaulding Classification

Item	comes in contact with	Type recommended
Critical	Tissue, vascular space	Sterilization
Semicritical	Mucous membrane Non intact skin	High level disinfection High level disinfection
Noncritical	Intact skin only not mucous membranes	Intermediate or low level disinfection

Use Spaulding with a Grain of Common Sense

- **Interpret with common sense**
 - Mouth pieces have to be disinfected to a high level
 - Silverware simply cleaned
 - However both come into contact with mouth mucosa
- **Other considerations:**
 - Feasibility of the disinfection method
 - Effect of disinfectant on instrument (for example tonometer tips do not take well to heavy use of disinfectants)
 - Safety to employee

Factors Affecting Effectiveness of Disinfection

- **Cleaning**
 - Residual particles harbor & shelter from disinfectant
 - Organic load restrict disinfectants effectiveness of alcohol, phenols, chlorine & iodines
- **Nature of object: crevices, hinges, lumens more difficult to disinfect.**
- **Concentration of disinfectant:**
 - Diluted during application
 - Lose potency with time
- **Time of contact**
- **Physical and chemical environment: temperature, water hardness, pH.**

Wiping /Soaking /Contact time

- **Using a germicide soaked cloth:**
 - Consider time needed to kill
 - All germicides require minimum time
 - If wiped surface is dry before required disinfection time: disinfection cannot be assured
 - Wiping would remove a large amount of contamination and the germicide may kill some left over microorganisms but there is no assurance that all microorganisms were killed

Steam Sterilization

- Saturated steam under pressure.
- Cheap & nontoxic
- Penetrates fabric
- Method of choice for all items except those which are moisture or heat sensitive.

- 4 parameters of importance
 - 1-Steam
 - 2-Pressure
 - 3-Temperature
 - 4-Time

- Air must be removed and steam must reach the item for required time at required temperature

Steam Sterilization

- **Anhydrous materials (oil, greases, powders) cannot be sterilized by steam**
- **Steam cannot penetrate hollow needles or instruments packed in moisture resistant materials (test tube, glass)**

Steam Sterilization

- High speed pre-vacuum sterilizer:
 - Vacuum pump removes air from sterilizing chamber
 - Once the proper vacuum attained (15mm Hg \pm 1mm)
 - Steam admitted.
- Sterilization time:

– Penetration	1mn
– Kill	2mn
– Safety	1mn
– Total time	4mn at 133°C 272°F

Steam Sterilization

- **Sterilization cycle includes**
 - 1-warming of the chamber**
 - 2-vacuum extraction**
 - 3-pre-steam penetration time**
 - 4-steam penetration time**
 - 5-holding time**
 - 6-cooling time**

Sterilization time = 4mn

Temperature recorder should show the sterilization time properly.

Dry Heat Sterilization

- Used for materials that cannot be steam sterilized because of
 - damage from steam
 - lack of penetration
 - instruments that cannot be disassembled
- Sterilization takes:
 - 60 mn at 170 °C (340 °F)
 - 120 mn at 160 °C (320 °F)
 - 150 mn at 150 °C (300 °F)
 - 12 hours at 121 °C (250 °F)

Ethylene Oxide Sterilization (ETO)

- Used almost exclusively to sterilize medical products that cannot be steam sterilized
- Colorless gas
- Flammable & explosive
- Mixtures of ETO (10-12%) with CO₂ or the fluoridated hydrocarbons reduce risk
- Because of implications of effect of halocarbons on ozone layer, restrictions are emerging

Ethylene Oxide Sterilization (ETO)

- **Disadvantages**
 - Lengthy cycle time
 - Cost
 - Potential hazards to patients & staff
- **Advantage: can sterilize heat or moisture sensitive medical equipment without deleterious results**
- **ETO toxicity to employees:**
 - OSHA reduced permissible exposure limit (PEL) for ETO to a time-weighted average (TWA) of 1ppm

Ethylene Oxide Sterilization (ETO)

- Symptoms associated with EtO exposure:
- Irritation of eyes, upper respiratory passages
- Peculiar "taste"
- Headache, nausea, vomiting
- Dyspnea, cyanosis, pulmonary edema, unsteadiness, EKG abnormalities
- Dermal irritation or burns if direct contact
- Elevated lymphocytes, decreased Hgb
- High number of chromosomal aberrations

Other Sterilization Methods

- **LIQUID PERACETIC ACID (STERIS ®)**
 - Uses a solution of peracetic acid with H₂O₂
 - Peracetic acid disrupts and denatures proteins
 - Extra oxygen rapidly inactivates many cell systems.
 - Harmless to environment & very safe for personnel
 - System fully automated
- **HYDROGEN PEROXIDE PLASMA STERILIZATION (STERRAD ®)**
- Radio frequency emissions applied to the H₂O₂
- Electric field creates gas plasma
- No harmful substances
- Fully automated

Other Sterilization Methods

- Glutaraldehyde 10 hrs
- ClO₂ = Demand Release Chlorine 6 hrs
- H₂O₂ = Hydrogen peroxide (6%) 6 hrs

High Level Disinfection

- Glutaraldehyde (2%) 45 mn
- Demand relchlorine dioxide 20 mn
- Hydrogen peroxide (6%) 20 mn
- Wet pasteurization 75 °C 30 mn
- Chlorine 1000 ppm 20 mn

Intermediate Level Disinfection

- Ethyl alcohol 10mn
- Isopropyl alcohol 10mn
- Chlorine 1000 ppm 10mn
- Phenolic germicidal solution 10mn
- Iodophor germicidal solution 10mn

Low Level Disinfection

- Ethyl alcohol $\leq 10\text{mn}$
- Isopropyl alcohol $\leq 10\text{mn}$
- Chlorine 100 ppm $\leq 10\text{mn}$
- Phenolic germicidal solution $\leq 10\text{mn}$
- Iodophor germicidal solution $\leq 10\text{mn}$
- Quaternary germicidal $\leq 10\text{mn}$

Chlorine

- Sodium hypochlorite (ClONa), Clorox, household bleach: 5% solution
- Ca hypochlorite (powder, granules or tablets) with 70% Cl
- Demand release chlorine dioxide
- Chloramine T powder or tablets. Diluted in water it provides a more stable solution than regular Na hypochlorite.
- Sodium dichloroisocyanurate (NaDCC), 60% Cl, tablets which dissolved in water generate Na hypochlorite which is more stable.
- Disinfectant power of all chlorine releasing compound is expressed as available chlorine in ppm (parts per million):
1mg/litre = 0.0001% = 1 ppm
10 mg/liter = 1% = 10,000 ppm = 3°
Some countries express the chlorometric degree ($1^\circ=0.3\%$)

Chlorine

Spores: bacterial, fungal not inactivated

⇐ High/Intermediate Level Disinfection
at 100-1000ppm

TB Bacilli

Hydrophilic viruses

Lipophilic viruses

Vegetative forms: bacteria, fungi

Chlorine

Concentration/Time,Activity:

Bleach = 5.25% or 52,500ppm ClONa

For immediate use: 24 hr

1: 10 \Rightarrow 5000 ppm * 1: 50 \Rightarrow 1000 ppm

1:100 \Rightarrow 500 ppm * 1:500 \Rightarrow 100 ppm

For a 30 days use twice amount

Chlorine

Kills vegetative bacteria

without organic load at 25 ppm in 10s,

with organic and heavy load at 100ppm in 10 mn.

Kills viruses at 200ppm in 10mn.

Inactivates HBV at 500ppm in 10mn

Inactivates HIV at 50ppm in 10mn

Tuberculocidal at no less than 1000ppm

Does not destroy spores.

It is very effective against HBV and HIV viruses, therefore its use is recommended at 1:10 dilution for disinfection of blood spills. It is also recommended for disinfection of counter tops and work surfaces, CPR manikins, hydrotherapy tanks, laundry, tonometers, diaper surface areas and dental impressions at dilutions of 1:100

Chlorine

- High level chlorination for drinking or recreational water, 30 mn 10 ppm
- Drinking water 0.35 – 0.5 ppm
- Pools 0.4 – 1 ppm