Sterilization and Disinfection

Harsha Perera

Standard Precautions

- Basic level of infection control to be used in the care of all patients

Key components

- Hand hygiene
- Use of PPE (gloves, face protection, gown)
- Safe injection practices
- Respiratory hygiene and cough etiquette
- Safe handling of contaminated equipment and surfaces in the patient environment
- Environmental cleaning
- Handling and processing of used linens
- Proper waste management

Hospital Environmental Surfaces

- May become contaminated
- May not directly involved in transmission of infections
- Do not require stringent decontamination procedures

Categories of Environmental Surfaces

- Clinical contact surfaces
  - High potential for direct contamination
- Housekeeping surfaces
  - Do not come into contact with patients or devices
  - Limited risk of disease transmission

General Cleaning Recommendations

- Use barrier precautions always

  e.g., heavy-duty utility gloves, masks, protective eyewear

- Physical removal is as important as disinfection

- Follow manufacturer's instructions

- Do not use high-level disinfectants on environmental surfaces

Cleaning Housekeeping Surfaces

- Routinely clean with soap and water or hospital disinfectant

- Clean mops and cloths and allow to dry thoroughly before re-using

- Prepare fresh cleaning and disinfecting solutions daily (manufacturer recommendations)

Why Cleaning ??

Physical removal of dirt removes many microorganisms

Should be done prior to sterilization and disinfection

Thorough cleaning with soaps and detergents can remove more than 90% of microorganisms

Mechanical Cleaning

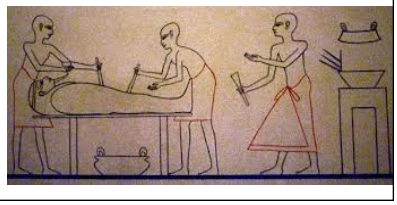
- Play a huge role
- Please respect this inexpensive procedure

Cleaning Methods

- Mechanical cleaning
  - Utensil washer-sanitizer
  - Ultrasonic cleaner
  - Washer sterilizer
  - Dishwasher
  - Washer disinfector
- Manual cleaning

History

- Burial, incineration, boiling, Mercury derivatives etc…..
- In the year 429 BC, fumigation was recommended by Hippocrates
- Mummification



Blancou 1995, Piyadasa 1994, philipveerasingam.blogspot.com

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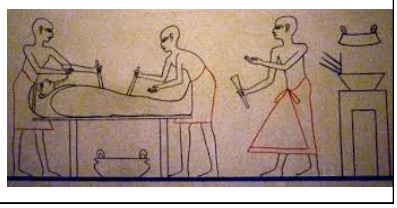
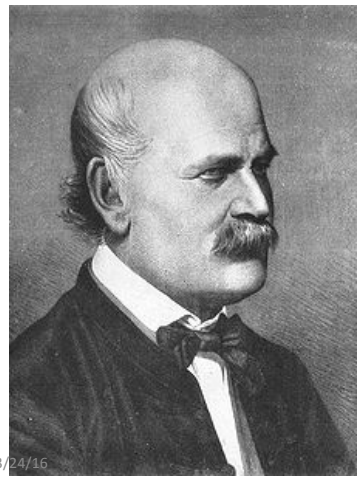


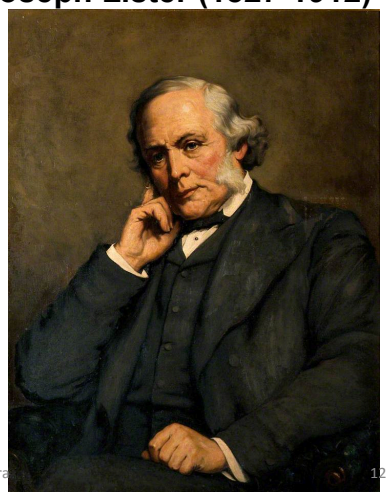
Blancou 1995, Piyadasa 1994,
philipveerasingam.blogspot.com

Historical background

Ignatz Semmelweis (1816-65)



Joseph Lister (1827-1912)



Disinfection and sterilization

- Invasive procedures involve contact by a medical device or surgical instrument with a patient's sterile tissue or mucous membranes

Why Worried

- Risk of introduction of pathogenic microbes
- Cross contamination

Choice of Method

- Depends on the
  - Nature of the item
  - Likely microbial contamination
  - Risk of transmission

Medical materials are categorized

Critical materials

Semi-critical materials

Non-critical materials

Historical background

- Early Disinfection
- Phenol being sprayed over operation wounds by 19th Century surgeons

Factors influence degree of microbial killing

- Type of organism
- Number of organisms
- Contact time
- Temperature
- pH
- Biofilms
- Concentration of disinfecting agent
- Presence of organic material (e.g., serum, blood)
- Nature/composition of surface to be disinfected
- Compatibility of disinfectants and sterilants

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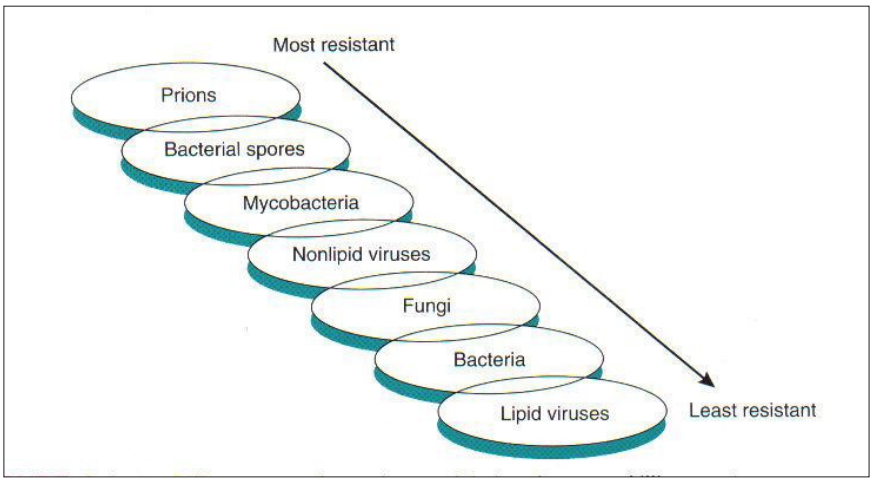
Degree of resistance to killing agents



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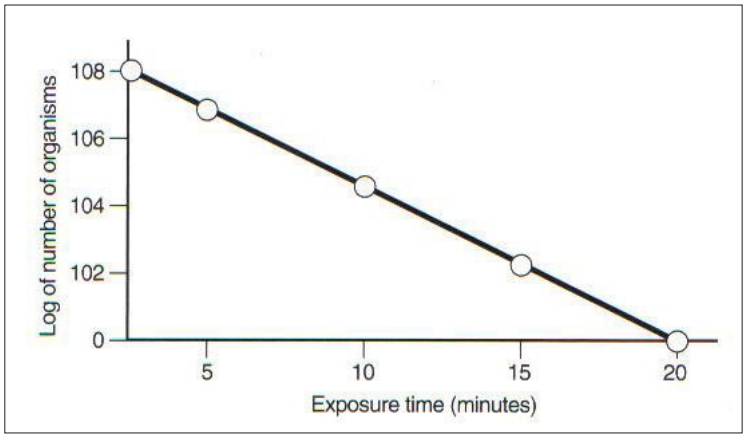
The effect of exposure time versus number of organisms



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Sterilization

- Physical/Chemical process
- Completely destroys or removes all microbial life, including spores
- **ABSOLUTE**

Disinfection

- Killing or removing harmful microorganisms
- Mainly vegetative organism are targeted
- Not necessarily kill spores

Concepts

Disinfectant

- Kill microorganisms on inanimate objects or surfaces
- Not necessarily sporicidal

Antiseptic

- Destroys or inhibits the growth of microorganisms in or on living tissue
- Not necessarily kill but may be sporostatic

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Medical materials are categorized

Critical materials

Semi-critical materials

Non-critical materials

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Critical materials

- Invade sterile tissues/ enter vascular system
  - Surgical instruments
  - Cardiac and urinary Catheters
  - Implants
- *Should be purchased sterile*
- *Sterilized with steam*

www.cdc.gov/hicpac/Disinfection_Sterilization

Semi- critical materials

- Items contact mucous membranes or intact skin
- Require high-level disinfection agents
  - *Endoscopes*
  - *Laryngoscope blades*
  - *Anesthesia equipment*

www.cdc.gov/hicpac/Disinfection_Sterilization

Non-critical materials

- Come in contact with intact skin but not mucous membranes
- Require intermediate-level to low-level disinfection
  - Bedpans
  - Blood pressure cuffs
  - Crutches

www.cdc.gov/hicpac/Disinfection_Sterilization

Table 4-1 Device Classification and Methods of Effective Disinfection

Device Classification	Disinfection Method	Killing Action Against: Spores	Mycobacteria	Nonlipid Viruses	Fungi	Bacteria
Critical	**Sterilization**					
	Steam	+	+	+	+	+
	Dry heat	+	+	+	+	+
	Gas	+	+	+	+	+
	Chemical	+	+	+	+	+
	Ionizing radiation	+	+	+	+	+
Semicritical	**High-level disinfection**					
	2% glutardehyde	±	+	+	+	+
	Chlorine dioxide	±	+	+	+	+
	Wet pasteurization	–	+	+	+	+
	Low-level disinfection					
	Sodium hypochlorite	–	+	+	+	+
	Quaternary ammonium compounds	–	–	±	+	+
	Ethyl, isopropyl alcohol (70%-90%)	–	–	+	+	+
	Phenolics	–	±	+	+	+
	Iodophors	–	–	+	+	+

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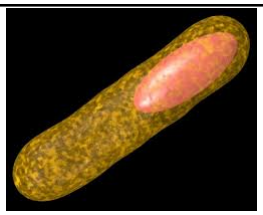
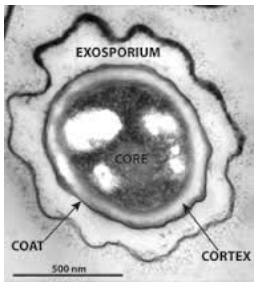
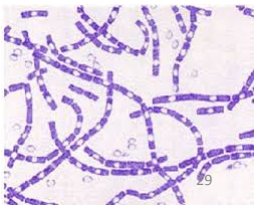
High Level Disinfectants HLD

- Active against all microorganisms except high numbers of bacterial spores
  - Glutaradelhyde
  - Peracetic acid
  - Hydrogen peroxide and Peracetic acid

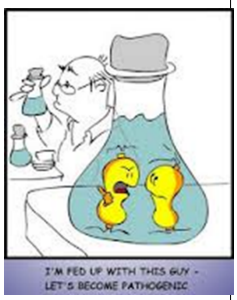






Intermediate-level disinfectants

- Most vegetative bacteria, most viruses, most fungi. Has tuberculocidal activity but not sporocidal
  - Alcohol
  - Iodophor compounds
  - Phenolic compounds



low-level disinfectants

- Kill most bacteria, some viruses and some fungi, but no sporocidal or tuberculocidal activity

  Quaternary ammonium compounds

STERILIZATION AND DISINFECTION

- **Physical methods**
- **Chemical agents**

Physical methods

- Heat
  - boiling
  - dry heat
  - moist heat
  - pasteurization
  - Filtration
- Radiation

Heat
Physical methods

Most common method used of elimination of microorganisms

- economic
- reliably
- easy of handle

Heat
Physical methods

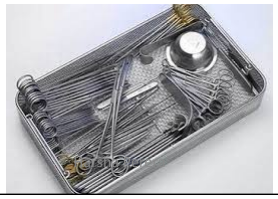
Boiling
Kills most microorganisms
30 min X at 100°C

Tyndallisation
Occasionally used
100°C X 20 min X 3 successive days
sporicidal

Heat dry heat
Physical methods

- Much longer exposure times and higher temperatures *vs* moist heat
  - 160^{o}C X hours
  - 180^{o}C X 30 min
- **Practical application**

sterilization for heat-stable substances
Glassware or surgical instruments



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Moist heat
steam under pressure

- Kill **ALL** micro organisms and their spores
- (??prions)
- most effective and most efficient means of sterilization
- Different autoclave temperature and time pressure protocols
- e.g Steam under 1 atm of pressure,
  15psi, 121°C, 15 min

Application

- Method of choice for heat-stable objects

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Autoclaves
Physical methods

Pasteurization
Physical methods

- LTH (low temperature holding)
- UHT(ultra-high temperature)
- HTST(high temperature short time

- Application

  Food industry eliminating food-born pathogens without affecting the taste (e.g. UHT milk)
- **Do not kill spores**

Physical methods
Summery

Table 4-2 Control of Microorganisms Using Health Methods

Method	Temperature (°C)	Time Required	Applications
Boiling water (steam)	100	15 minutes	Kills microbial vegetative forms; endospores survive
Autoclave (steam under pressure)	121.6	15 minutes at 15 psi	Sterilizes and kills endospores
Pasteurization			
Batch method	63	30 minutes	Disinfects and kills milk-borne pathogens and vegetable forms; endospores survive
Flash method	72	15 seconds	Same, but shorter time at higher temperature
Over (dry heat)	160-180	1.5-3 hours	Sterilizes; keeps materials dry

Adapted from VanDemark PJ, Batzing BL: *The microbes: an introduction to their nature and importance*, Redwood City, Calif, 1987, Benjamin-Cummings.

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Filtration

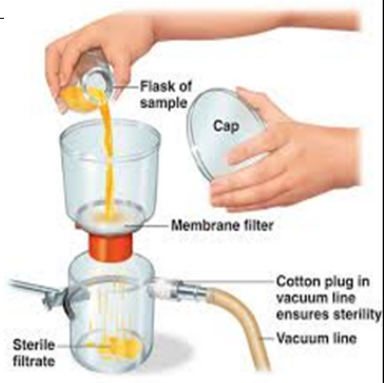
Physical methods

- Filters composed of plastic polymers/cellulose esters.
- Pores of certain size
  - 0.45 and 0.80 µm: Most bacteria, fungi
  - 0.22 µm: Critical sterilizing
  - 0.01 µm: Retain small viruses
- **Application:**

  Parenteral solutions/vitamins/vaccines/antibiotic solutions and VTM

Concept

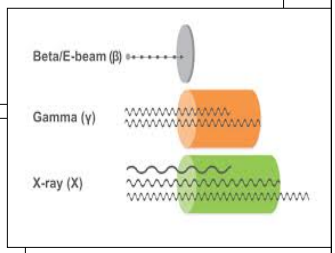
- Liquid is pulled (vacuum) or pushed (pressure) through the filter matrix, organisms larger than the size of the pores are retained



Radiation
Physical methods

- **Two forms:**
  - Ionizing
  - Non ionizing

Ionizing radiation
physical methods



- Gamma rays
- Short wavelength/high energy

Application:

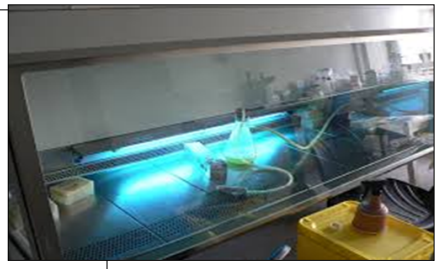
Medical industry

Disposable supplies

- syringes
- catheters
- gloves
- heat-sensitive pharmaceuticals

Nonionizing radiation
Physical methods

- Ultraviolet rays (UV)
  280-200 nm
- Long wavelength and
  low energy
- Poor penetrability



Chemical agents

- Alcohols
- Aldehydes
- Halogens
- Phenols
- Chorhexidine
- Gases (ethylene oxide, oxidants)

chemical agents

- In general chemical agents are disinfectants
- Some may be used to sterilize (chemosterilizers)

Alcohols

- **In use**
  - ethanol 70%
  - isopropanol 70%
  - propanol 60%
- Denaturing proteins

- **Wide spectrum against**
  - bactericidal/fungicidal/tuberculocidal/virucidal/not sporocidal
- Most effective 60%-90%
  (why water is required? Home work)
- **Application:**
  - Surgical and hygienic
  - Disinfection of the skin and hands

Aldehydes

Formaldehyde

Water-soluble gas -formalin

Glutaraldehyde: disinfectant and sterilizer

- Irritate mucosa and skin
- Broad-spectrum: bacteria, fungi, and viruses
- Chemosterilizer in higher concentrations

- Application:
  - Disinfection of surfaces, plastic and rubber items
  - Sterilizer of heat-sensitive medical equipment

Halogens(chlorine/iodine)

- Chlorine
- Used in the form of hypochlorite
  (e.g. liquid sodium hypochlorite -household bleach)
- Broad-spectrum activity: sporocidal required the long exposure time
- Corrosive
- **Application**
  Disinfection in lab, water, swimming pool, cleaning and washing products

Halogens
Iodine

- Tincture (alcohol and iodine)
- Iodophores (iodine and surfactants)

  Povidone iodine

- Bactericidal, not sporocidal
  less irritant than pure iodine

- **Application:**
  Antiseptics
  Disinfection of skin and small wounds

Phenols

- **Lister** was the first to use phenol (**carbolic acid**)
  irritate the skin, corrosive

- Broad-spectrum, but not sporocidal, not virucidal

- **Application**
  widely used, disinfection of hospital & household environment

Chorhexidine

- Disinfect (inanimate/skin)
- Antiseptic for cleaning wounds
- Use for MRSA decolonization
- Many pharmaceutical preparations available

Peracetic acid/peroxyacetic acid (PAA)

- High activity (sterilization) biocidal including endospores
- **Positive aspects**: -no toxic residues -effective in presence of organics
- **Negative aspects**: -corrosive on some surface - pungent odor and expensive

Applications:

disinfection medical equipment endoscopes etc….

Overview of Common Disinfectants

			Active Against						Important Characteristics								
Disinfectant	Use Dilution	Level of Disinfection	Bacteria	Lipophilic Viruses	Fungi	Hydrophilic Viruses	*M. tuberculosis*	Bacterial Spores	Shelf Life >1 Week	Corrosive Effect	Residue	Inactivated by Organic Matter	Skin Irritant	Eye Irritant	Respiratory Irritant	Toxic	Environmental Concerns	Typical Application in Hospitals
Glutaraldehyde	2%-3.2%	High	+	+	+	+	+	+	+	−	+	−	+	+	+	+	−	Endoscope
Hydrogen peroxide	3%-25%	High	+	+	+	+	+	±	+	±	−	±	+	+	−	+	−	Contact lenses
Chlorine	100-1000 ppm free chlorine	High	+	+	+	+	+	±	+	+	+	+	+	+	+	+	±	Semicritical devices
Isopropyl alcohol	60%-95%	Intermediate	+	+	+	±	+	−	+	±	−	±	±	+	−	+	−	Small surface area
Phenolic compounds	0.4%-5% aqueous	Intermediate	+	+	+	±	+	−	+	−	+	−	+	+	−	+	+	Diagnostic instruments
Iodophors	30-50 ppm free iodine	Intermediate	+	+	+	+	±	−	+	±	+	+	±	+	−	+	−	Surgical instruments; medical equipment
Quals	0.4%-1.6% aqueous	Low	±	+	±	−	−	−	+	−	+	+	+	+	−	+	−	Disinfection in food preparation areas and floors

Modified from Widmer AF, Frej R: Decontamination, disinfection, and sterilization. In Murray PR et al, editors: *Manual of clinical microbiology*, ed 7, Washington, DC, 1999, American Society for Microbiology.
+, Active; −, not active; ±, poor activity.

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Gases

Ethylene oxide

- **Ethylene oxide**

  Most commonly used for sterilization
  Highly reactive gas, flammable and toxic
  Mucosal irritant
  Explosive
  Active against ALL microorganisms and spores

- **Application**

Materials that cannot withstand steam sterilization

MONOTORING STERILIZATION

- **Physical Methods**
- **Chemical Methods**

Hygienic hand disinfection

Alcohols are the agent of choice**!**

- Not necessary to kill spores

Surgical hand disinfection

- Surgeon's hands as free of organisms as possible
- After washing the hands thoroughly
- Alcoholics preparation or alcohols combined with disinfectants/iodophores

Disinfecting patient's skin

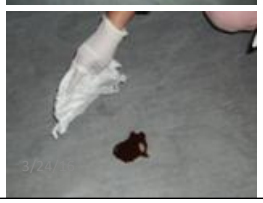
- Preparation for surgery and injections
- **Alcohols and iodine compounds**

Disinfection of excretion

- Feces, sputum, urine, etc.
- Not necessary to kill spores
- **Phenolic preparations**

Blood Spillage







http://www.parn.org.pk/index_files/SPILLAGE.htm

Thanks