DISINFECTION
STERILIZATION

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Any deficiency in disinfection and sterilization procedures can lead to infections and may cancel the efforts of the entire medical team!

Definitions

- **Cleaning** - a decontamination method that ensures the removal of microorganisms from surfaces and objects with the removal of dust and organic substances;

- **Disinfection** - a decontamination process which 90-99.9% of existing microorganisms are destroyed on inert objects (except bacterial spores);

- **Antisepsis** - a process by which most of the germs on living tissues are temporarily destroyed (uninjured or injured tegument / mucosa);

- **Sterilization** – a method by which all microorganisms, both vegetative and sporulated, are eliminated / destroyed.

Decontamination / disinfection

- It can be :
  - **Prophylactic disinfection** - to prevent the occurrence and the spread of communicable diseases in the population (disinfection of drinking water, public transportation)
  - **Disinfection in the outbreak :**
    - **the current form** - in the area where the confirmed or suspected case of transmissible disease is present, the entire period of contagious disease, and around the contacts and bearers during germ removal. **It targets the biological and pathological products eliminated by the patient or the bearer as well as the environment in the patient's room, including all the objects here.**

Decontamination / disinfection

- **Terminal disinfection - after removing the patient or carrier from the outbreak.**
  - **In the infectious and contagious disease departments, following cases of disease with nominal declaration;**
  - **In outbreaks of nosocomial infections with multiresistant germs;**
  - **In the areas of immunosuppressed, burned, neonatology, premature, graft / transplantation departments, oncology and oncohematology departments;**
  - **In the operating block, in the nursing home, intensive care units;**
  - **emergency services, ambulance, the place where the bed sheets is being sorted.**
- **Microorganisms requiring terminal disinfection :**
  - ***Mycobacterium tuberculosis*,**
  - **enterobacteria or non-fermentative BLSE germs (beta-lactamase secreting enterobacteria),**
  - **MRSA (*methicillin resistant Staphylococcus aureus*),**
  - ***group A streptococcus* (GAS),**
  - **Hepatitis viruses, poliomyelitis.**

Cleaning methods

- **Product mixing is not allowed and the distribution on the sections should be done in the original package with a label;**
- **Storage - in central spaces with easy to clean pavements / walls, with natural ventilation, optimum degree of humidity, storage in order;**

Detergents

- have a hydrophilic and hydrophobic group with surfactant and emulsifying water with fats.
- They may be sparkling, emulsifying or dispersing stabilizers.

  It works by blocking and destroying enzymes or by distorting and inactivating proteins.

- **Anionic detergents**
  - These are Na and K salts of higher fatty acids, wherein the active disinfecting radical is organic acid.
  - They have detergent action, by entrapping lipids / superficial cells and colonizing bacteria together with foam and eliminating them. Protein debris and acid pH reduce their effectiveness.
  - In addition they are bactericides for Staphylococcus spp. and Streptococcus pneumoniae;
  - Ex. alkylsulfates and lauryl sulfates for pavers, glassware, toilets.

Detergents

Cationic Detergents

- **Their main action is bactericidal, fungicidal, partially virucidal and secondary a detergent;**
- **The spectrum of action is selective, predominantly Gram-positive and less Gram-negative;**
- **The presence of organic substances does not affect their efficacy, but an anionic detergent inhibits it;**
- **Ex. Bromocet, Zefirol**

Disinfection by physical methods

I. By dry heat :

- **Flaming - ansa for bacterial culture, DO NOT apply to surgical instruments;**
- **Incineration - for waste, anatomical parts, laboratory animals**

II. By wet heat :

- **Pasteurization - Disinfection of liquids at temperatures between 55-95 ° C - Destroys 90-95% of the pathogenic microorganisms;**
- **Washing at T = 90 ° C - Lingerie, dishes, laboratory glassware;**
- **Boiling at T = 100 ° C - destroys in 10-20 minutes the vegetative forms as well as some sporadic forms less resistant - food, water, lingerie, cutlery, dishes**
- **Steam ironing - destroys vegetative forms in 5-10 s as well as spores in 50 s;**

III. By ultraviolet rays (ultraviolet light) :

- **Disinfection of aeromicroflora in laboratory, operating rooms, insulators or smooth surfaces (15-30W tube lamps with direct or indirect radiation).**

Disinfection by chemical methods - Classification Order 961/2016

Disinfection level	Feature
High level disinfection	- Destroys all vegetative forms except bacterial spores - Contact time - at least 20 min. - 1h. - glutaraldehyde 2%, H 6% peroxide, peracetic acid, Na2 hypochlorite 5.25% - includes medium level disinfection, cleaning, high-level disinfection by immersion and rinsing. - the solution should be used for up to 48 hours or 30 cycles of preparation, provided it is kept in containers with lid.
Medium-level disinfection	- Destruction of M. tuberculosis, bacterial vegetative forms, most viruses and fungus except bacterial spores -Contact time - at least 10 min. - Phenols, Iodophors, alcohols, Cl-based compounds
Low-level disinfection	-Destroys most bacterial vegetative forms, some viruses, fungus, except bacterial spores and resistant germs - M. tuberculosis -Contact time - less than 10 min - Phenols, Iodophors, alcohols, Na hypochlorite 5.25%

Factors that influence disinfection

- Spectrum and germicidal power;
- Initial number of bacteria on the treated support;
- The amount of organic material on the support;
- the surface type;
- The concentration of the disinfectant;
- Contact time, temperature;
- pH - optimal acid pH - phenols, halogens,
  - optimal activity alkaline pH - glutaraldehyde, quaternary ammonium compounds,
  - optimal neutral pH - chlorhexidine activity;
- Product stability over time (Na hypochlorite is unstable);
- Corrosivity - hypochlorites corrode metals;
- Toxicity - formaldehyde and glutaraldehyde.

Criteria for choosing disinfectants

- **Efficacy, with high bactericidal capacity; reduced action time;**
- **Not to be neutralized by protein debris;**
- **Ease in preparing and applying solutions and storing them;**
- **Stable in time;**
- **Lack of corrosivity and destructive effects;**
- **Knowing of disinfectant toxicity under the circumstances of use;**
- **biodegradable;**

PRACTICAL RULES OF DISINFECTION

- **It does not replace cleanliness and it does not replace sterilization!**
- **In the outbreak– disinfection precedes cleanliness!! with active disinfectants on the pathogen;**
- **Alternate disinfectants is recommended to prevent resistance!**
- **According to its effective concentration, time of action, use of fresh solutions, within its validity period;**
- **Compliance with labor protection rules!**

Classification of medical instruments

Type of Instrument	Method of disinfection / sterilization
Critical instrument	- Instruments that penetrate the skin and mucous membranes - needles, scalpels, catheters, implants, drainage tubes, surgical instruments, including dental, biopsy endoscopes - Disinfection followed by STERILIZATION!
Semi-critical instruments	-Instruments that come in contact with intact mucous membranes (except periodontal or injured skin) -endoscopes, laryngoscopes, endotracheal tubes, assisted anesthesia / breathing equipment, internal incubator surface - at least medium-level disinfection! -Oral, rectal thermometers, hydrotherapy baths -medium-level DISINFECTION!
Non-critical instruments	-Instruments that come in contact with intact skin - stethoscopes, platforms, frames for people with disabilities, pavements, furniture, etc -medium-level or low level DISINFECTION!

Classification of the hospital environment

Hazard	Method of decontamination
Minimum risk	**- walls, floors, ceiling, sewer, drainage channels, bed fittings, cabinets** **- CLEANING, DRYING**
Low risk	-Items that come in contact with intact skin - stethoscopes, tonometers, dishes, other sanitary items **- CLEANING, DRYING**
Medium risk	**-Objects that come into contact with mucous membranes - thermometers, endoscopes, respiratory assistance equipment** **-Contaminated objects** -Objects used in immunosuppressive patients **-High level DESINFECTION**
High risk	**-Objects in contact with skin / injured skin or introduced into sterile areas - needles, catheters, surgical instruments, implants** **-STERILIZATION**

CLASSES OF DISINFECTANTS

1. PHENOLIC DERIVATIVES

- **Benefits :**
  - Stable in solution, cheap;
  - Bactericidal (including Pseudomonas aeruginosa), fungicidal, tuberculocidal, poorly virucidal (or null) but not sporicidal;
  - They are used only for disinfection of the environment - air, surfaces and sometimes for anatomo-pathological instruments;
- **Disadvantages :**
  - corrosive to Al, Cu, Zn;
  - They are not effective for parenterally transmitted viruses;
  - Caustic for skin, eye, respiratory or gastric mucosa;
  - Moderately toxic - SNC;
  - Not used in food offices, patient rooms, pediatrics, neonatology, and equipment that comes into contact with mucous membranes;

Vesfene – 1%, in 10 min. kills *M. tuberculosis*,
for surfaces - 0,4% by wiping, spraying; for rooms– 10%

2. Substances releasing the active chlorine

•**Benefits :** Cheap, effective at low concentrations - are not toxic, broad spectrum of use, act quickly;

• **Disadvantages :**

- •may cause eye, oro-pharyngeal irritation,
- •They are corrosive to metals, they can discolour or whiten the objects;
- •They are inactivated by organic debris, release chlorine (toxic gas);
- •They have relatively low stability.

Lime chloride (chalky lime) 25% Cl activ:

- •Bactericide, virulicide, sporocide– 10, 20,40,50, 100 g‰, pH – 6;
- •Disinfection of surfaces - pavements, walls, bathrooms; bed linen, protective equipment, bins, waste collection containers, excretions of contagious patients,
- •Storage in tight, sealed containers.

2. Substances releasing the active chlorine

Na Hypochlorite 12,5% Cl activ:

- universal spectrum of action - bactericide, virucide, fungicide, tuberculocide;
- toxic to 5%, corrosive to 10%;
- For surfaces -4%, lingerie - 2%, dishes - 0,5-1%, glassware 10%.

- **Chloramines B, T - 25-29% Cl activ:**
  - Bactericide, virucide, fungicide, at high concentrations and tuberculocide;
  - More stable solutions;
  - For walls, 2g% paving, moss, plastic covers 1-2 g%;
  - Bed linen, protective equipment - 1-2 g% 1-2 h, dishes 30-60 min. 0,5-1 g%, thermometers.

3. Iodophors

- Bactericidal, virucidal, tuberculocidal, sporicidal or fungicidal activity;
- Used for disinfection / antisepsis of hands, teguments, operator field;
    - **Povidone-iodine** – 7,5 and 10%;
    - antiseptic for hands– 5-10%;
- Eye, gastric and skin irritations, rarely allergic to iodine.

4.BIGUANIDE

Chlorhexidine

- Bactericidal activity (higher on G +), fungicidal, partially virucidal;
- It has no tuberculocidal and sporicidal action;
- Pre- and postoperative antisepsis of the skin 0,5-1%, wounds;
- Eye irritant, contact dermatitis.

HEXACLOROPHENE

- occasionally used in nosocomial epidemics with staphylococcus, for hands.

5. ALCOHOLS

Watery solutions of ethyl (50-70%) and izopropilic (30-50%) alcohol

•Bactericidal action, tuberculocidal, fungicidal, virucidal (resistant to v.polio)

• do not have sporicidal activity; low penetration power, flammable, evaporates easily, destroys rubber / other plastics;

•Ethyl alcohol below 50% is no longer effective;

•Disinfection of surfaces, instruments - oral, rectal, stethoscopes, laryngoscopes;

•Antisepsia of teguments - hands, places of inoculation for parenteral treatments.

6. ALDEHYDES

FORMALDEHYDE (sol. 40%=FORMOL)

- The broadest range of bactericidal, fungicidal, virucidal, sporicidal, tuberculocid;
- The presence of organic material does not reduce agent efficiency;
- Disadvantages: toxic agent, mutagenic potential, teratogenic;
- It is used for disinfection of surfaces, linen, excretions and for **formolization of rooms** (in spaces with B.K. bacillary load);
- It is not used in patient rooms, pediatric, neonatology departments, food offices!
- **Spraying** – 2-5%, 6-24h, sealing of rooms with special appliances;
- **vaporization** – 3-10 g/m^3 sealing the rooms, lifting mattresses / pillows, 24h, neutralization with ammonia 3 h, ½ of the amount of formol, ventilation 2-4 h;
- **dipping** – for disinfection of linen 2%.

ALDEHYDES

GLUTARALDEHYDE

Broad spectrum bactericide, fungicide, tuberculocide, virucide, slow sporicid (3h) - high level disinfectant or chemical sterilization;

- It is not corrosive, activity preserved in the presence of protein debris;
- Relatively cheap;
- Skin, eye, respiratory mucosa and gastric irritation; teratogenic, mutagenic effect;
- For disinfection of objects, heat-sensitive medical equipment - endoscopes, intensive care equipment, anesthesia, dialyzers;

ANTISEPTIC

- They are not sterilizing but temporarily reduce the microorganisms on the skin and mucous membranes;
- the bottle is marked with the date and time of the opening and the final date until which the product can be used in accordance with the manufacturer's recommendations;
- Closure of the bottle after each handling (contamination prevention);
- Do not fill the empty bottle partially with a new amount of product;
- it is recommended to choose products that are used as such and do not require dilution - products in small-sized vials are preferred;
- Only sterile water is used for watery solutions!
- Aqueous chlorhexidine 0.05-0.5%, Chlorhexidine gluconate;
- Merfene / Fenosept;
- Spitaderm;
- Cutisan; povidone-iodine 7,5- 10%,
- Betadine dermal, tinctură de iod 5%, hydrogen peroxide 3%;
- Poliodine; Amukine; Biseptine.

HYDROGEN PEROXIDE

•Has good germicidal activity, including bactericidal, virucidal, sporicidal and fungicidal properties;

•It is marketed as a 3% antiseptic solution but high level disinfection requires a solution of 7.5%, 30 minutes at 20 ° C;

• **Benefits** - does not produce residues, does not generate odor or irritation,

- does not coagulate blood, does not require activation,

• **Disadvantages** - lack of compatibility with some materials (zinc, copper, nickel, silver)

- through contact can cause eye damage.

PERACYTIC ACID

- **Benefits :**
  - **does not produce residues, acts quickly (a cycle lasts 30-40 minutes), remains effective in the presence of organic materials, has sporicid action and at low temperatures (50-55ºC), is compatible with most materials and instruments.**
- **Disadvantages**
  - **corrodes copper, bronze, steel, galvanized sheet, can only be used for instruments that can be submerged, expensive, can damage the eyes or skin, a little stable.**
- **There are automatic chemical sterilization machines for medical and surgical instruments using 0.2% peracetic acid, the temperature being 50-55ºC.**

Disinfection

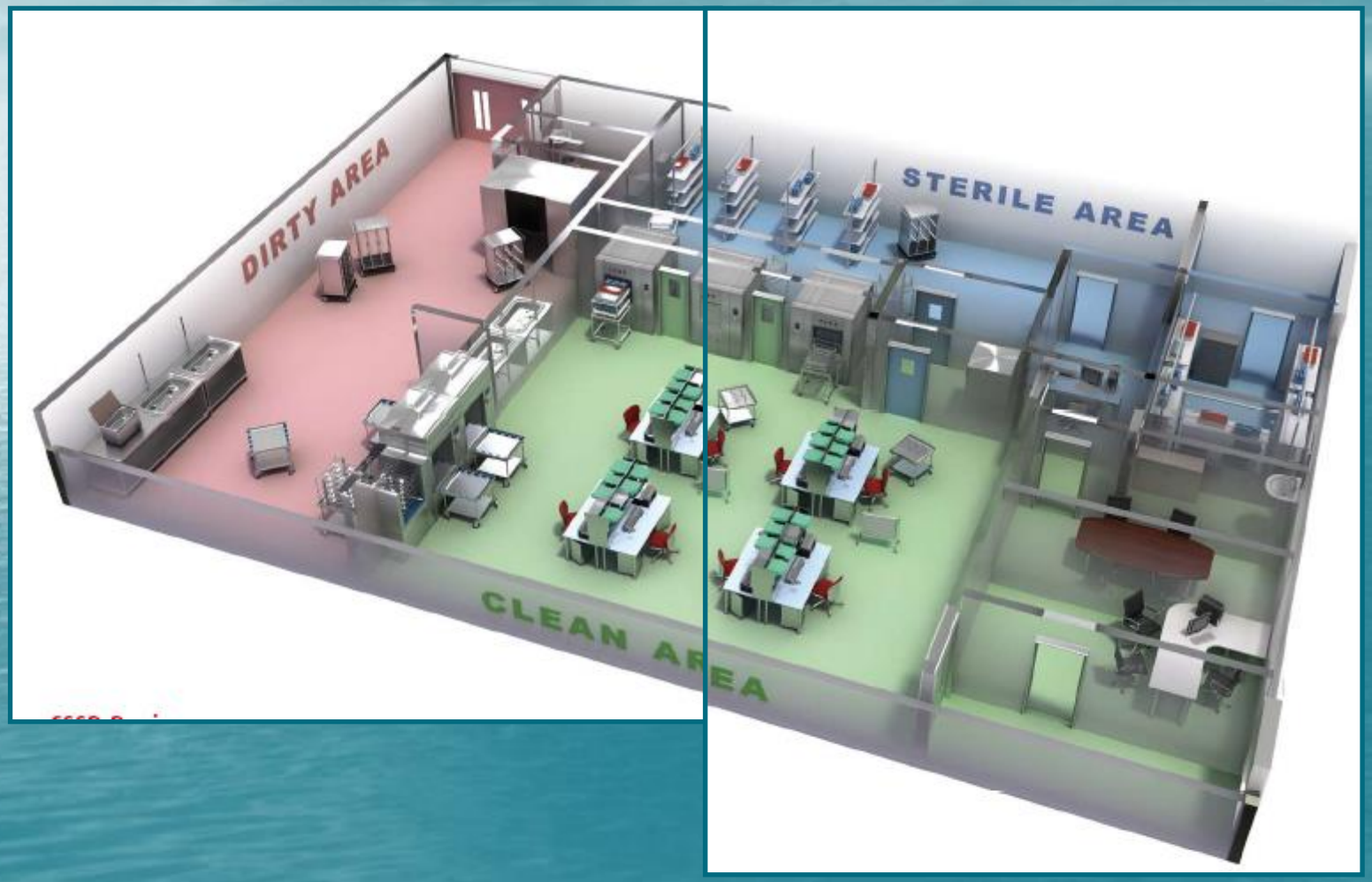
Disinfectants

Antiseptics

STERILIZATION

- **The medical unit must guarantee the sterility of medical devices purchased from the market or sterilized in the hospital;**
- **All surgical instruments, textiles, objects, solutions that penetrates the sterile tissues or vascular system must be sterile;**
- **Disposable devices and materials will never be resterilized!!**
- **Observing the functional circuits of sterile / non-sterile instruments!**

Sterilization station



Methods of sterilization

I. Through hot air ovens (Pupinel)

- The full cycle (4-5 hours) contains :
    - the heating phase,
    - the latency phase with the indicated temperature,
    - the sterilization phase – at 180 °C/ 1 h or 160 °C/ 2 h,
    - cooling phase;
- Do not open the machine during sterilization to insert packages!
- Materials packed in metal cans remain sterile 24h;
- Packaged in plastic bags – 2 months;
- Do not open the device until it falls below 50 °C;
- Check sterility and package labeling;
- Efficiency - on each cycle - t, strips; 1 month - biological testimonies; 6 months revision
- *Bacillus atropheus spores* are used to check the dry sterilization process

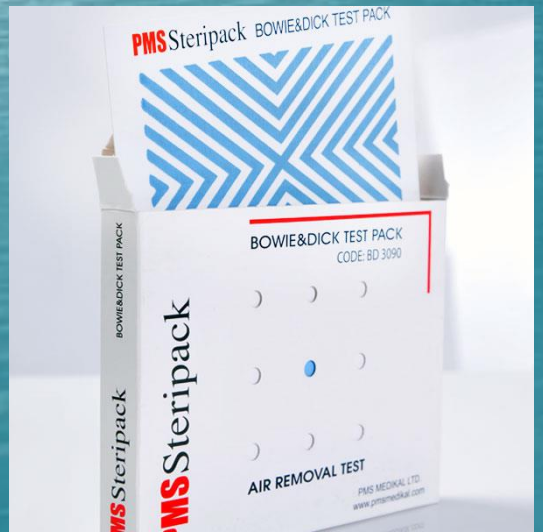
Methods of sterilization

II. Autoclaving - exposure of materials to dry saturated steam 100%;

- **The most effective method of sterilization of metallic surgical material**
- **For surgical instruments, soft material (2 bar, 134ºC, 10-30 min.) , rubber (1,3 bar, 125ºC, 30 min.) for waste decontamination / sterilization of laboratory media, infusions;**
- **Compliance with sterilization cycle times :**
  - **Pretreatment and preheating phase;**
  - **The sterilization phase;**
  - **Post-treatment phase (post-vacuum) - textiles may have an increase in G of 1%**
- **For good air circulation in the autoclave the packages are ordered on shelves or in shuttles;**
- **Obligatory use of cotton gloves;**

Autoclaving

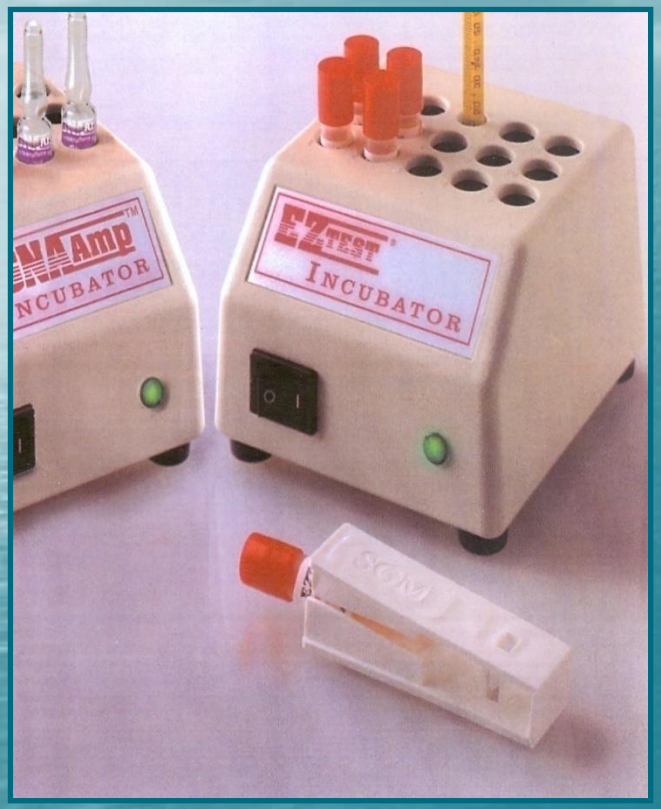
- Verification of sterilization efficiency - physical parameters - t / p, physicochemical - coloring of adhesive tapes, special wrapping papers, packet integrators (if the material is not sterilized);
- biological agents with Bacillus stearotermophylus or stearotest vials - violet color 120 ºC,
- Textile moisture control - sample box with 20 g folded gauze - weighing before and after sterilization;
- Steam penetration test - Bowie & Dick test - towels + special paper - correct: uniform color change of the geometric model;

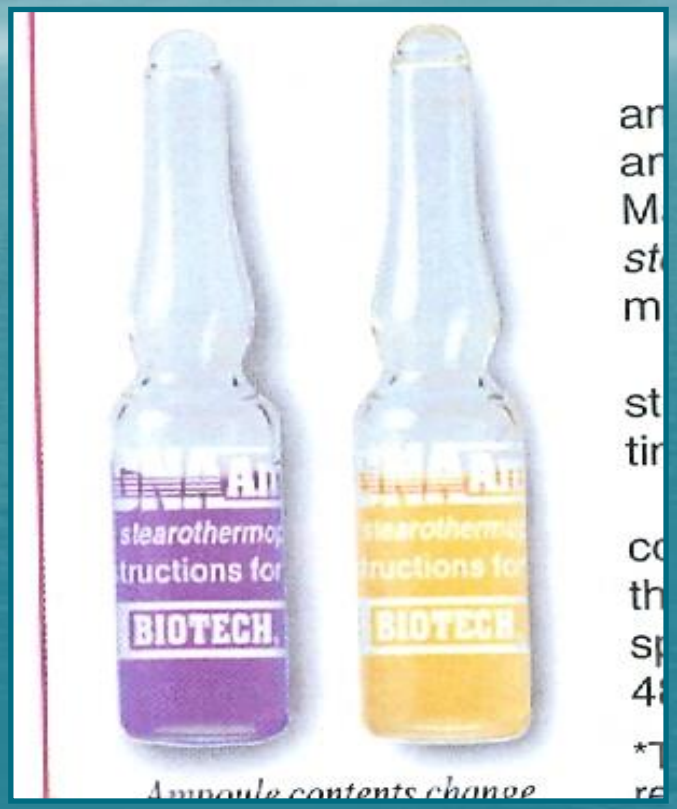


- **Package labeling - date, time, sterilizer, sterilization person + record in sterilization registry;**
- **Duration of sterilization - 24 hours for boxes, 2 months for plastic wrapped bags, paper;**
- **Performing physical tests for each cycle;**
  - **Daily steam penetration and biological indicators;**
  - **Periodic inspection of the appliance - 1 date / quarter.**

Physical indicators

Biological indicators





Registry of sterilization evidence

- **Sterilization by physical and physicochemical methods is recorded in the registry, which contains:**

- **date and appliance number, content and number of objects in the batch, number of the batch, temperature, sterilization pressure, start and end time of the cycle, results of the physicochemical indicators and the result of the biological tests, signature of the person responsible for sterilization and releasing sterile material.**

III. Water Sterilization for Surgery

- In the autoclave for 30 min. at 1,5 bar;
- Prepare on the day of use;

IV. Sterilization with ethylene oxide

- For objects, thermosensitive equipment - plastic, composite materials, fragile materials;
- Ethylene oxide - toxic: in person may cause contact dermatitis, respiratory mucosal irritation, SNC depression;
  - In patients: Insufficient desorption may cause haemolytic events, tracheal stenosis, cardio-circulatory collapse, allergies;
  - Flammable - from 3%;
- 180 min./37ºC/ subatmosferic pressure– 4-8 h
- 60 min./55 ºC/ subatmosferic pressure– 2-5 h
- For desorption - ventilated space, t 20 ° C, where it is forbidden to standing staff.

Methods of sterilization

V. Sterilization with low temperature formaldehyde

- **10 min./73ºC/ subatmosferic pressure– 3-5 h;**
- **10 min./80ºC/ subatmosferic pressure;**
- **30 min./65ºC/ subatmosferic pressure;**
- **Toxic agent!**

- **Responsibilities – medical nurse responsible for preparing sterilization materials and assistance from the sterilization station!**

REFERENCES

- **Guides CDC**
- **ORDER Nr. 961/02.09.2016 for the approval of the Technical Norms on cleaning, disinfection and sterilization in public and private sanitary units, the working and interpretation techniques for tests for the evaluation of the effectiveness of the cleaning and disinfection procedure, the recommended procedures for hand disinfection, depending on the level of risk, chemical disinfectants depending on the support to be treated and the methods for assessing the performance and efficiency of the sterilization process**

Thank You For Your Attention!!