



Pirogov Russian National Research Medical University
Department of General Surgery

Asepsis and antisepsis (infection control in surgery)

Dr. Kirill Lobastov, PhD, Associate professor

Surgery

The branch of medical practice that treats injuries, diseases, and deformities by the physical removal, repair, or readjustment of organs and tissues, often involving **cutting** into the body.



Surgical incision

Infection

Pain

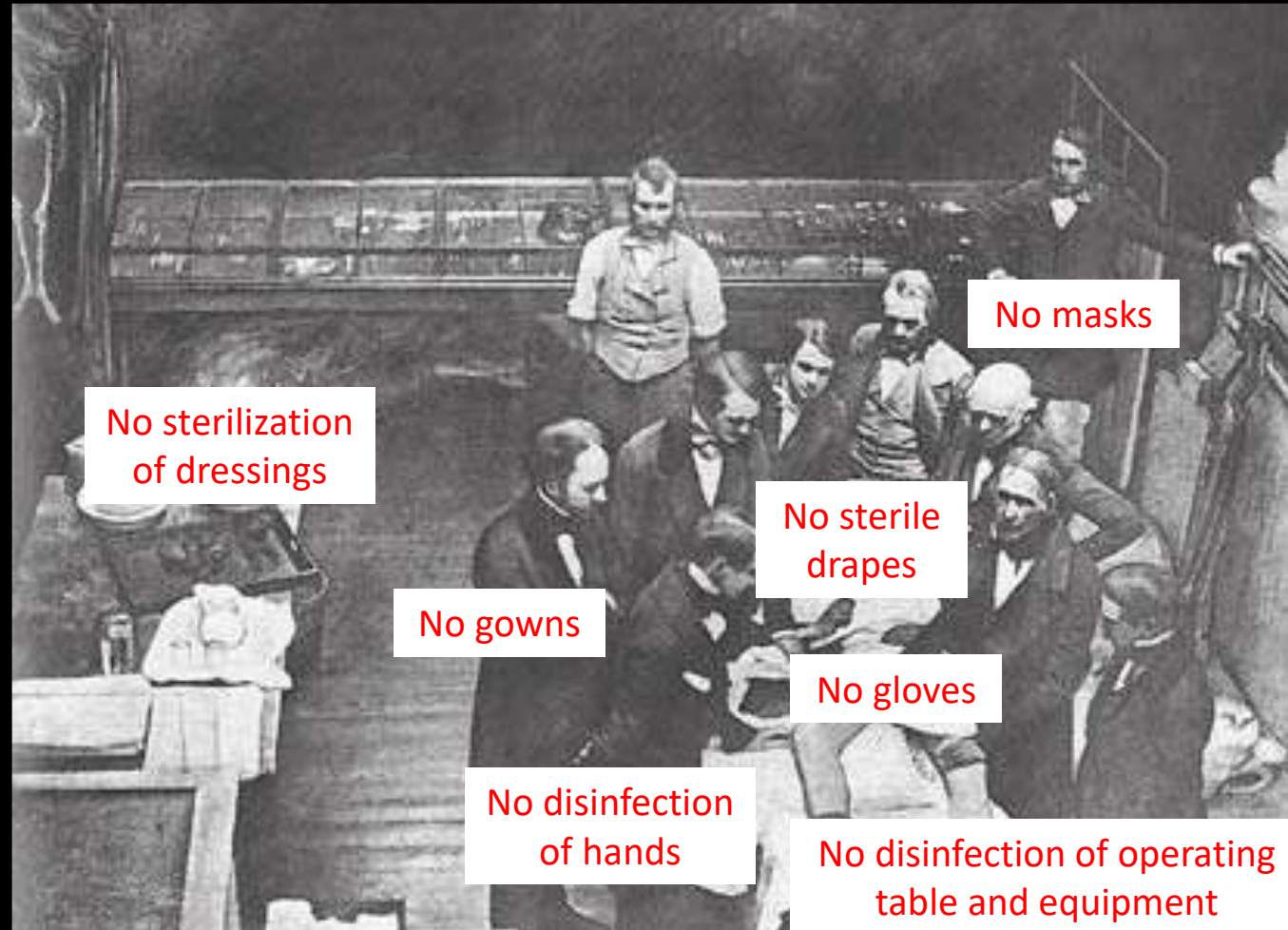
Bleeding



Every operation in surgery is an experiment in bacteriology

Berkeley Moynihan, 1st Baron Moynihan,
British abdominal surgeon, 1920

Sometime surgery looked like this



1847, Operating room of the Massachusetts General Hospital

Sometime surgery looked like this

- Surgeons performed operations in their street clothes with the only concessions being the removal of coats and rolling-up of shirt-sleeves during bloody procedures.
- Surgeons often wore black “frock coats” to reflect respectability and the “somber nature of their work”.
- The mark of a busy and successful surgeon was the profusion of blood and fluids on his clothes leading to the perennial surgical story of the frock coat “stiff with caked blood”.

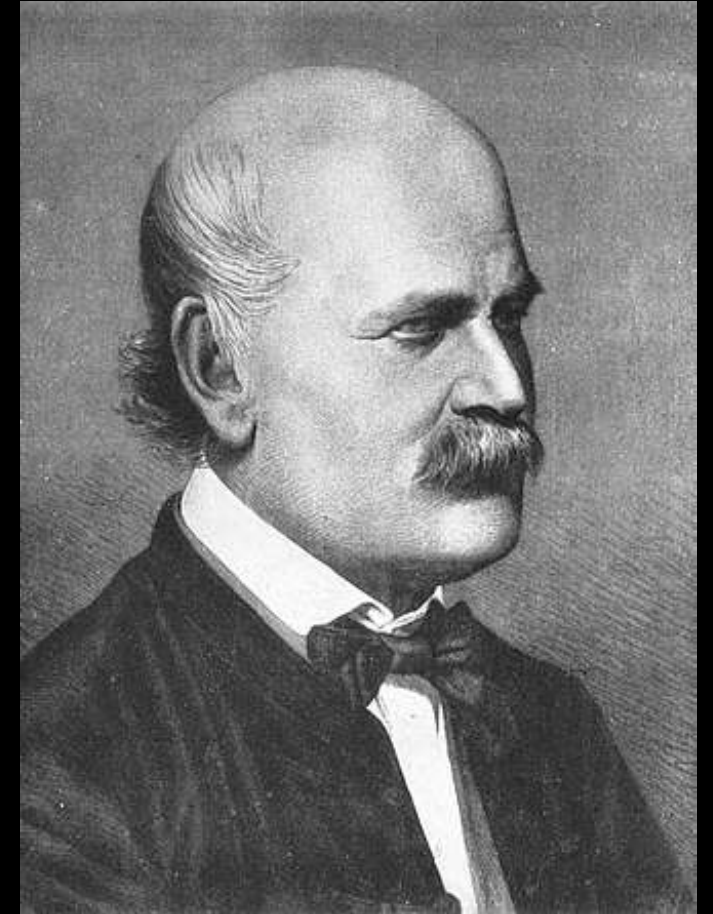


Early surgery

Mortality due to surgical infection
reached 50%

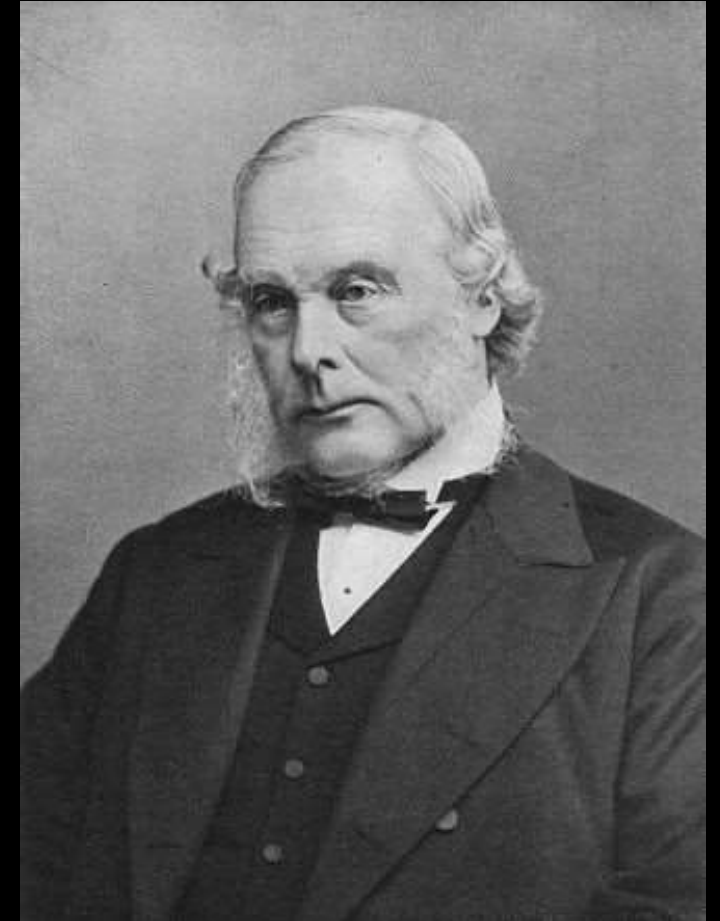
Ignaz Semmelweis (1818-1865)

- Ignaz Philipp Semmelweis was a Hungarian physician and scientist, now known as an early pioneer of antiseptic procedures.
- Described as the "saviour of mothers", Semmelweis discovered that the incidence of puerperal fever (also known as "childbed fever") could be drastically cut by the use of hand disinfection in obstetrical clinics.
- Puerperal fever was common in mid-19th-century hospitals and often fatal. Semmelweis proposed the practice of washing hands with chlorinated lime solutions in 1847 while working in Vienna General Hospital's First Obstetrical Clinic, where doctors' wards had three times the mortality of midwives' wards.

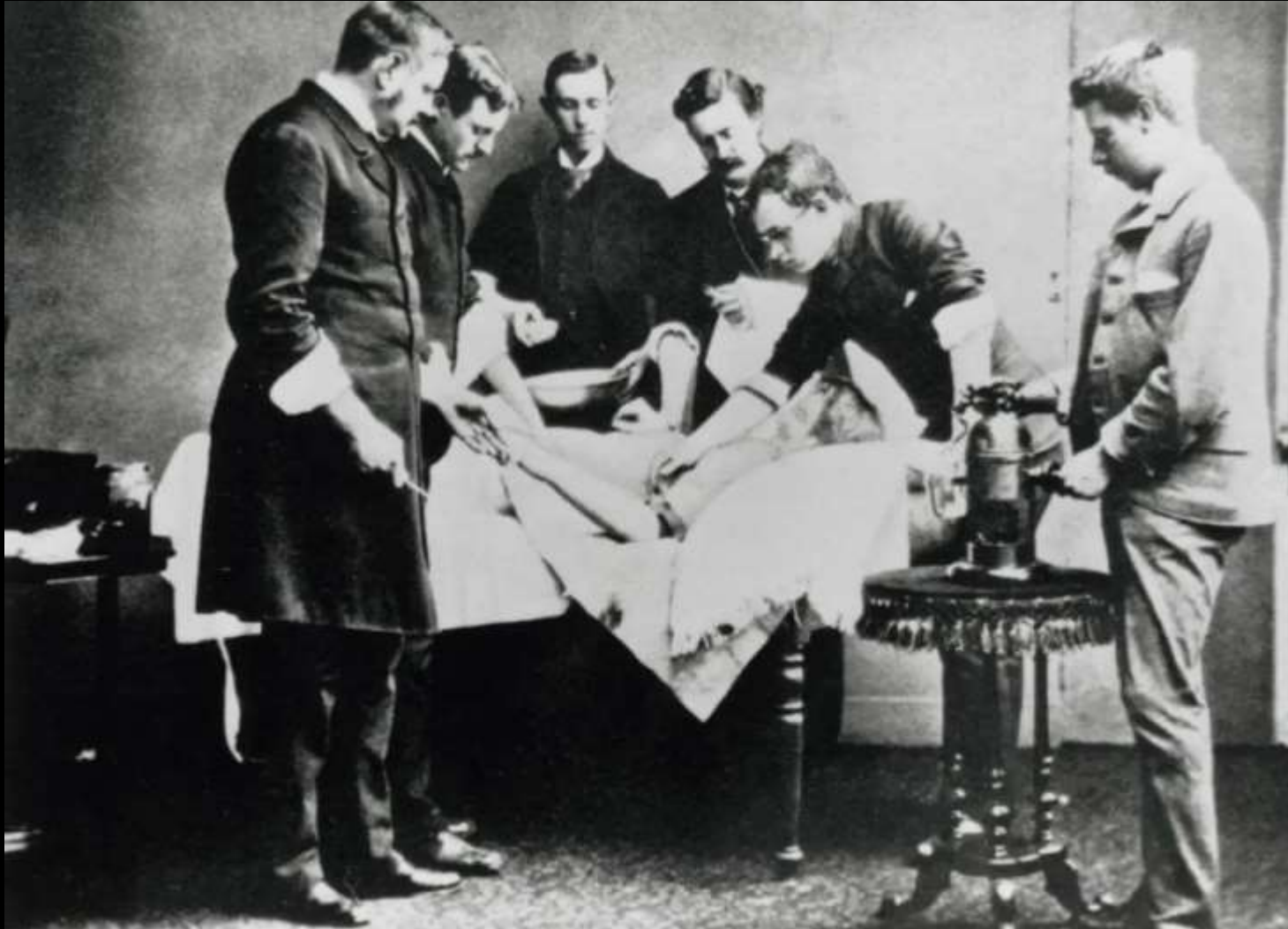


Joseph Lister (1827-1912)

- Joseph Lister, Baron Lister of Lyme Regis OM, PC, PRS, FRCSE, FFPS was a British surgeon, experimental pathologist and a pioneer of antiseptic surgery.
- From a technical viewpoint, Lord Lister was not an exceptional surgeon, but his research into bacteriology and infection in wounds raised his operative technique to a new plane where his observations, deductions and practices revolutionised surgery throughout the world.
- Lister championed the use of carbolic acid as an antiseptic, so that it became the first widely used antiseptic in surgery. He first suspected it would prove an adequate disinfectant because it was used to ease the stench from fields irrigated with sewage waste. He presumed it was safe because fields treated with carbolic acid produced no apparent ill-effects on the livestock that later grazed upon them.
- Lister invented the antiseptis method as a part of modern surgery
- Created a routine where he covered the wound with a piece of lint drenched in carbolic acid, whereas the death rate fell significantly from 50% to 15%
- Invented the machine that misted out proportions of carbolic acid into the air around the operation table and equipment, to kill airborne germs. Invented a carbolic spray
- Proposed a sterilization of rubber gloves



Carbolic spray by Lister



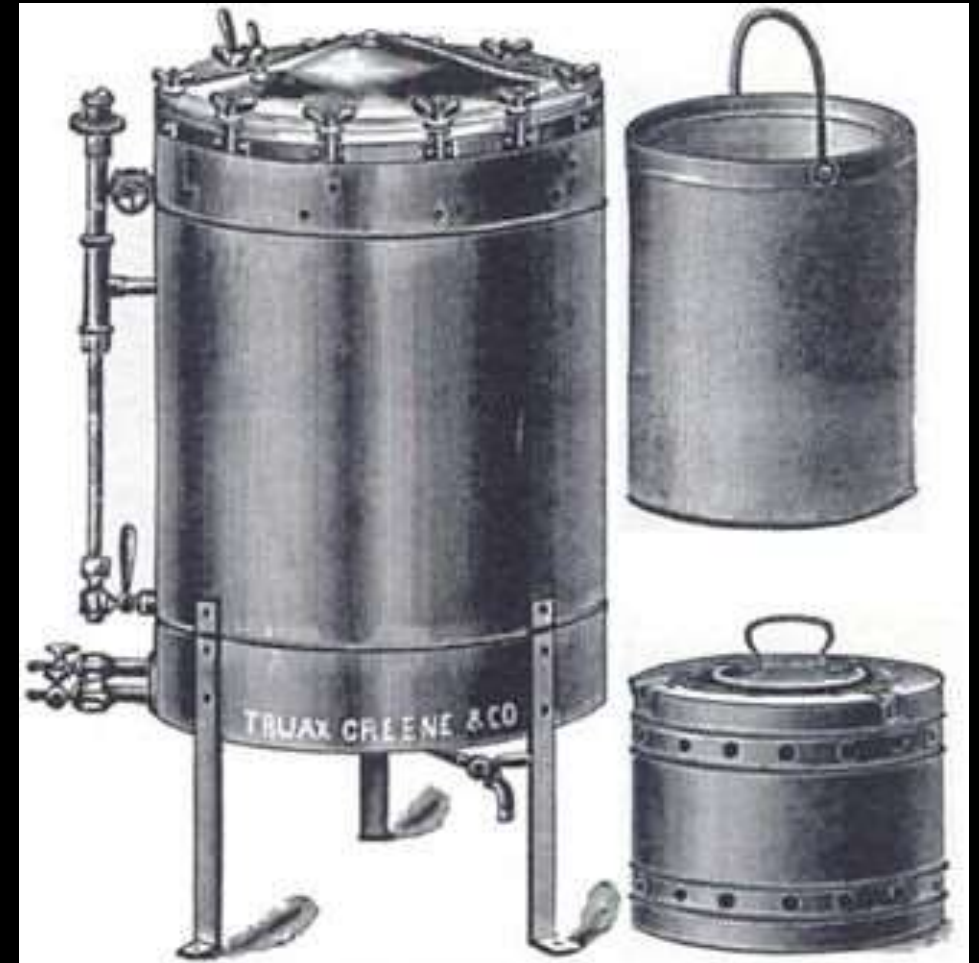
Ernst von Bergmann (1836-1907)

- Bergmann was the first physician to introduce heat sterilization of surgical instruments, thus greatly reducing the number of infections in surgery.
- He also used steam sterilized dressing material, demonstrating its superiority to chemical antiseptics.
- He was also an early adopter of the "white coat".



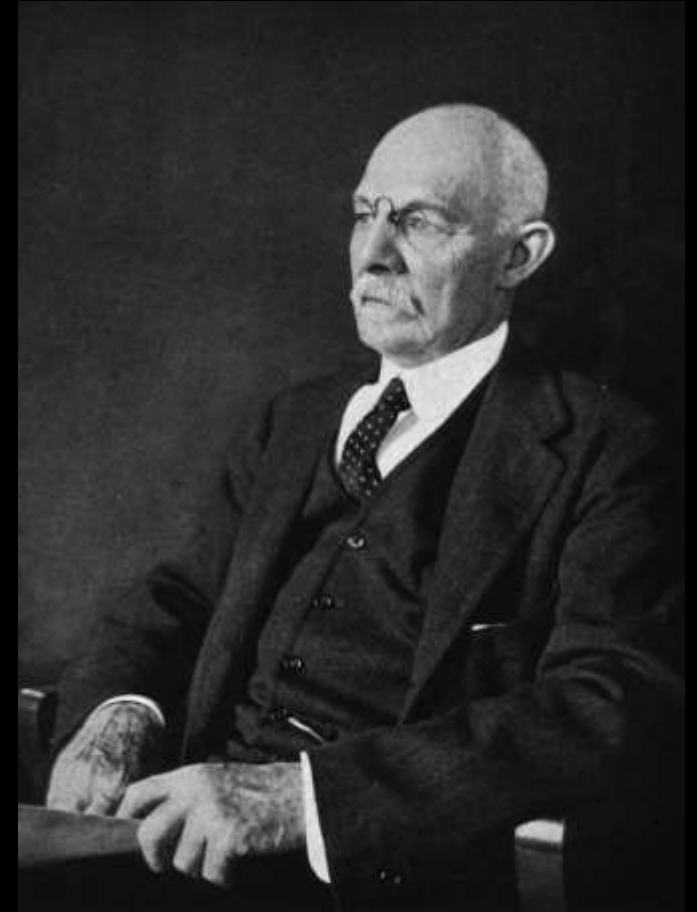
Curt Schimmelbusch (1860-1895)

- Ernst von Bergmann hired Schimmelbusch in 1889, having been impressed with his work on bacteriology.
- Bergmann used a number of methods of disinfection and sterilisation, which Schimmelbusch documented and formalised.
- Schimmelbusch proposed that medical dressings should be sterilised daily, prior to surgery, and that they should remain in the same vessel until their use.
- He noted that items described as sterile that arrived from a factory or pharmacy were often contaminated, resulting in the need to conduct sterilisation in the hospital.
- To achieve this, he proposed a variation on the designs of autoclave that already existed, in which items should be sterilised for twenty to thirty minutes.
- He also designed several storage boxes which could hold the instruments inside the autoclave, and then be closed so that the instruments could be transported to the location of the operation without being contaminated.
- The boxes had sliding bands to open or close gaps to allow steam or prevent contaminants from entering the box

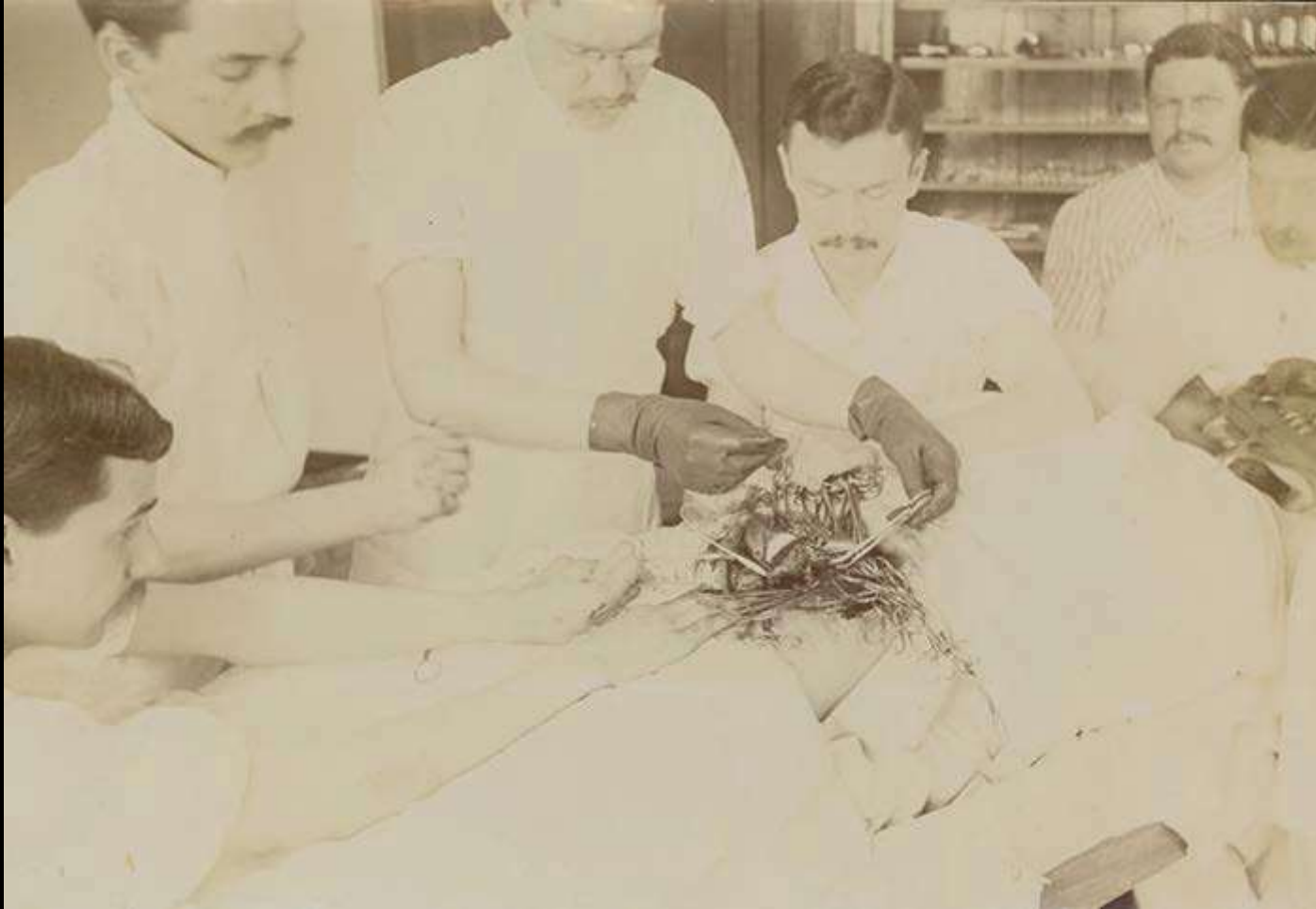


William Stewart Halsted (1852-1922)

- Following the work by Lister, Halsted decided to use a combination of carbolic acid and mercuric chloride as a disinfectant during his surgical procedures.
- Hampton (his wife in future), acting as his scrub nurse would have to handle these chemicals regularly, and as a consequence, she developed severe contact dermatitis on her hands.
- Halsted could not bear to see her go through this and reached out to the Goodyear Rubber Company to create a rubber glove that she could wear during surgery to protect her hands.
- Only nurses and assistants were used rubber gloves at first time.
- In 1893 Halsted's senior resident, Dr. Joseph Bloodgood, noted that the practice of gloving the surgical team dramatically decreased infection rate but surgeons reluctant because gloves led to an "impaired sense of touch".



Surgical gloves



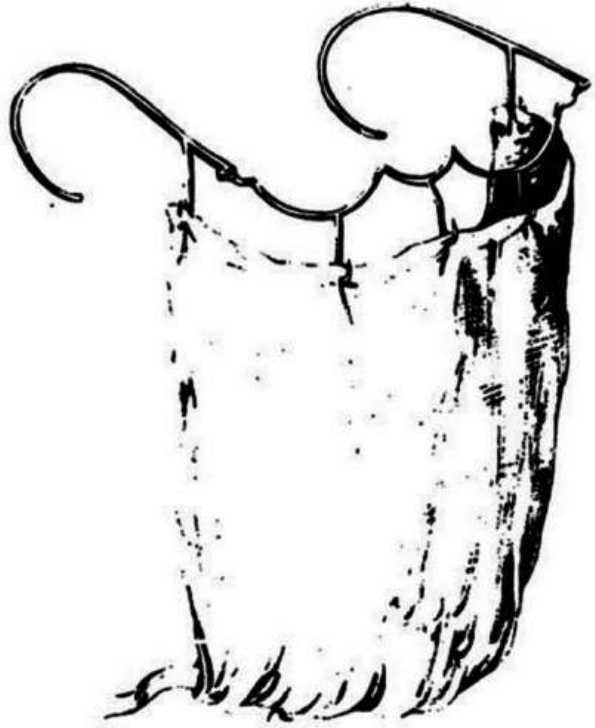
Dr. Joseph Bloodgood

Johannes von Mikulicz (1850–1905)

- In 1897, the hygienist Carl Friedrich Flügge working in Breslau at this time published his works on the development of droplet infections as part of his research on the genesis of tuberculosis.
- In the same year, 1897, a cooperation work between Flügge and Theodor Billroth's disciple Johannes von Mikulicz, who also worked in Breslau since 1890, was published.
- Their publication dealt with performing operations wearing a 'mouth bandage'. In here, Mikulicz described a one-layered mask made of gauze.
- Mikulicz, who had already been responsible for the introduction of sterile gloves made from cloth, noted concerning the applicability of surgical masks: '...we breathed through it as easily as a lady wearing a veil in the streets...'

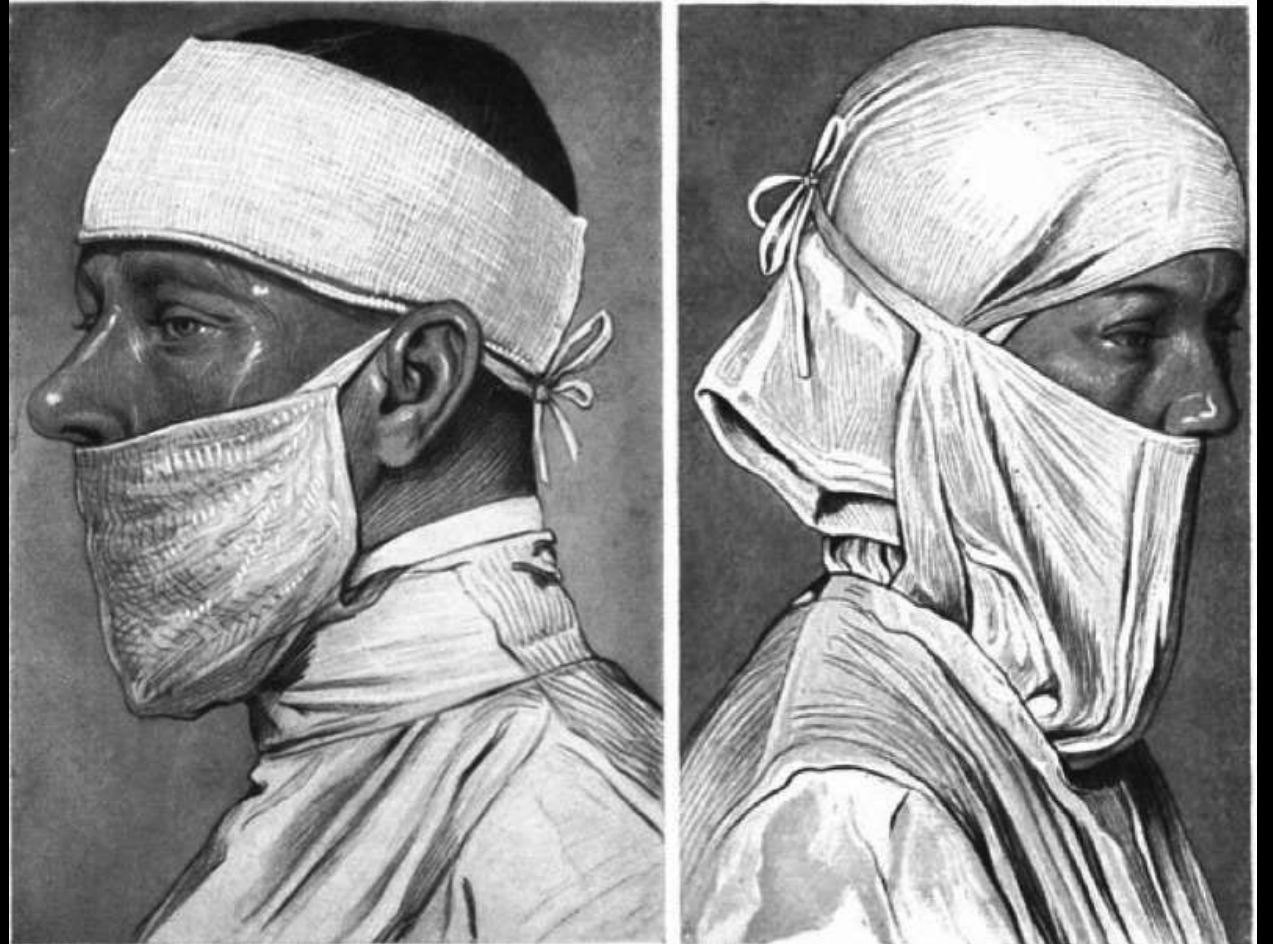


Face mask



Gauze mask. The gauze is suspended on hooks dependent from a spectacle frame.

1906



1927

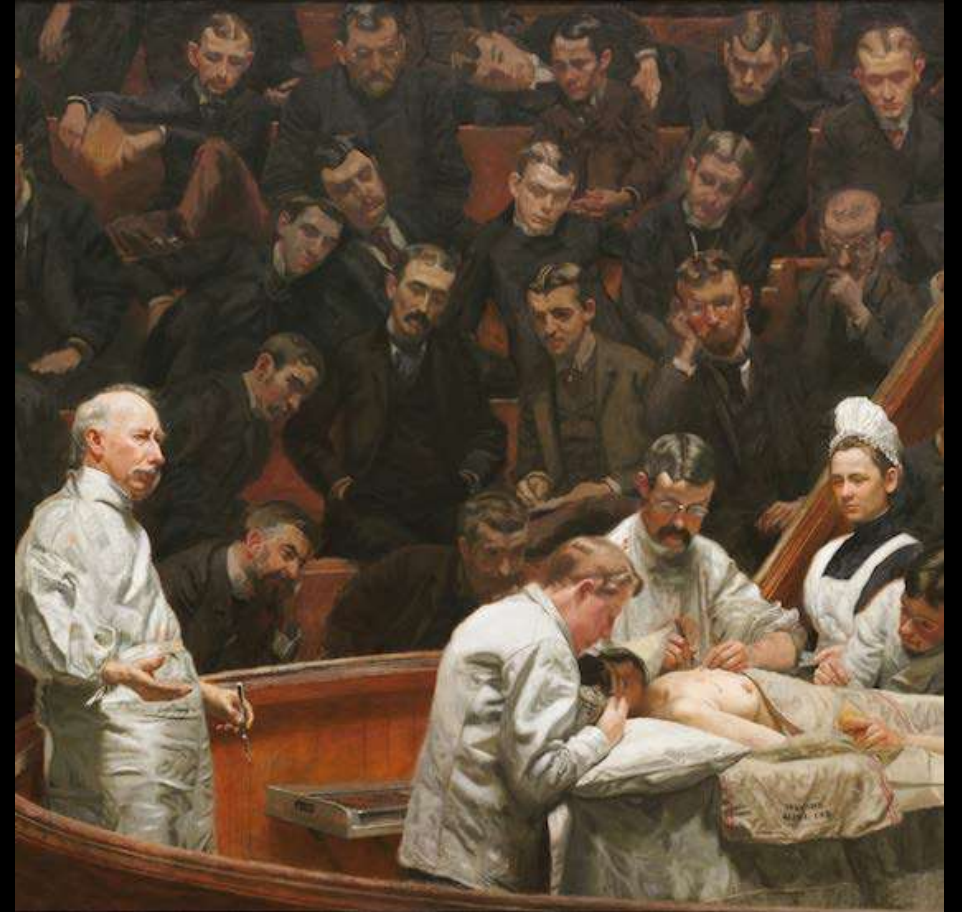
Gustav Adolf Neuber (1850-1932)

- In 1883 he was the first to use a sterilized surgical gown
- In 1884 he first proposed the use of separate operating rooms for septic and non-septic surgery, emphasizing the need for complete cleanliness in all aspects of surgery.
- In 1886, he opened his own private hospital on Königsweg in Kiel, where he implemented modern principles of asepsis. Neuber's clinic in Kiel is considered to be the first aseptic hospital in the world.



Surgical gown

- 1885 - Lucy Osburn, Lady Superintendent of Sydney Hospital, wrote to Florence Nightingale about the outfits worn by surgeons in the operating theatre: “The doctor and all his assistants take off their coats and have tied round them garments of white makintosh which cover them from chin to toes, and over this a shift- a kind of white cotton surplice with loose sleeves coming to the elbows, this latter changed after each case”



Summary

- 1847 – washing hands proposed by Semmelweis
- 1867 – carbolic acid and principles of antiseptics proposed by Lister
- 1882 – heat sterilization introduced by Bergmann and formalized by Schimmelbusch in 1892
- 1883 – first sterile surgical gown used by Neuber
- 1889 – surgical gloves introduced by Halsted
- 1897 – face mask was introduced by Flügge and Mikulicz
- Early 1900s - The Spanish flu pandemic and growing interest in Lister's germ theory led to some surgeons wearing cotton masks in surgery to protect themselves from diseases
- 1916 - The technique of “donning gloves” during surgery first appears referenced in texts
- 1920s - The use of masks becomes routine practice in the operating room
- 1939 - Devenish and Miles showed that when the wrists of a cotton gown became wet during an operation, skin microorganisms which may infect the patient pass readily through the material. By equipping the surgeon with waterproof over-sleeves Devenish and Miles prevented wetting of the sleeves.
- 1940s - Advances antiseptics and wound infection led to antiseptic drapes and gowns become adopted.

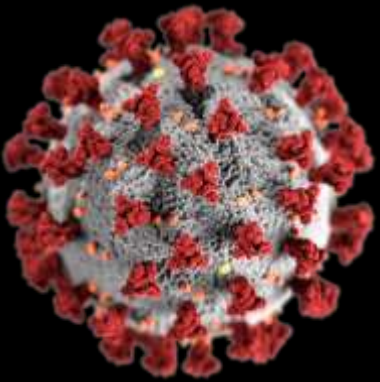
Modern surgery



Terms

- **Colonization (contamination)** is the presence of bacteria on a body surface (like on the skin, mouth, intestines or airway) without causing disease in the person.
- **Infection** is the invasion of an organism's body tissues by disease-causing agents, their multiplication, and the reaction of host tissues to these organisms and the toxins they produce.
- **Infection process** is an interaction between macro-organism and pathogenic micro-organisms in the specific environment.
- **Infection disease** is the pathological result (illness) of this interaction between the body and microorganisms.
- **Inflammation** – the most common clinical sign of infection process and infection disease.

Causes of infection (germs)



Viruses



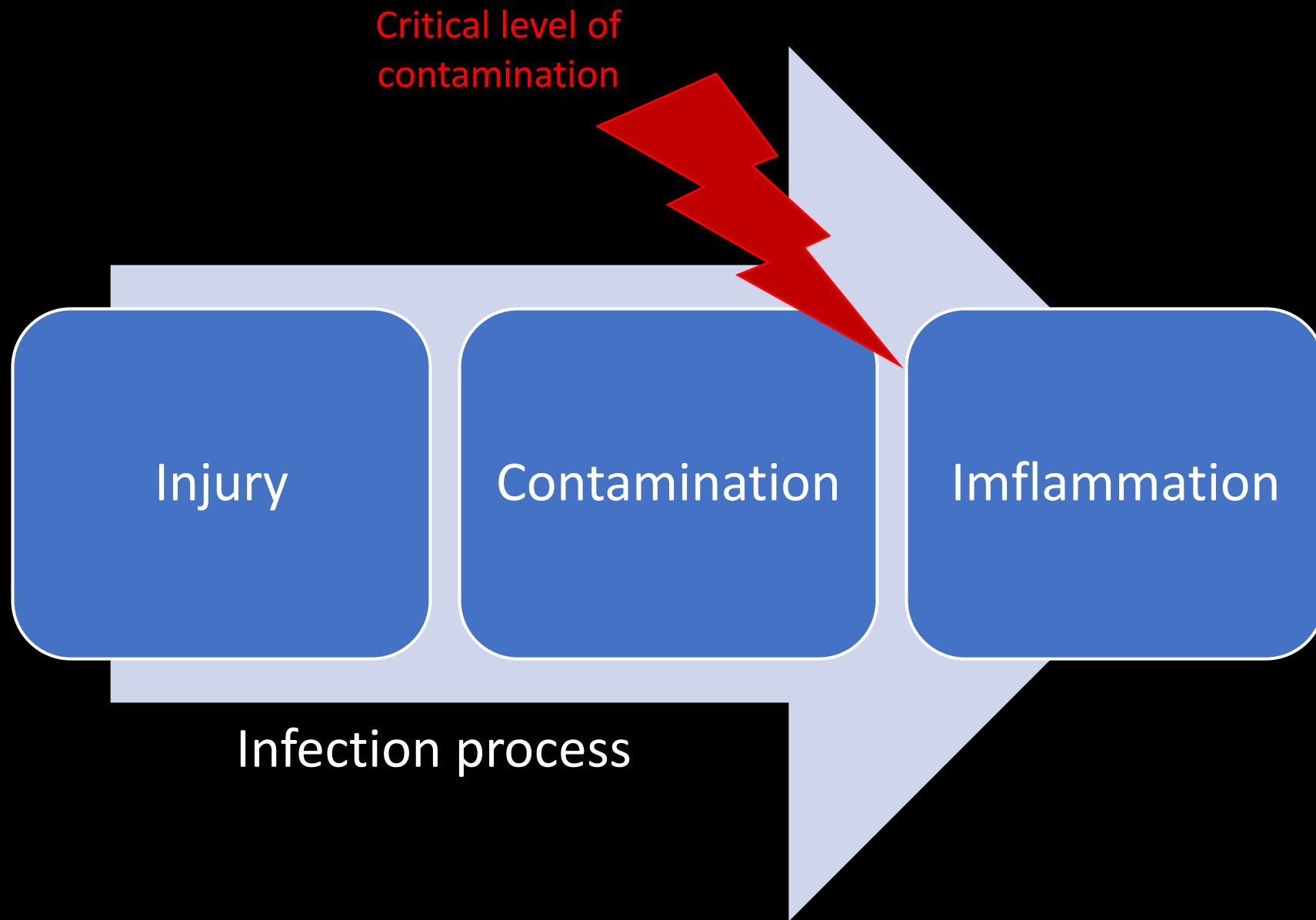
Bacteria



Fungi



Protozoa



Definition

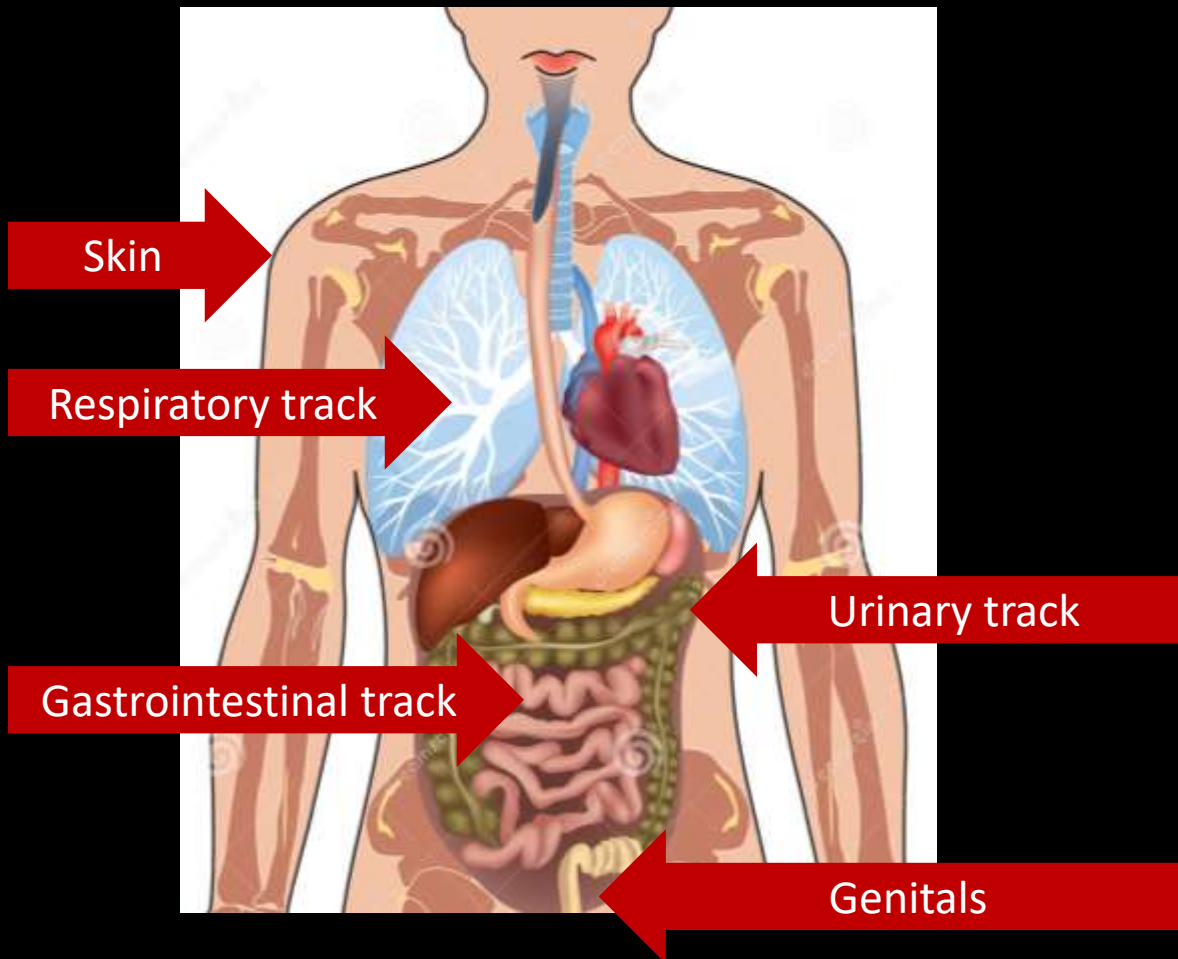
- **Asepsis** – is a complex of measures aimed to prevent the contamination of surgical wound (patient's body) over a critical level.
- **Antisepsis** – is a complex of measures aimed to reduce the contamination of surgical wound (patient's body) lower than critical level.
- **Critical level of contamination** – the number of bacteria that provides clinically relevant surgical infection in a healthy subject: 10^6 colony-forming units per 1 gram of the tissue.

Source of infection

- The source is taken to mean the place of dwelling, growth and multiplication of microorganisms.
 - Exogenous
 - Clinically ill patient (infection of skin and soft tissues, respiratory infection, urinary infection, etc.)
 - Healthy carrier (e.g. nasopharyngeal *S.Aureus* in medical staff)
 - Animal (e.g. *Clostridium* spp. in the gut of cattle)
 - Environment (rarely, e.g. Marine vibrios that live in salt water and may produce necrotic infection, some hospital-acquired infection)
 - Endogenous
 - The pathogenic and opportunistic bacteria that normally colonize skin and mucosa membranes
 - Sources of acute and chronic infection

Source of infection

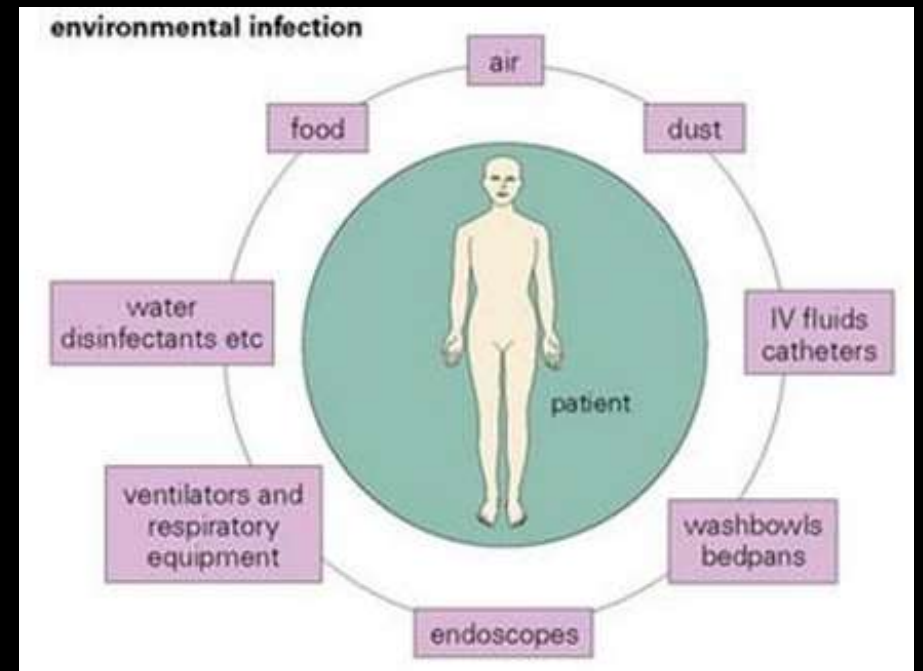
Endogenous



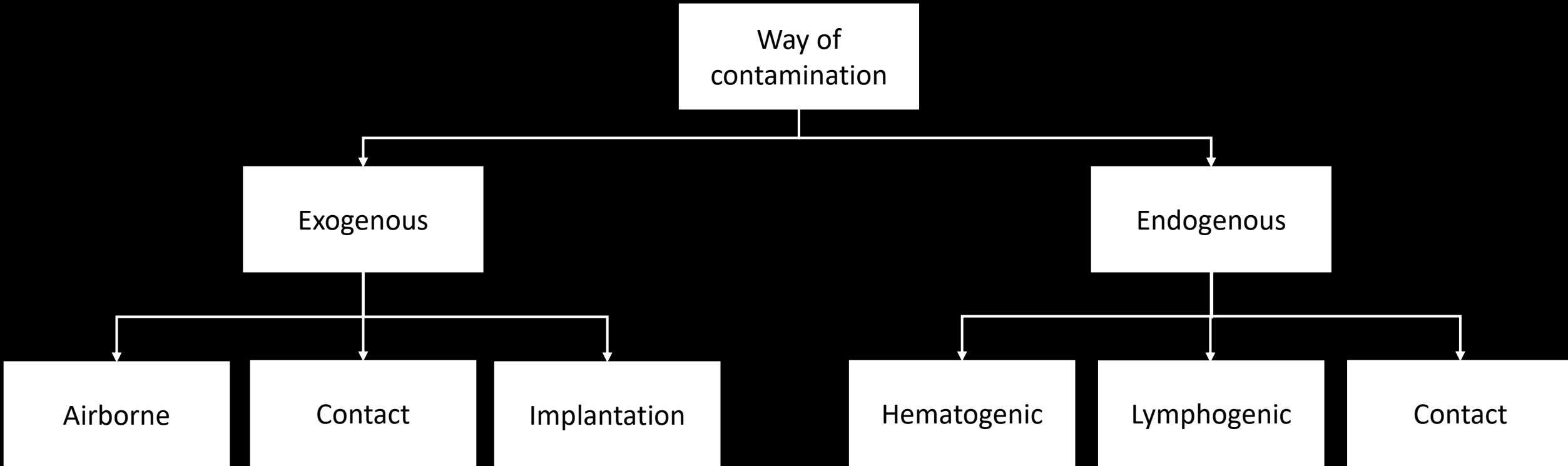
Exogenous

Out-hospital

In-hospital

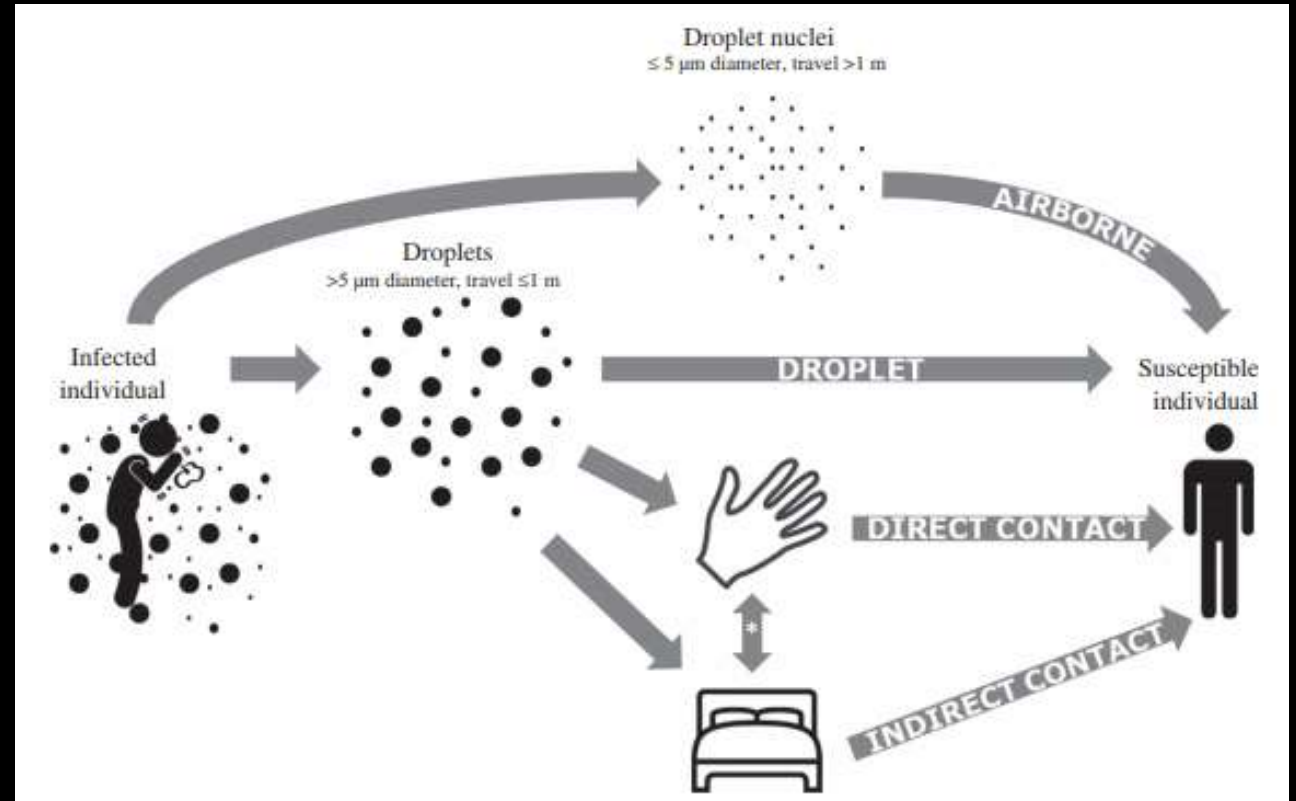


Transmission of infection



Airborne way of contamination

- Water droplets
 - Coughing, sneezing, breathing, speaking
 - Aerosolized wound exudate
- Dust particles
 - Evaporation of droplets and exudate



Contact way of contamination

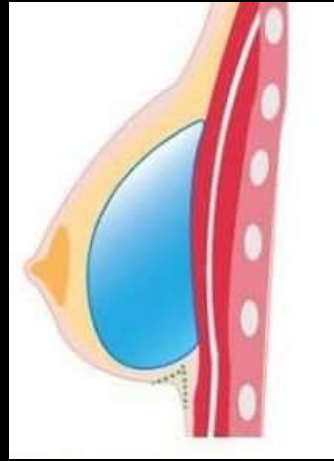
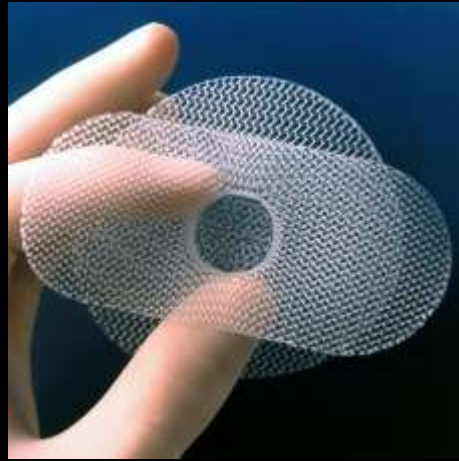
- Direct – contaminated skin of the hands
- Indirect – contaminated objects, that contact the wound:
 - Surgical instruments
 - Dressings
 - Gloves
 - Drapes
 - Gowns



Implantation way of contamination

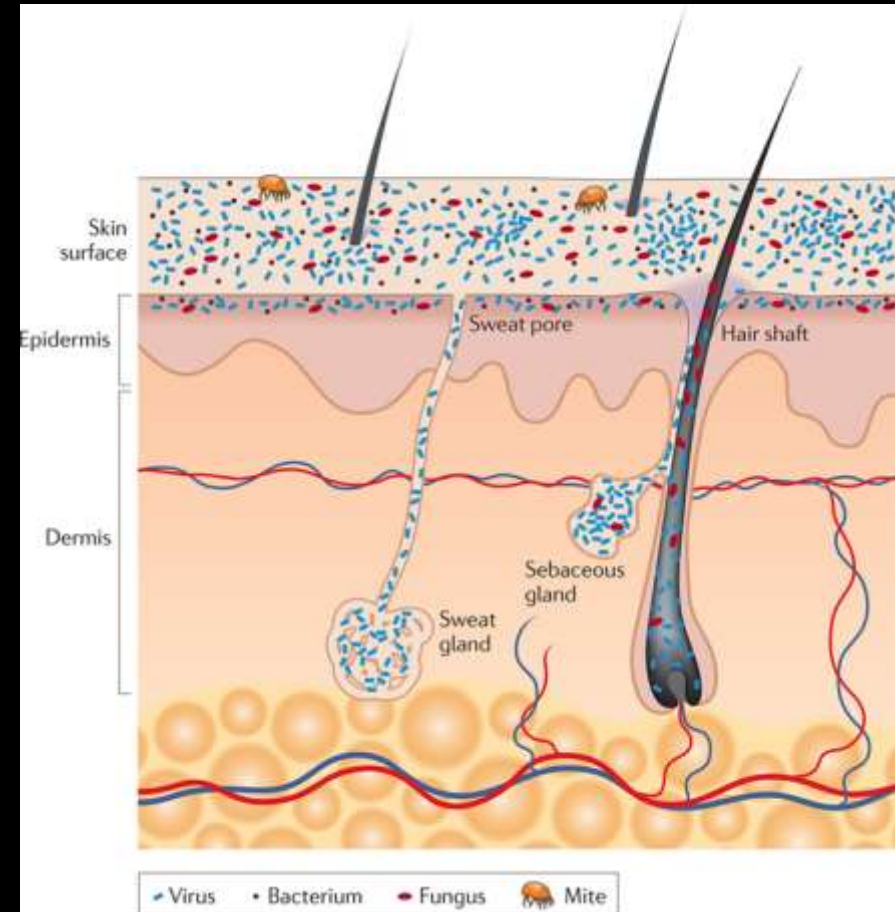
- Any foreign body that will be left in the wound:

- Sutures
- Mesh
- Implants

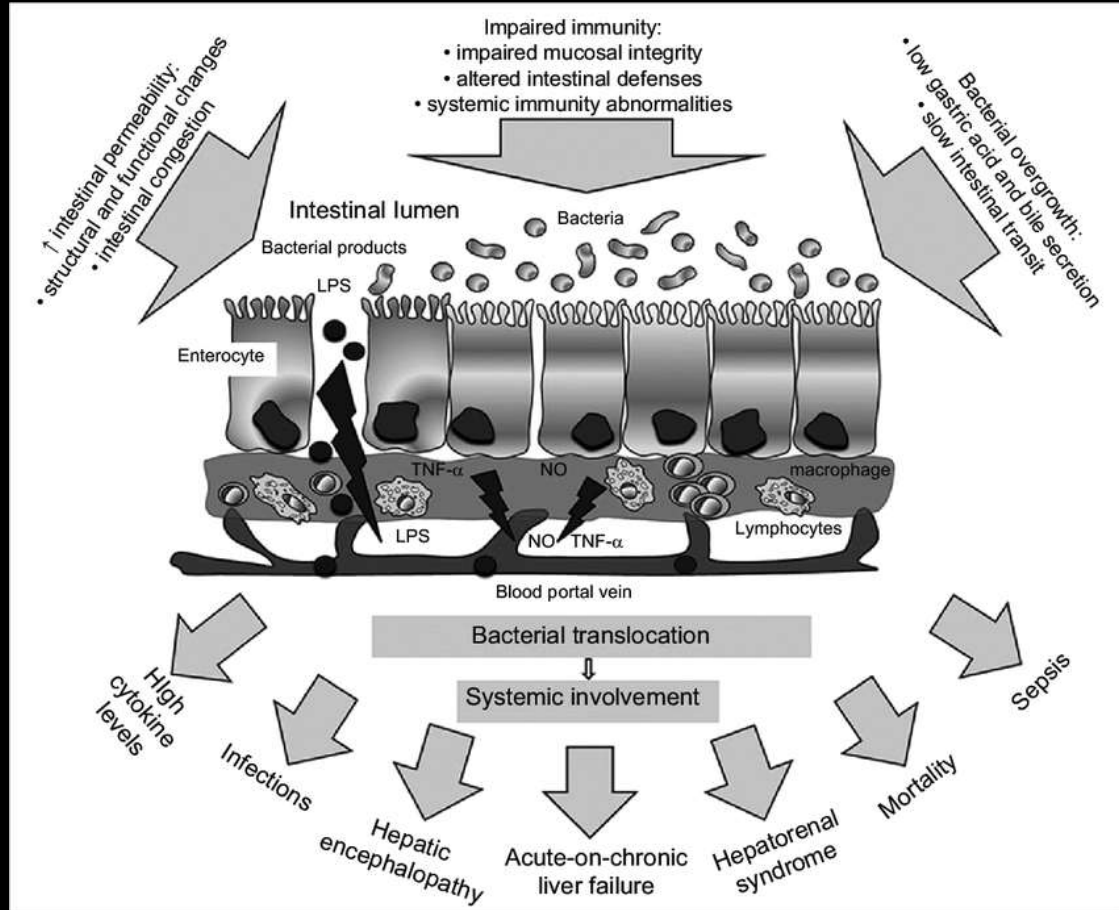


Endogenous contamination: contact

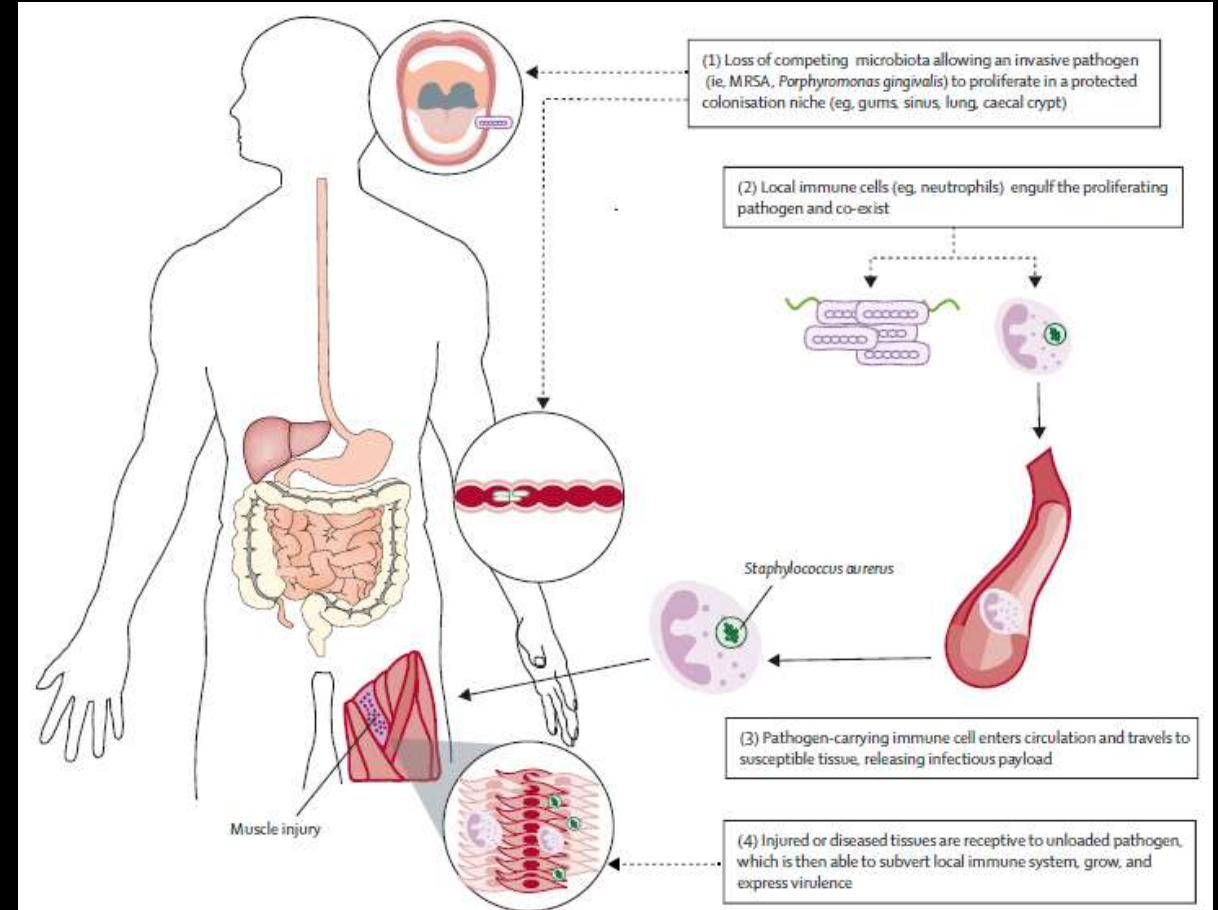
- Mechanical moving and migration of bacteria from skin into the wound
- Pollution of the wound or cavity by purulent exudate, intestinal contents, infected urine, etc.



Endogenous contamination: hemato- and lympho-genic



Intestinal bacterial translocation



Alternative bacterial load

Measures of asepsis

	Exogenous airborne way	Exogenous contact way	Exogenous implantation way	Endogenous contact way	Endogenous hematogenic and lymphogenic way
Organization	+++	++			
Decontamination	+	+++	+++		
Preparation of the patient				+++	+++
Special surgical techniques				+++	

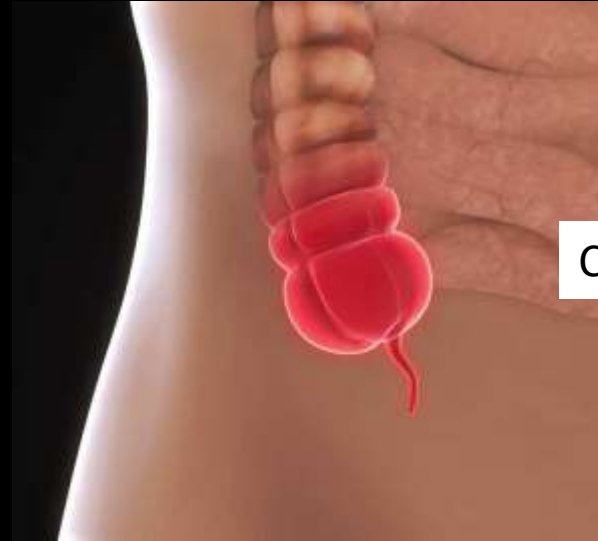
Organization of surgical department

- Emergency department (work at the admission): registration of patient, examination, partial and complete sanitary processing of patient and correctly transportation of patient:
 - Walk on foot accompanied by medical staff
 - Transportation on a wheelchair
 - Transportation on a wheel stretcher



Separation of patients

- “Clean” patients have no infected exudation into environment
- “Purulent” patients have infected exudation into environment
- Separation:
 - Different departments
 - Different rooms
 - Different operation rooms
 - Different dressing rooms
 - Different time of operation (clean first)



Clean

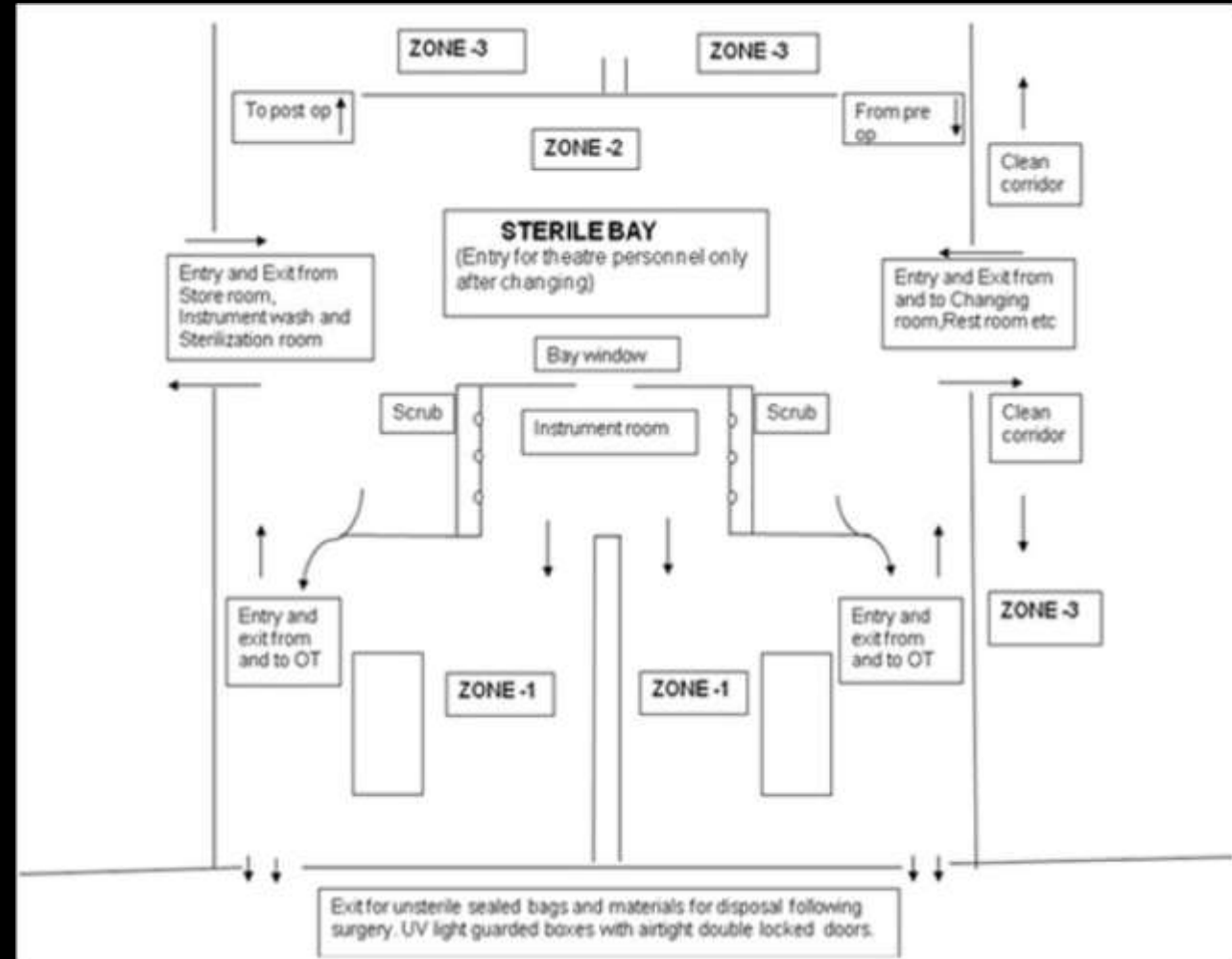


Dirty



Organization of operating theater

- ZONE 1 (sterile), i.e. the operating theatre (to operate on patients), scrub up room (for preoperative cleansing surgeons' hands and arms) and the room for sterilisation (to sterilise the instruments to be used during the operation).
- ZONE 2 (clean), i.e. the rooms for personal hygiene and changing clothes of the staff.
- ZONE 3 (technical), i.e. the rooms where apparatus for air conditioning or oxygen supplying and vacuum devices are stored.
- ZONE 4 (dirty), i.e. the nurse's room, the room of the head of surgery and the one for dirty clothes etc.



Cleaning of operating room

- Preliminary preparation of the operating room
- During the surgery (operation) current cleaning
- After the procedure ends and the patient has exited the room
- Daily final cleaning
- General cleaning of surgery block (one time per week and according necessity)



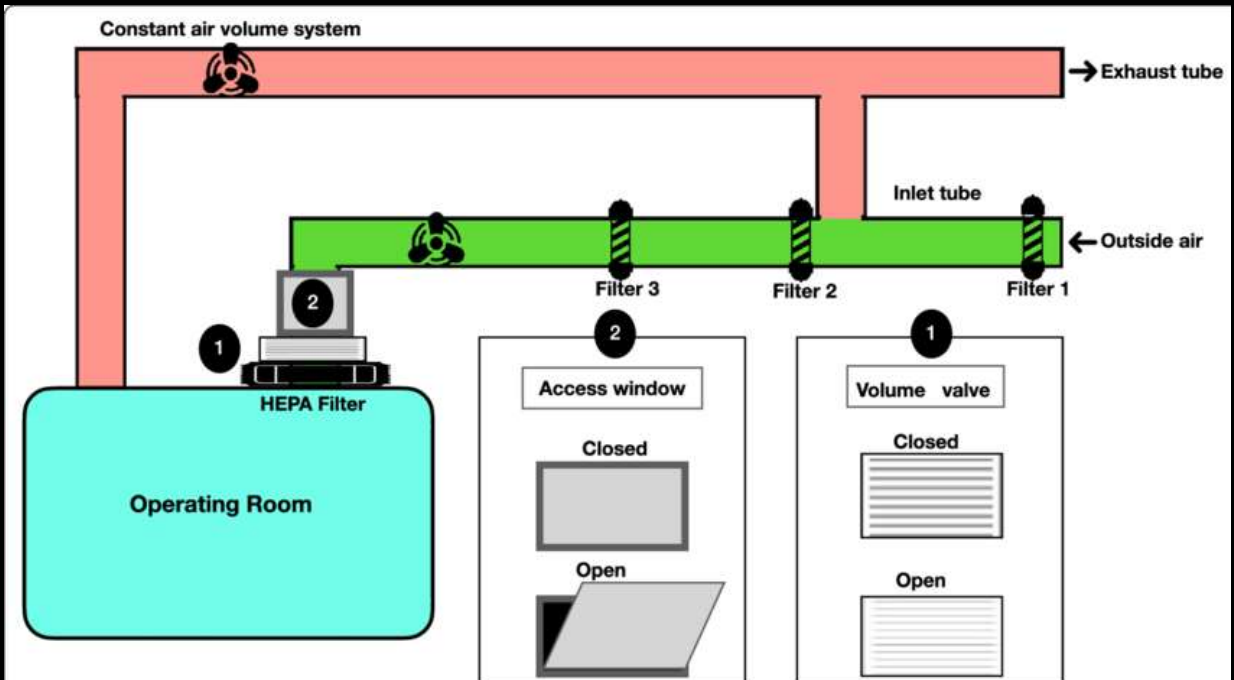
Behavior rules in the operation theater

- Only sterile items are used within the sterile field
- Sterile persons are gowned and gloved
 - Gowns are only sterile from waist to shoulder
 - Gloved hand must be kept in sight at all times
- Only the top of a draped table is considered sterile
- Sterile persons touch only sterile items or areas
- Unsterile persons avoid reaching over the sterile field
- The edges of anything that encloses sterile contents are considered unsterile
- Sterile field is created as close as possible to the time of use
- Sterile areas are continuously kept in view
- Sterile persons keep well within the sterile area
- Sterile persons keep contact with sterile areas to a minimum
- Limit number of staff in the operation theater
- Limit talking and moving in the operation theater



Other organizational methods of asepsis

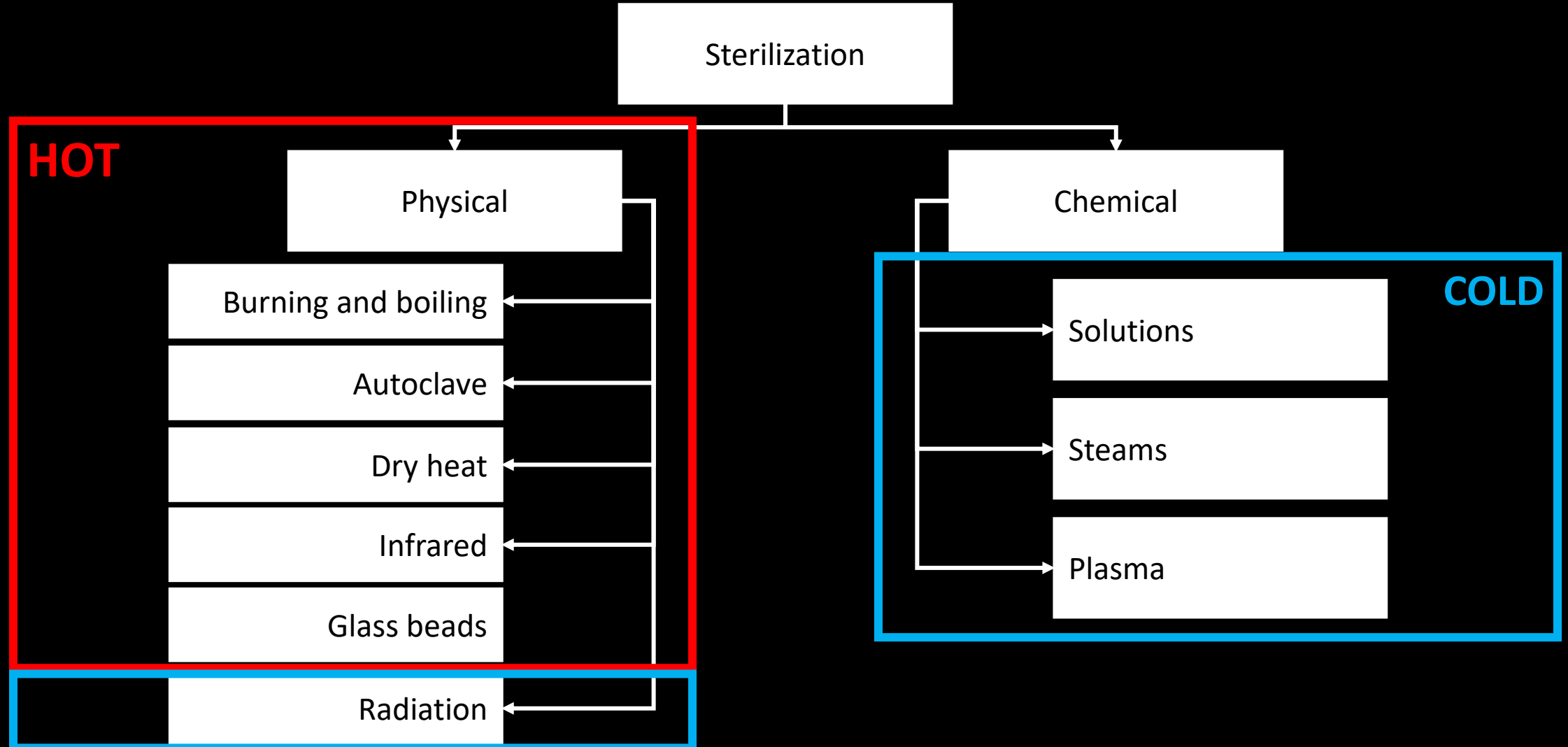
- Wearing surgical attire, hats and masks
- Equipment with sterile disposable gloves, gowns, drapes, instruments
- Personal hygiene of patients and medical staff
- Revealing and treating of infection carriers
- Hospital floor plan, organization of restricted areas with locks
- Ventilation system



Decontamination

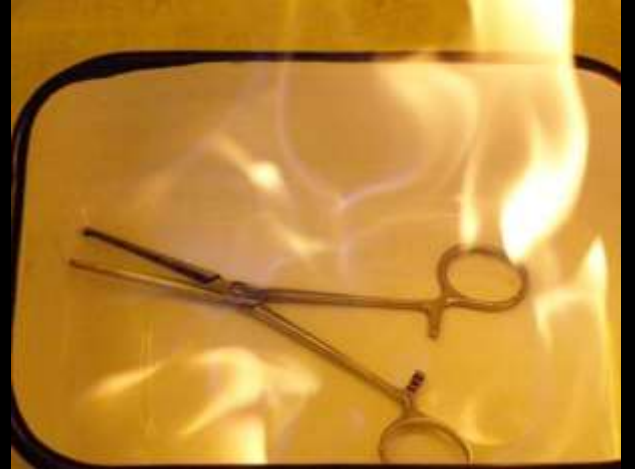
- **Sterilization** is a process by which all forms of bacteria are destroyed.
- **Disinfection** is a process by which only all pathogenic bacteria are destroyed.
- Antiseptic (solution) is a substance that will inhibit the growth of bacteria without necessarily destroying them.
- Disinfectant is an agent, usually a chemical, that kills pathogenic bacteria.
- Germicide or Bactericide is any agent that kill all germs or bacteria.

Methods of sterilization



Burning and boiling

- Burning (naked flame): the tool is put on a metal subject, ethyl alcohol is poured and set fire
- Boiling: metal sterilizers are used. Required 1-3 hours for effective sterilization. Spores could be persisted after this.
- Only emergent use in the absence of more effective approaches



Dry heat sterilization

- Is one of the earliest forms of sterilization practiced.
- It uses hot air that is either free from water vapor or has very little of it, where this moisture plays a minimal or no role in the process of sterilization.
- Temperature of 160-180 degrees of Celsius requires 1-2 hours of sterilization
 - High Velocity Hot Air of 190 degrees: 6-12 mins
- Poor penetration into the deep layers of tissues
- Predominantly for metal and glass equipment



Steam sterilization (autoclave)

- Water steam at increased pressure that has a higher temperature and penetrate into deep layers of tissues by air expelling due to expansion
 - 1.1 atm – 120 degrees (60 mins)
 - 1.5 atm – 126 degrees (45 mins)
 - 2 atm – 132 degrees (30 mins)
- Modern autoclaves provide initial cycles of vacuum to eliminate the air and increase steam penetration
- Any materials and instruments resistant to high temperature



Infrared sterilization

- Infrared heat could provide different temperature up to 900 degrees of Celsius
- Used in laboratories for small instruments as alternative to naked flame



Glass bead sterilizer

- Glass balls are heated by 150-250 degrees of Celsius
- Used for small instruments and equipment resistant to high temperature
- The efficacy against viruses is not proven



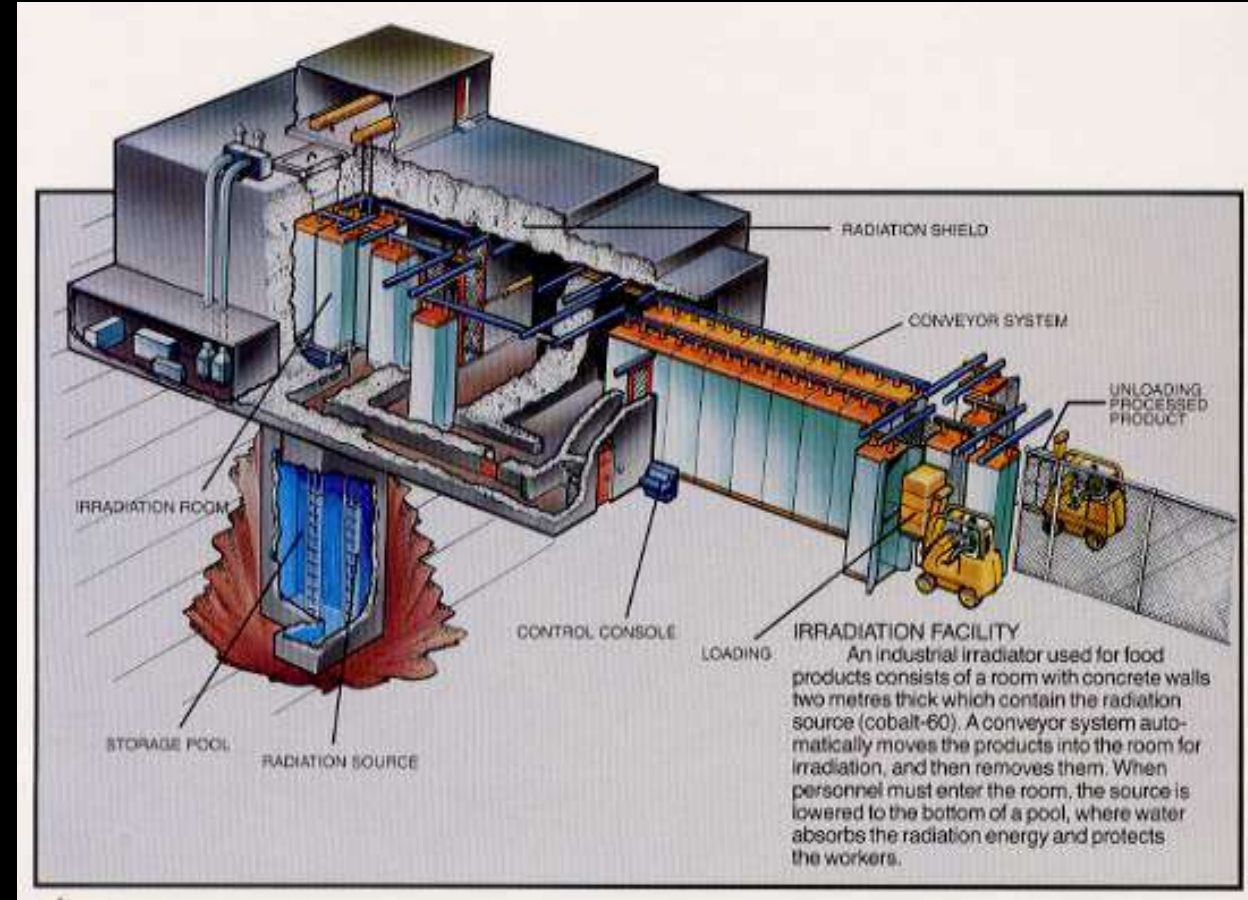
Ultraviolet

- Does not provide sterilization, only disinfection
- Could be used for the room air
- Could be used for instrument disinfection and storage



Gamma-radiation

- Industrial sterilization of all disposable sterile instruments



Ultrasound

- Cleaning and disinfection
- Sterilization of liquor (drug solutions)



Chemical sterilization with solutions

- Loading of instruments in the antiseptic solution for some time
- The time depends on chemical compound
 - Ethyl alcohol 96%
 - Hydrogen peroxide 6%
 - Specific compounds e.g. containing modified phenolic chemicals (phenylphenol, amyphenol, etc); quaternary ammonium chemicals (dimethyl benzyl ammonium chloride); sodium hypochlorite/bleach; iso- or ethyl alcohol; or other common disinfectants.



Chemical sterilization with steam



Formaldehyde steam



Ethylene Oxide steam

Chemical sterilization with steam

Formaldehyde steam

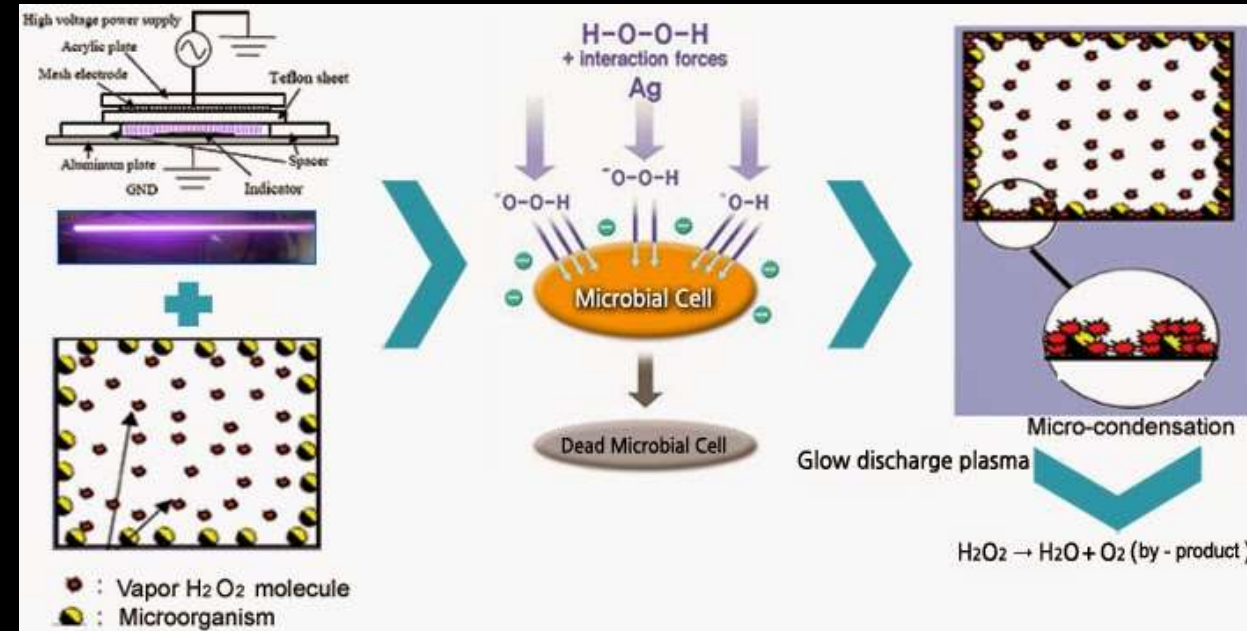
- The vapour is extremely irritating to the eyes
- Weak penetrating power compared to EtO
- Operates on a higher temperature than EtO
- Residues can remain on the sterilized goods and can be harmful for the patients.
- A relative humidity of ~ 75% is required in order to be effective as the gas has to dissolve in a film of moisture surrounding the bacteria

Ethylene Oxide steam

- Excessively Long cycle
- Safety concerns - carcinogenic to humans
- Toxicity issues - toxic residues on surgical instruments and tubing
- Not recommended for flexible scope
- EtO is flammable
- Requires special room conditions, safety equipment and separate ventilation system
- Relatively high annual costs for maintenance, servicing and consumables

Hydrogen peroxide plasma sterilizer

- The sterilization chamber is evacuated and hydrogen peroxide solution is injected from a cassette and is vaporized in the sterilization chamber to a concentration of 6 mg/l.
- The hydrogen peroxide vapor diffuses through the chamber (50 minutes), exposes all surfaces of the load to the sterilant, and initiates the inactivation of microorganisms.
- An electrical field created by a radio frequency is applied to the chamber to create a gas plasma.
- Microbicidal free radicals (e.g., hydroxyl and hydroperoxyl) are generated in the plasma.
- The excess gas is removed and in the final stage (i.e., vent) of the process the sterilization chamber is returned to atmospheric pressure by introduction of high-efficiency filtered air.
- The by-products of the cycle (e.g., water vapor, oxygen) are nontoxic and eliminate the need for aeration.
- Thus, the sterilized materials can be handled safely, either for immediate use or storage.
- The process operates in the range of 37-44°C and has a cycle time of 75 minutes.

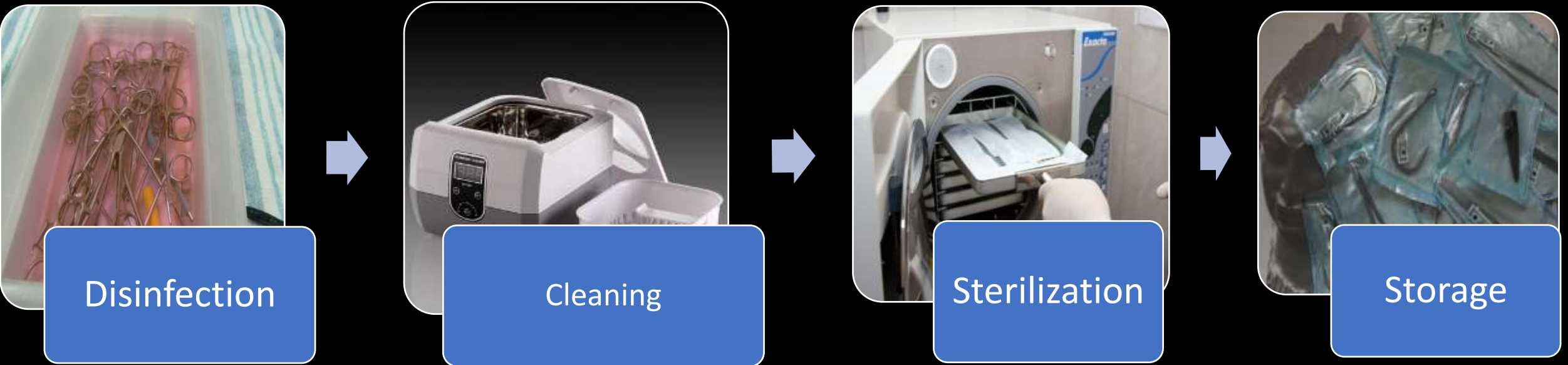


Gas plasmas have been referred to as the fourth state of matter (i.e., liquids, solids, gases, and gas plasmas). Gas plasmas are generated in an enclosed chamber under deep vacuum using radio frequency or microwave energy to excite the gas molecules and produce charged particles, many of which are in the form of free radicals. A free radical is an atom with an unpaired electron and is a highly reactive species. The proposed mechanism of action of this device is the production of free radicals within a plasma field that are capable of interacting with essential cell components (e.g., enzymes, nucleic acids) and thereby disrupt the metabolism of microorganisms. The type of seed gas used and the depth of the vacuum are two important variables that can determine the effectiveness of this process.

Hydrogen peroxide plasma sterilizer



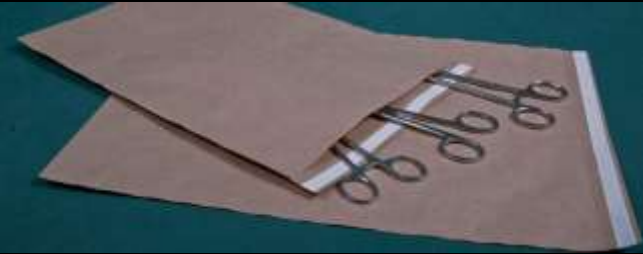
Stages of sterilization



Packing for sterilization



Medical crepe paper



Plastic



Paper-plastic peel packages



Cloth



Nonwovens



Metallic boxes

Packing for sterilization

Sterilization Method	Packaging Material Requirements	Acceptable Materials
Steam autoclave	•Should allow steam to penetrate	•Paper •Plastic •Cloth •Paper/plastic peel packages •Wrapped perforated cassettes
Dry heat	•Should not insulate items from heat •Should not be destroyed by temperature used	•Paper bags •Aluminum foil •Polyfilm plastic tubing •Wrapped perforated cassettes
Unsaturated chemical vapor	•Vapors should be allowed to precipitate on contents •Vapors should not react with packaging material •Plastics should not contact sides of sterilizer	•Wrapped perforated cassettes •Paper •Paper/plastic peel packages

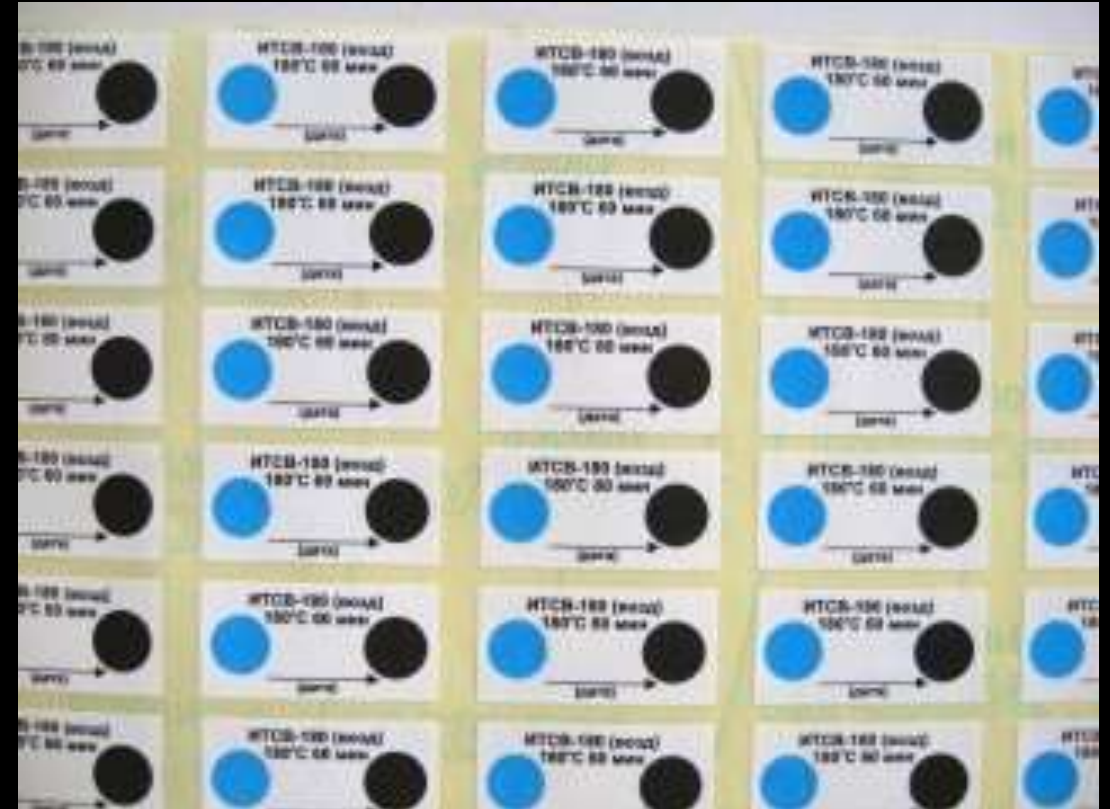
Storage

- Schimmelbusch box open – up to 24 hours
- Schimmelbusch box closed – up to 72 hours
- Schimmelbusch box with filter closed – up to 20 days
- Cloth – 3 days
- Nonwovens – 10-14 days
- Crepe paper, plastic, paper/plastic packages – up to 5-6 months depend on type of sterilization and manufacturer instruction



Control for sterility

- Direct: bacteriological test of the instrument
- Indirect:
 - Indicator that changes its color when the temperature reaches the set level
 - Indicator changes its color after the contact with active chemical compound (EtO).
- Modern packages already contain indicators



Surgical hand preparation

- Reduce the risk of contact contamination while the gloves are penetrated or damaged
 - 18% of gloves have tiny punctures after surgery
 - 35% of all gloves demonstrate puncture, thus allowing water to penetrate the gloves without using pressure, after 2 hours of surgery
- Eliminate transient and reduce resident flora
- Inhibit growth of bacteria under the gloved hand



Scrubbing with medical soap

- Keep nails short and pay attention to them when washing your hands – most microbes on hands come from beneath the fingernails.
- Do not wear artificial nails or nail polish.
- Remove all jewellery (rings, watches, bracelets) before entering the operating theatre.
- Wash hands and arms with a non-medicated soap before entering the operating theatre area or if hands are visibly soiled.
- Clean subungual areas with a nail file. Nailbrushes should not be used as they may damage the skin and encourage shedding of cells. If used, nailbrushes must be sterile, once only (single use). Reusable autoclavable nail brushes are on the market.
- Start timing. Scrub each side of each finger, between the fingers, and the back and front of the hand for 2 minutes.
- Proceed to scrub the arms, keeping the hand higher than the arm at all times. This helps to avoid recontamination of the hands by water from the elbows and prevents bacteria-laden soap and water from contaminating the hands.
- Wash each side of the arm from wrist to the elbow for 1 minute.
- Repeat the process on the other hand and arm, keeping hands above elbows at all times. If the hand touches anything at any time, the scrub must be lengthened by 1 minute for the area that has been contaminated.
- Rinse hands and arms by passing them through the water in one direction only, from fingertips to elbow. Do not move the arm back and forth through the water.
- Proceed to the operating theatre holding hands above elbows.
- At all times during the scrub procedure, care should be taken not to splash water onto surgical attire.
- Once in the operating theatre, hands and arms should be dried using a sterile towel and aseptic technique before donning gown and gloves.
- Previously the standard time of scrubbing was 10 mins, later was shown that 5 min scrubbing have the same efficacy. Modern trials suggest that 3 mins may be enough.

Preparation with alcohol-based handrubs

- Wash the hands with plain soap
- Use handrubs according to the instruction
 - The standard time of exposition is 3 mins
 - Some modern solutions allow to shorten this time to 1.5 mins
 - In others the time may be longer
- Most common compounds of handrubs:
 - n-Propanol 60%
 - Isopropanol 90%, 80%, 70%
 - Isopropanol 70% + chlorhexidine gluc. 0,5%
 - Ethanol 95%, 85%, 80%, 70%
 - Ethanol 95%, 77%, 70% + chlorhexidine gluc. 0,5%
 - Povidone-iodine 1%
 - Peracetic acid 0,5%



Antiseptics for hand preparation

Antiseptics	Gram-positive bacteria	Gram-negative bacteria	Viruses enveloped	Viruses non-enveloped	Myco-bacteria	Fungi	Spores
Alcohols	+++	+++	+++	++	+++	+++	-
Chloroxylonol	+++	+	+	±	+	+	-
Chlorhexidine	+++	++	++	+	+	+	-
Hexachlorophene ^a	+++	+	?	?	+	+	-
Iodophors	+++	+++	++	++	++	++	± ^b
Triclosan ^d	+++	++	?	?	±	± ^e	-
Quaternary ammonium compounds ^c	++	+	+	?	±	±	-

Antiseptics	Typical conc. in %	Speed of action	Residual activity	Use
Alcohols	60-70 %	Fast	No	HR
Chloroxylonol	0.5-4 %	Slow	Contradictory	HW
Chlorhexidine	0.5-4%	Intermediate	Yes	HR,HW
Hexachlorophene ^a	3%	Slow	Yes	HW, but not recommended
Iodophors	0.5-10 %)	Intermediate	Contradictory	HW
Triclosan ^d	(0.1-2%)	Intermediate	Yes	HW; seldom
Quaternary ammonium compounds ^c		Slow	No	HR,HW; Seldom; +alcohols

- Good = +++, moderate = ++, poor = +, variable = ±, none = -
- HR: handrubbing; HW: handwashing
- *Activity varies with concentration.
- a Bacteriostatic.
- b In concentrations used in antiseptics, iodophors are not sporicidal.
- c Bacteriostatic, fungistatic, microbicidal at high concentrations.
- d Mostly bacteriostatic.
- e Activity against *Candida* spp., but little activity against filamentous fungi.

Scrubbing or handrubs?

Reference	Assay method	Relative efficacy
Dineen & Hildick-Smith, 1965	Fingertip agar culture	HCP < 50% EA foam + QAC
Berman & Knight, 19694	Fingertip agar culture	HCP < P-I < 50% EA foam + QAC
Gravens, 1973	Fingertip agar culture	HCP soap < EA foam + 0.23% HCP
Lowbury, Lilly & Ayliffe, 1974	Broth culture	Plain soap < 0.5% CHG det. < 4% CHG det. < alc. CHG
Ayliffe et al., 1975	Hand broth test	Plain soap < 0.5% CHG det. < 4% CHG det. < alc. CHG
Rosenberg, Alatary & Peterson, 1976	Glove juice test	0.5% CHG det. < 4% CHG det. < alc. CHG
Pereira, Lee & Wade, 1997	Glove juice test	P-I < CHG det. < alc. CHG
Galle, Homesley & Rhyne, 1978	Fingertip agar culture	P-I = 46% EA + 0.23% HCP
Jarvis et al., 1979	Broth culture of hands	Plain soap < P-I < alc. CHG < alc. P-I
Aly & Maibach, 1979	Glove juice test 70%	IPA = alc. CHG
Zaragoza et al., 1999	Fingertip agar culture	Plain soap < 70% – 90% EA
Larson et al., 1990	Glove juice test, modified	Plain soap < triclosan < CHG det. < P-I < alc. CHG
Babb, Davies & Ayliffe, 1991	Glove juice test	Plain soap < 2% triclosan < P-I < 70% IPA
Rotter, Simpson & Koller, 1998	Fingertip broth culture	70% IPA < 90% IPA = 60% n-P
Hobson et al., 1998	Glove juice test	P-I < CHG det. < 70% EA
Mulberry et al., 2001	Glove juice test	4% CHG det. < CHG det./61% EA
Furukawa et al., 2004	Glove juice test	P-I < CHG det. < 70% EA

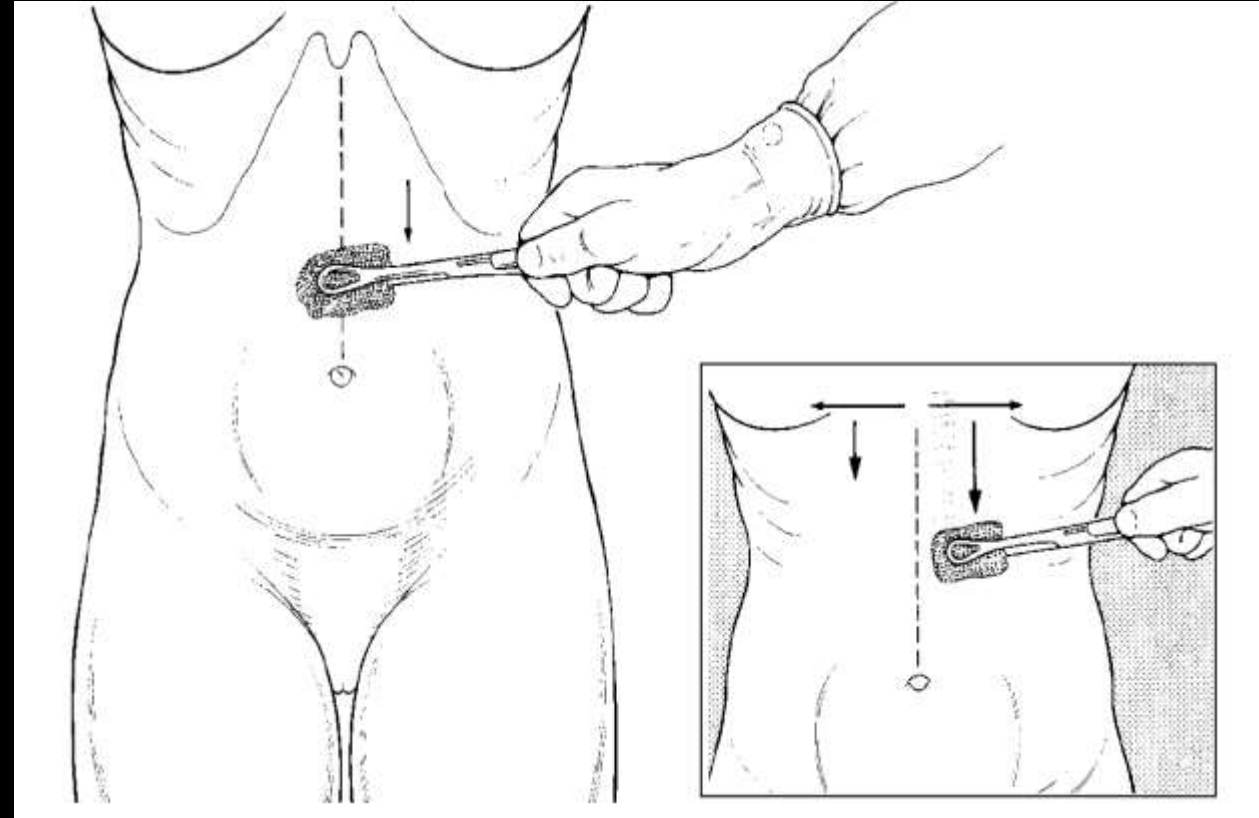
QAC = quaternary ammonium compound; alc. CHG = alcoholic chlorhexidine gluconate; CHG det. = chlorhexidine gluconate detergent; EA = ethanol; HCP = hexachlorophene detergent; IPA = isopropanol; P-I = povidone-iodine detergent.

Removing of endogenous infection

- Pre-operative clinical evaluation for chronic infectious diseases
- Treatment of chronic infectious disease prior to elective surgery
- Assess the risk of postoperative infection
- Use the peri-operative antibiotic prophylaxis
- Specific measures to reduce contamination:
 - Colon decontamination
 - Ulcer decontamination
 - etc

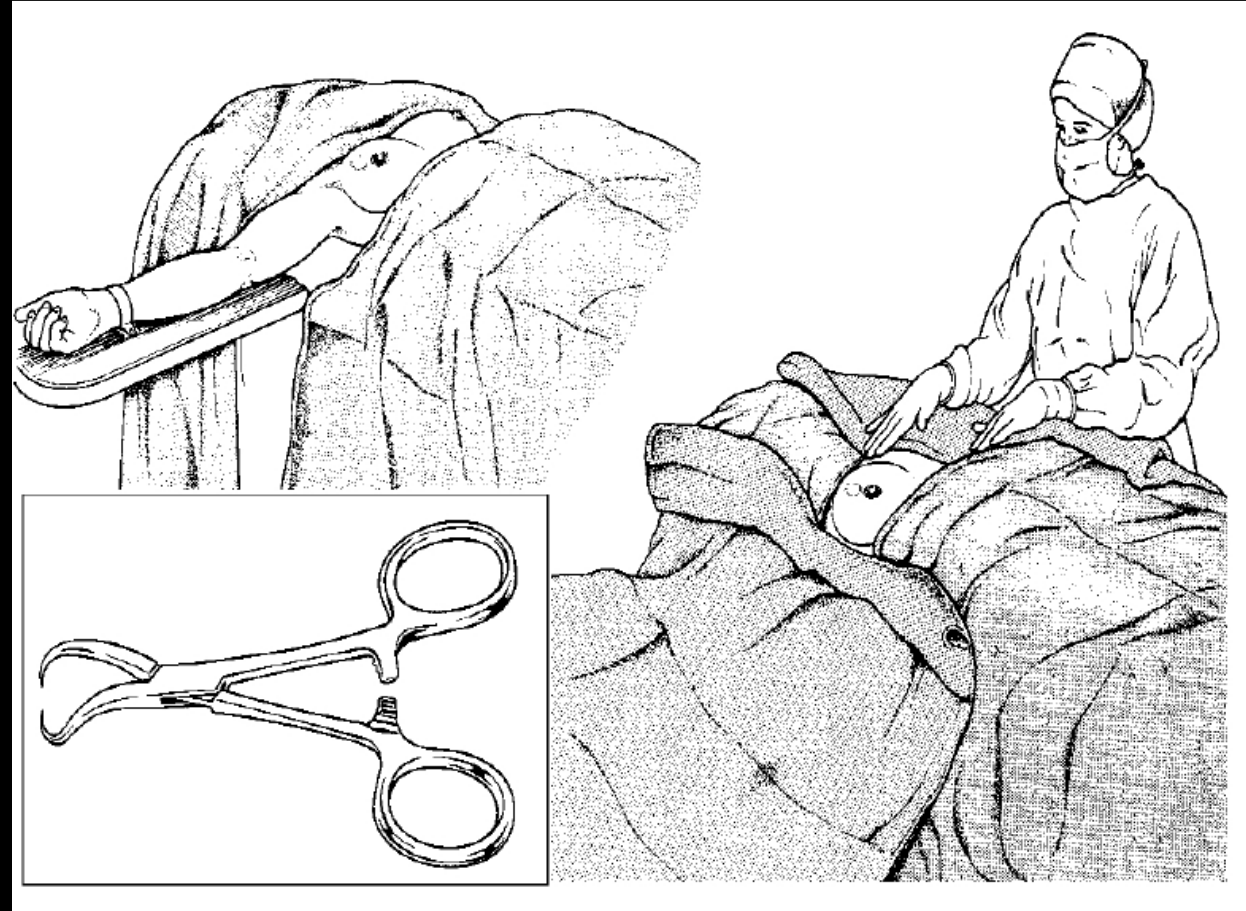
Preparation of the patient

- Hygienic processing before operation
- Dry shaving not earlier than before 6 hours before operation
- Disinfection of operating field:
 - Prepare the skin with antiseptic solution, starting in the center and moving out to the periphery.
 - Chlorhexidine gluconate and iodine are preferable to alcohol and are less irritating to skin.
 - The solution should remain wet on the skin for at least two minutes

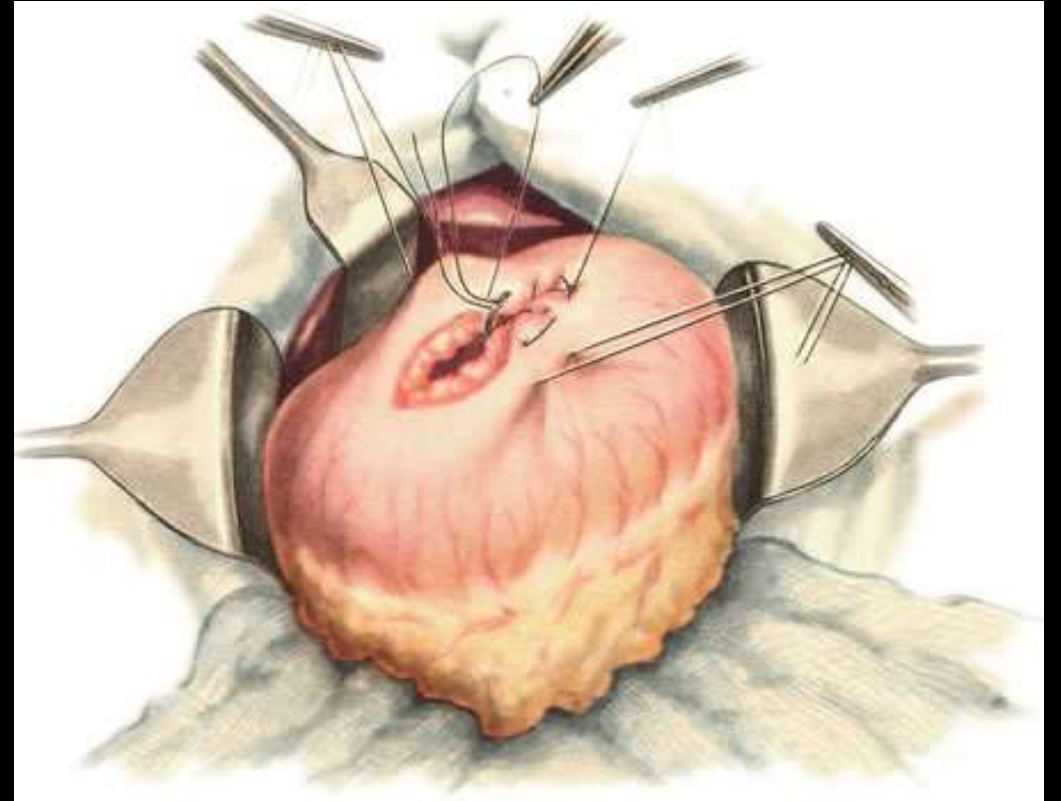
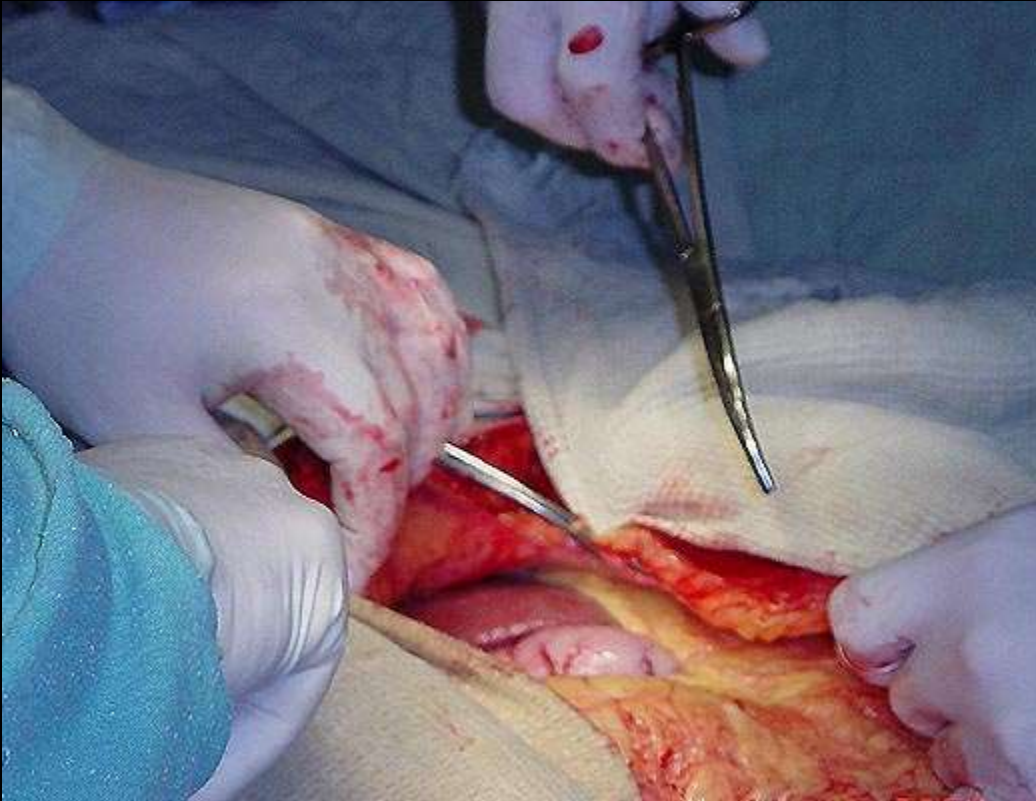


Preparation of the patient

- Do not place drapes on the patient until you are scrubbed, gowned and gloved
- Leave uncovered only the operative field and those areas necessary for the maintenance of anesthesia.
- Secure the drapes with towel clips at each corner.



Specific surgical techniques



Types of antiseptics

Antisepsis

Surgical (mechanical, physical)

Mechanical

Surgical debridement

Additional
debridement

Drainage

Physical

Specific approaches
for wound
management

Therapeutic (chemical, biological)

Local

Systemic

**Chemical or
biological**

Surgical debridement

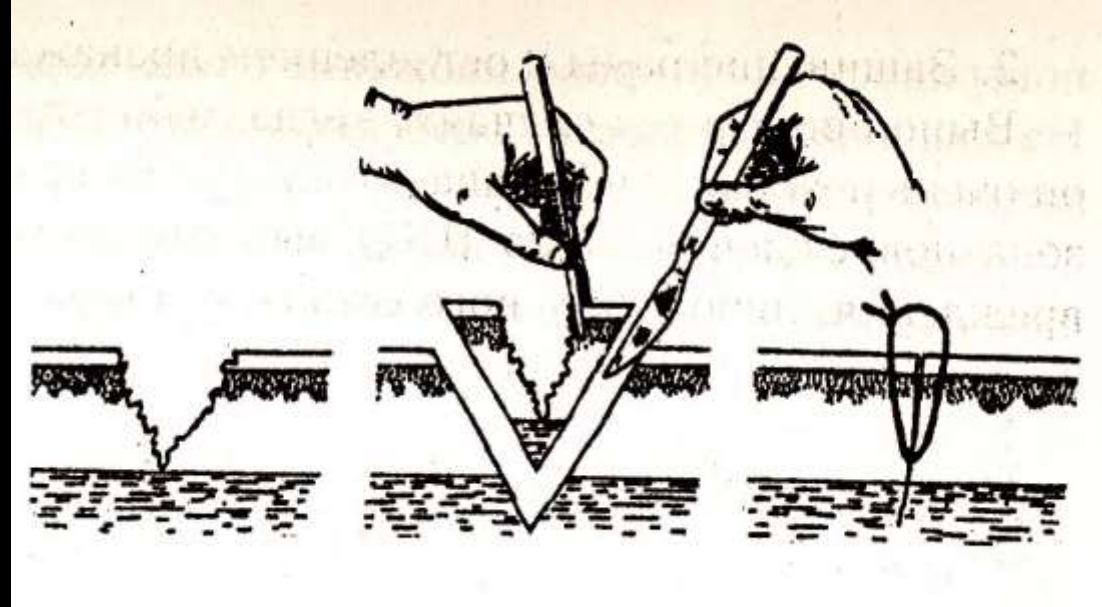
- Wounds
 - Primary (before occasionally wound become inflamed)
 - Early (24 hours)
 - Delayed (24-48 hours)
 - Late (>48 hours)
 - Secondary (debridement of the purulent wound)
- Purulent sources
- Infected cavities



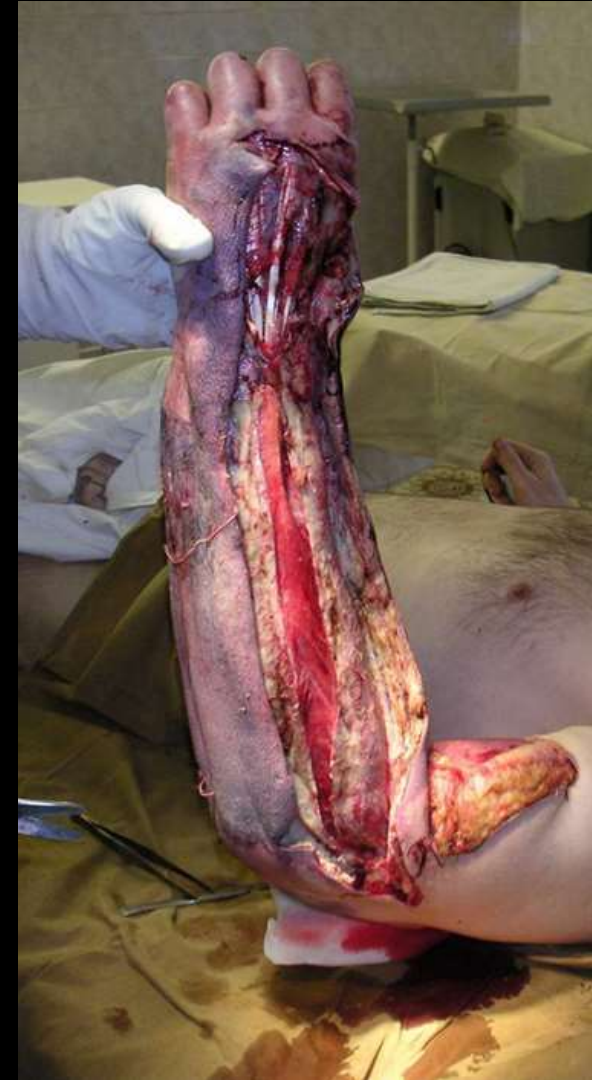
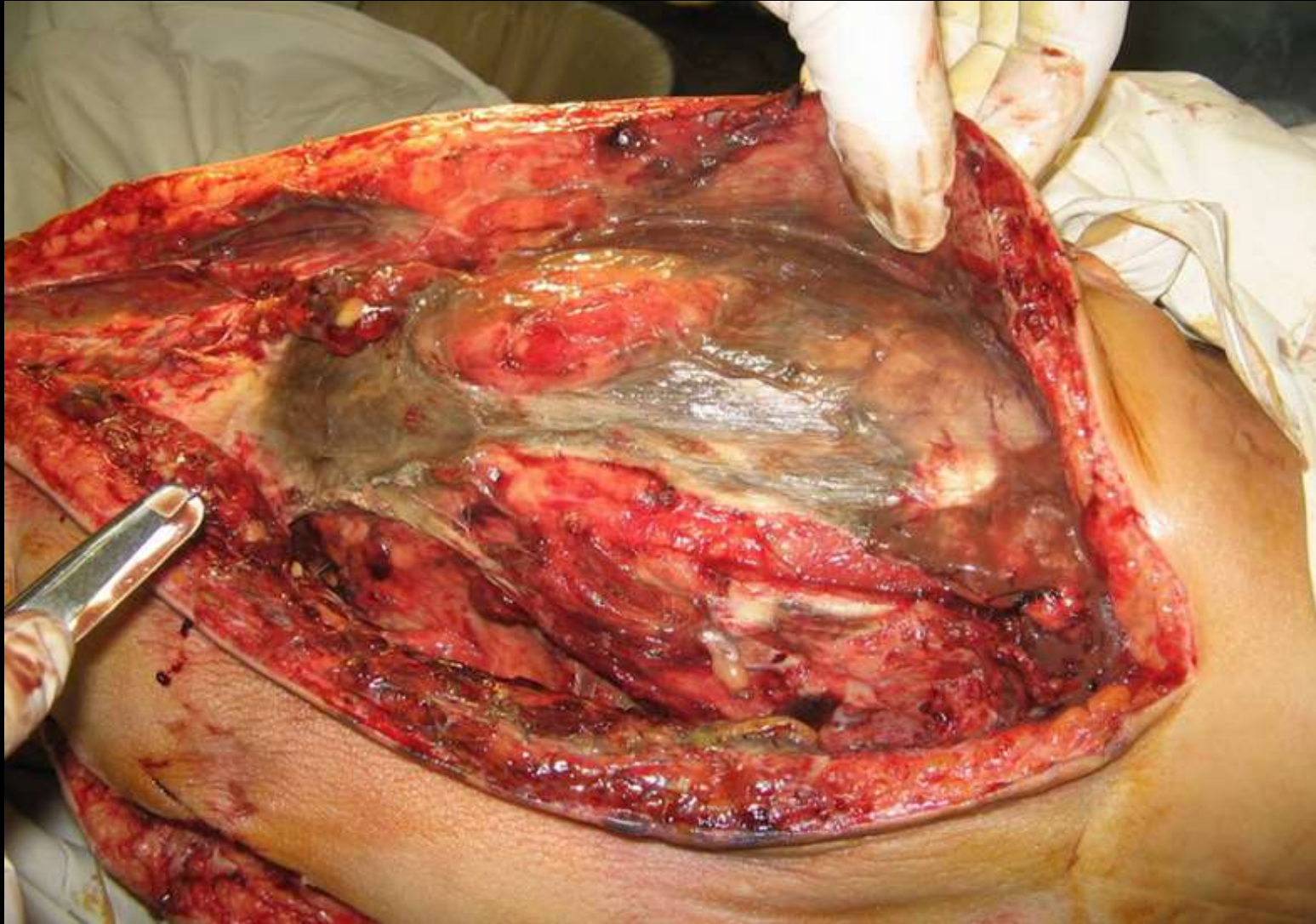
Wound cleaning



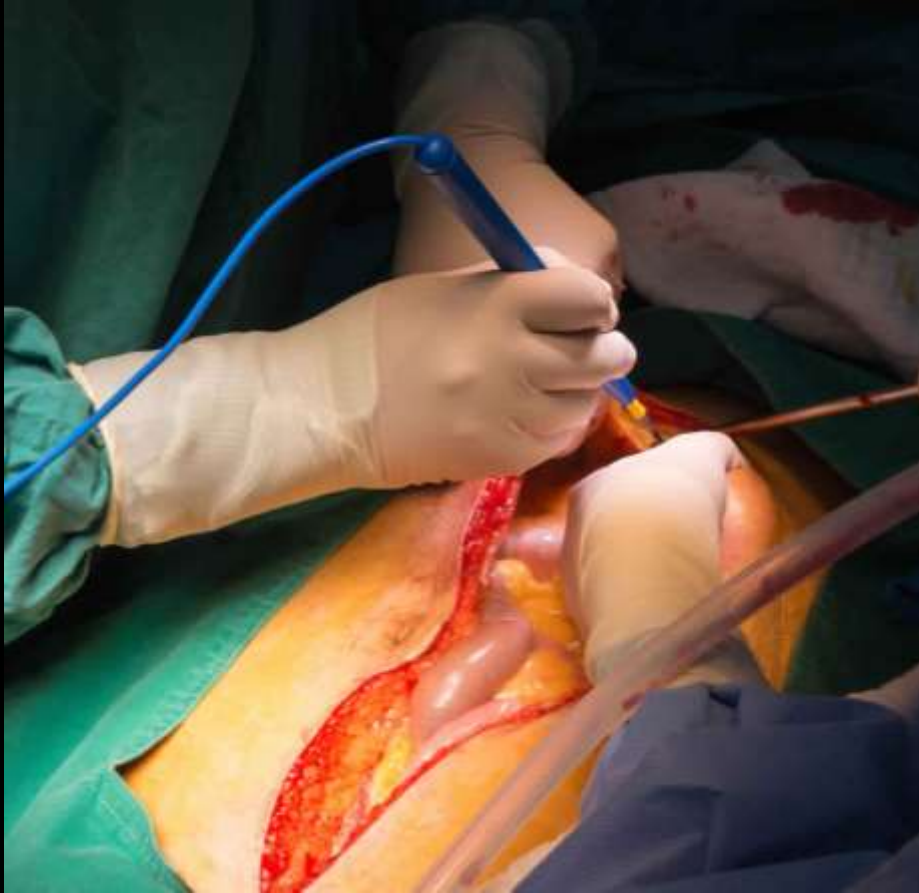
Primary surgical debridement



Surgical debridement of purulent sources



Surgical debridement of cavities



Additional debridement

- Washing
- Washing under pressure
- Ultrasound cavitation
- Laser irradiation
- Ultraviolet irradiation
- Nitric oxide therapy
- Argon or Helium plasma
- Therapy in ozone chamber
- etc.
- Inactivation of bacteria, viruses and fungi
- Ant inflammatory effect
- Stimulation of immune response
- Stimulation of microcirculation
- Improve of rheological properties of blood
- Increase antioxidant protection of tissues
- Increase blood oxygenation

Additional debridement



Washing under pressure



Laser irradiation



NO-therapy



Argon-plasma therapy



Helium-plasma therapy



Ultrasound cavitation

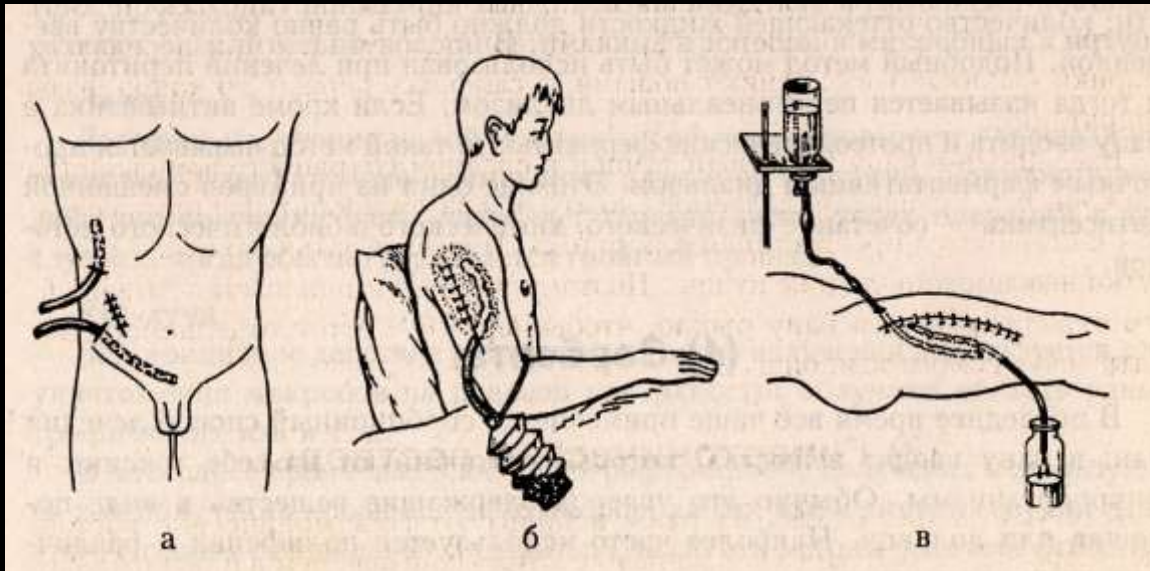


Ozone therapy

Drainage

- Passive
- Active
- Flow-flushing

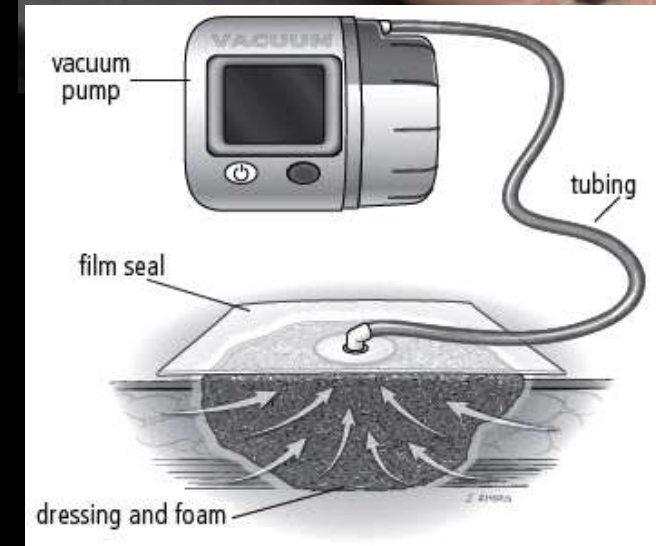
- Gauze
- Hypertonic solution
- Sorbents
- Latex strips or tubes (Penrose drain)
- Silicone tubes
- Multi-channel silicone tubes (Blake drain)
- Tube with bulb (Jackson Pratt Drain)



Specific approaches for wound management



Open management in the abacterial environment



Healing under negative pressure



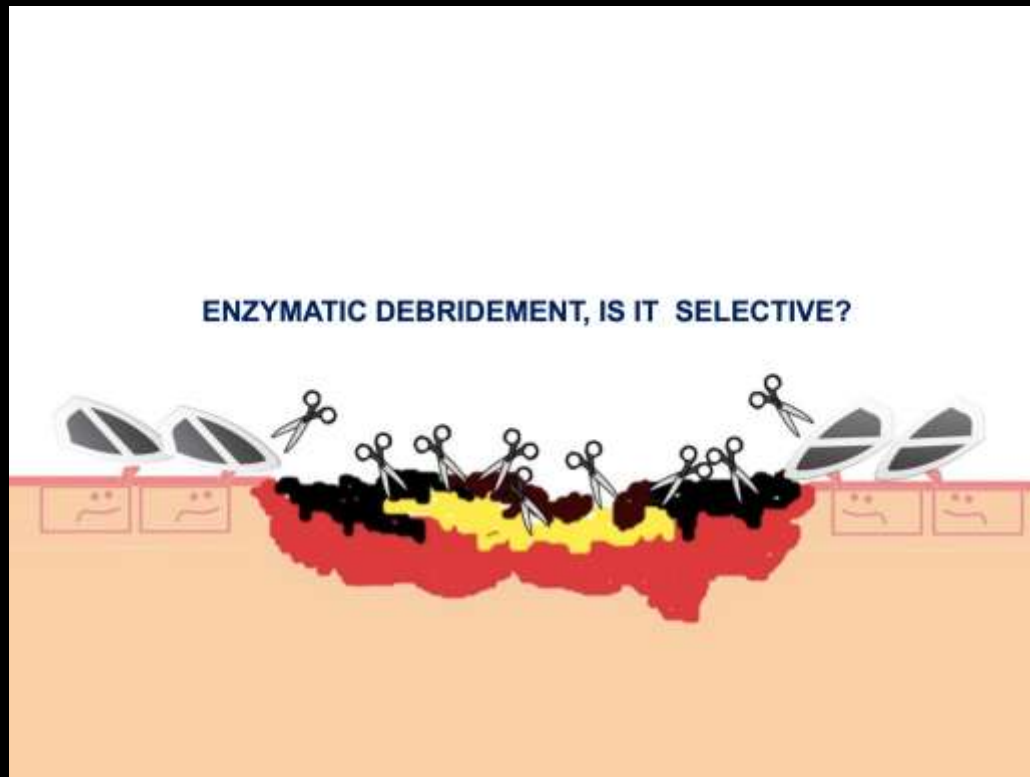
Ozone therapy

Local chemical antiseptics

Chemical group	Antiseptics	Mechanism of action	Superficial use	Deep use
Halogens	Iodine (elementary and non-organic), Iodophors (compositions of elemental iodine, iodide or triiodide, and a polymer carrier (of high molecular weight)	Rapidly penetrate the cell wall of microorganisms and inactivate cells by forming complexes with amino acids and unsaturated fatty acids, resulting in impaired protein synthesis and alteration of cell membranes	+++	Iodophors
Heavy metal salts	Silver nitrate (organic and non-organic), zinc oxide, mercury dichloride, lead, bismuth, aluminum, copper	Dissociate into anion and cation. The cation forms albuminate with proteins, interacting with thiol groups of enzymes and displacing hydrogen from them, leads to protein coagulation.	+++	+
Alcohols	Ethanol, isopropanol or n-propanol in concentration of 60-80%	Denaturation of proteins	+++	-
Aldehyds	Formaldehyde, glutaraldehyde	Protein coagulation, dehydration	+	-
Phenols	Chloroxylenol, Hexachlorophene, Carbolic acid	Inactivation of bacterial enzymes and alteration of cell walls	+/-	-
Acids	Boric acid, salicylic acid	Coagulation of enzymes and other cytoplasmatic compounds, dehydration	+++	+/-
Alkalis	Ammonia	Hydrolysis of enzymes and other cytoplasmatic compounds, humidification	+++	-
Dyes	Methylene blue, brilliant green, ethacridine	Affect the function of enzymes	+++	+
Oxidants	Hydrogen peroxide, Potassium permanganate	Oxidative stress	Alcohol solution	Water solution
Detergents	Biguanides (Chlorhexidine) and quaternary ammonium compounds (Miramistin)	Surfactant activity, disruption of cytoplasmic membranes, resulting in precipitation of cellular contents	Alcohol solution	Water solution
Tars	Linimentum balsamicum Vishnevsky, Ichthyol ointment	Effects of benzol and phenol in tars, may be some additional compounds (e.g., bismuth)	+/-	+/-

Local biological antisepsis

Proteolytic enzymes



Larval (maggots) therapy



Proteolytic enzymes

Agent	Enzyme source	Advantages	Disadvantages	• Precautions
Collagenase	Strain of <i>Clostridium histolyticum</i>	- Approved by the US FDA for the debridement of chronic wounds and burns - Selective for collagen - Generally pain-free delivery - May be combined with a variety of other topical dressings	- Effectiveness compared with other forms of debridement may be questionable - Prescription based on wound area - High cost - Relatively slow acting	- Moist wound environment required for activation - Topical silver dressings significantly inhibit collagenase activity
Papain	Papaya	- Provides relatively "aggressive" enzymatic debridement - Generally pain-free delivery - May be combined with a variety of other topical dressings	- Not readily available in the United States - Nonselective (ie, will cleave any protein containing cysteine) - Relatively slow acting	- Agent is often combined with a chlorophyll complex that causes green wound discoloration following application - Need to avoid adjacent healthy tissues
Bromelain	Pineapple	- Relatively rapid acting - Selective for nonviable tissue	- Removal from base of wound required after several hours - Inhibits platelet function but is reversible	Evidence of efficacy is based on acute wounds or burns, not chronic wounds

Systemic antiseptis

- Antibacterial therapy
- Active and passive immunization

Thank you for attention!