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THE IMPLICATIONS OF THE SPECIALIZATION OF ASEPSIS AND ANTISEPSIS METHODS IN MEDICAL ASSISTANCE IN DIFFERENT SYSTEMIC PATHOLOGIES

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ABSTRACT

Sterilization and disinfection are the basic components of hospital infection control activities. Every day, hospitals perform various surgical procedures. More invasive procedures are also performed in various health care facilities. The medical device or surgical instrument that comes into contact with sterile tissue or the patient's mucosa during various procedures is associated with an increased risk of introducing pathogens into the patient's body. Healthcare providers are equally responsible for reducing and eliminating such infections. Each hospital should have its own sterilization and disinfection guidelines based on the intended use of medical devices and possible associated infections. Currently, there is an increase in the frequency of newly emerging and multidrug-resistant pathogens in all health care settings. Therefore, medical personnel, laboratory people and health care providers should have better knowledge about these techniques to prevent the spread of these pathogens

Key words: asepsis, antisepsis, surgical procedures, healthcare, Nosocomial infections

In the conditions of a medical act (especially in surgical interventions) it is necessary to apply some measures aimed at strengthening the barrier between the environment and the human body. This is achieved by applying the methods of asepsis and antisepsis with the aim of achieving disinfection [1].

Nosocomial infections significantly contribute to morbidity and mortality, which have been an emerging threat to the healthcare system. It is a prominent public health problem and is associated with a significant economic burden. Nosocomial infections have been attributed to inadequate disinfection, decontamination, sterilization of hospital supplies, and poor implementation of antimicrobial stewardship policies. Measures often taken in the prevention of nosocomial infections include cleaning, disinfection, sterilization and effective use of antiseptics and isolation of patients with highly infectious diseases [2].

Monitoring and surveillance of hospital disinfection is important and is considered crucial in understanding the roles played by the hospital environment in the long-term prevention of nosocomial infections and transmission. The hospital environment can serve as reservoirs for these pathogenic microorganisms that are transmitted mainly through air, hand contact and exposure to hospital articles [3] .

Sterilization and disinfection are the basic components of hospital infection control activities. Every day, hospitals perform various surgical procedures. More invasive procedures are also performed in various health care facilities. The medical device or surgical instrument that comes into contact with sterile tissue or the patient's mucosa during various procedures is associated with an increased risk of introducing pathogens into the patient's body [4]. Moreover, there is a chance of transmission of infection from patient to patient; patient to medical personnel and vice versa (for example, hepatitis B virus); or from the environment to the patient (eg, *Pseudomonas aeruginosa*, *Acinetobacter spp* .) through improperly sterilized or disinfected devices [5]. A significant number of outbreaks and infections have been reported in the literature due to improperly sterilized devices. Therefore, proper decontamination techniques for medical and surgical devices are required in all areas intended for health care facilities [6].

Healthcare providers are equally responsible for reducing and eliminating such infections. Each hospital should have its own sterilization and disinfection guidelines based on the intended use of medical devices and possible associated infections. Currently, there is an increase in the frequency of newly emerging and multidrug-resistant pathogens in all health care settings. Therefore, medical personnel, laboratory people and health care providers should have better knowledge about these techniques to prevent the spread of these pathogens [7].

Currently there is no clear definition or universally accepted uniform standards for sterilization, disinfection, but "The Clinical and Laboratory Standards Institute" stipulated some recommendations based on the minimum inhibitory concentration testing, which are currently standardized by "The International Organization for Standardization". The norms were first established in 2004, and later, in 2010, new guidelines were published [8].

Sterilization: Sterilization is defined as a process of complete elimination or destruction of all forms of microbial life (i.e. both vegetative and spore forms), which is
accomplished by various physical and chemical methods. Technically, there is a $\geq 10^{6}$ log colony-forming unit (CFU)

reduction of the most resistant spores achieved halfway through a typical cycle [9].

Chemical sterilizer: These are chemicals used for a longer duration (3–12 hours) to kill all forms of microbes, eg peracetic acid (PAA) (0.2%), glutaraldehyde (≥2.4%), ortho-phthalaldehyde (OPA) (0.55%) and hydrogen peroxide (7.5%) [10].

Disinfection:

Disinfection is defined as a process of complete elimination of vegetative forms of microorganisms except for bacterial spores on surfaces. Technically, there is a $\geq 10^{3}$ log CFU reduction of microorganisms by this spore-free method [11].

High-level disinfectants:

Used for a shorter duration and capable of killing 10^{6} log microorganisms except spores, eg glutaraldehyde (≥2.0%), OPA (0.55%), hydrogen peroxide (7, 5%), hypochlorite (650–675 ppm) and hypochlorous acid (400–450 ppm) [12].

Intermediate level disinfectants: These disinfectants work against *Mycobacterium tuberculosis* and are mainly used for non-critical items contaminated with blood/body fluids [12].

Low-level disinfectants: are used to eliminate the vegetative form of bacteria, some fungi and some viruses from non-critical surfaces, for example, 3% hydrogen peroxide, quaternary ammonium compounds, dilute glutaraldehyde, phenolic substances, etc.

Decontamination and cleaning: Decontamination is the process of removing pathogenic microorganisms from objects so that they are safe to handle. Cleaning is defined as the removal of visible traces (eg organic and inorganic materials) from surfaces and objects. From a technical point of view, a minimum reduction of ≥1 log CFU of microorganisms is achieved [13].

Antisepsis:

Antisepsis is a process of removing germs from the skin. When related to the patient's skin, it means disinfection of living tissue or skin. When related to the health care worker, it means the reduction or removal of transient microbes from the skin [14].

Germicide: is the agent that destroys germs. It includes both antiseptics and disinfectants. The type of microorganism is identified from the prefix (eg, virucidal, fungicidal, bactericidal, sporicidal, and tuberculocidal) [15].

Sterilization conditions:

To destroy microorganisms and spores
They should not be aggressive to patients and medical staff
Should be inert on the materials subjected to sterilization [16].

Before sterilization, the instruments are processed by [17]:

- decontamination in chloramine solution or hydrogen peroxide, the solution must cover the instrument completely, then the instruments are washed under running water

- washing the instruments - the instruments are washed in dishes containing a mixture of detergent and water, with a brush, then under running water
- drying - under normal conditions

All procedures at the preparation stage for sterilization are carried out with gloves and the instruments used in interventions applied to patients with viral diseases (HIV, syphilis) will be processed in separate vessels [12].

Sterilization methods

1. Dry heat sterilization

Ovens with hot air - ovens or Poupinel

Bring to incandescent

Incineration - is used for infected materials, which cannot be recovered: disposable syringes, dressings, experimental animals, biological waste resulting from microbiology laboratories, etc. [18].

2. Moist heat sterilization – with pressurized water vapor, the autoclave, raises the boiling point relative to the pressure in the vessel

The following can be sterilized in the autoclave: surgical instruments, materials for surgery and dressings, bleaching agents, gowns, gloves, infusion solutions, laboratory materials (culture media, tampoons for sampling, etc.) [19].

3. Chemical sterilization

With gases (formol, ethylene oxide) – it is used for sophisticated instruments that have plastic, glass components and cannot be thermally sterilized

With antiseptic solutions – cold sterilization, in oxygenated water solution.

4. Sterilization with uv rays - acts on microorganisms and even on anaerobic germs, but prolonged exposure poses a danger to patients and staff (used in empty rooms) [21].

Disinfection:

- primary - antiseptics for external use are used to process the instruments, surfaces, walls, floors
- terminal – formalization with formic aldehyde 40% for 48h
- UV lamps

Antisepsis: anti = against, sepsis = putrefaction; complex of measures aimed at destroying the germs present in a wound or in the body; curative method.

Antiseptics of chemical and biological origin must meet the following requirements [16]:

– T
o keep its activity in case of long-term storage;

- Not to lose its activity by contacting the tissues of the macroorganism;
- The antiseptic preparation process should be as simple as possible and the preparation used should not be expensive.

Types of antiseptic factors:

Mechanical factors – the wound is processed primarily in the first 6-8 hours by removing foreign bodies and blood clots, the mandatory excision of the edges of the wound to its bottom with the stoppage of bleeding, then it is completely sutured in such a way that no cavities remain. The mandatory condition for performing the primary surgical processing is the strict observance of asepsis. The wound is cleaned regularly by dressing, an already infected wound is processed secondary by draining the purulent collections and dressing with a sterile dressing.

Physical factors – light, heat, sound waves, various radiations applied to the wound, the environment (humidity, air, temperature); reduce the inflammatory process by actively draining wounds, irrigation with antiseptic solutions and suction reduce the amount of microorganisms in the wound.

Chemical factors

The conditions that antiseptic preparations must meet are: stability and solubility, lack of tissue aggressiveness, bactericidal effect, preservation of activity in different environments.

Chemical antisepsis is a method of fighting infection in the wound, the external environment, based on the use of chemical substances, which exert bactericidal and bacteriostatic action. Their application can be local or systemic. Classification of antiseptics: disinfectants, antiseptics for external use, chemotherapeutic remedies. Disinfectants are used for processing instruments, washing walls and floors, etc. Antiseptics for external use are used for processing skin, the surgeon's hands, for cleaning wounds and mucous membranes. Chemotherapeutic remedies are administered internally, in the body, have a resorptive effect and contribute to inhibiting the growth of bacterial culture in pathological foci.

Biological factors - Biological antisepsis provides for the use of factors of biological origin, which act suppressively on microorganisms, or the use of factors with immunostimulating action. Biological factors include a group of special preparations, obtained as a result of the vital activity of organisms – serums, immunoglobulins, vaccines, natural antibiotics, enzymes, phages.

Due to the current situation related to the COVID-19 pandemic, concern about controlling the spread of respiratory viruses is increasing . In fact, contamination through contaminated surfaces and direct person-to-person contact are characterized as potential sources of dissemination of many pathogens, not only viral, but also bacterial and fungal [11]. Considering these facts, it is extremely important to promote the improvement of cleaning, disinfection and sterilization processes of surfaces and people in the environment to allow safe interactions between humans and microbial pandemics that may occur . Despite the effort and access to technologies that act to control infections, and contrary to expectations, their risks are increasing every day, affecting people's lives. This situation is aggravated by the increase in the number of people susceptible to infections. Therefore, the use of disinfectant solutions in environmental decontamination may be necessary in the fight against infections that, in addition to combating several emerging microorganisms, can help control multiresistant microorganisms .

Surface disinfection has been included in several national and international policies and recommendations to combat environmental infections. The introduction of protocols for carrying out surface disinfection processes against microorganisms is therefore essential, especially in medical environments, because the exposure is more pronounced in these places .Previous studies have demonstrated the benefits of using ultraviolet light devices to disinfect hospital environments, portable devices with spray systems for surface decontamination, and disinfection chambers with different biocidal agents . The development, advertising and marketing of tunnels or booths or disinfection chambers have spread in several countries, although there is still no scientific evidence to support them .Some regions have installed this type of system in multiple places, such as high-traffic street areas, highways, industries, malls, and offices. These devices use substances such as sodium hypochlorite, ozonated water, ozone or other biocidal agents .

Among the list of disinfectants, one of the most promising biocidal agents is ozone gas (O_3(g)). It has unique biological properties, acting as a strong oxidant against viruses, bacteria and protozoars; at recommended levels, it can be used as a microbicidal gas and can be dispersed in water. O_3 leads to microbiological destruction through metabolic interference. However, viral susceptibility may fluctuate in its presence. For example, for enveloped viruses such as coronaviruses, the effectiveness of O_3 may be more pronounced than that of non-enveloped viruses due to the interaction of O_3 with lipid bilayer envelopes .

However, O_3 can be toxic in gaseous form; when dissolved in water, its degree of toxicity is reduced, and the sanitizing effect is maintained . In addition, O_3 dissolved in water (or ozonated water (O3(aq))) already has a wide application in the treatment of pathologies of the oral cavity, and its use has increased in other fields. In fact, O3(aq) has several advantages, being effective in reducing several pathogenic microorganisms, including not only viruses, but also bacteria and fungi .In this sense, the use of O3(aq), associated with disinfection chamber technology, allows a number of uses both in the current pandemic and in other contexts where infectious diseases can spread .

Emerging pathogens are a growing concern for the general public and infection control professionals. Relevant pathogens include *Cryptosporidium parvum*, *Helicobacter pylori*, *Escherichia coli* O157:H7, HIV, hepatitis C virus, rotavirus, multidrug-resistant *M. tuberculosis* , human papillomavirus, and nontuberculous mycobacteria (eg, *Mycobacterium chelonae*). Similarly, recent publications have highlighted concern about the potential for biological terrorism [33]. The Center for Disease Control (CDC) has listed several agents as "high priority" because they can be easily disseminated or transmitted by person-to-person contact, cause high mortality, and are likely to cause public panic and social disruption [34]. These agents include *Bacillus anthracis* (anthrax), *Yersinia pestis* (plague), smallpox (smallpox), *Francisella tularensis* (tularemia), filoviruses (Ebola and Marburg - hemorrhagic fever), and arenaviruses (Lassa - Lassa fever and Junin - Argentine hemorrhagic fever) and related other viruses .

With rare exceptions (eg, human papillomavirus), the susceptibility of each of these pathogens to chemical disinfectants or sterilants has been studied, and all of these pathogens have been found to be susceptible to currently available chemical disinfectants or sterilants [36]. Standard sterilization and disinfection procedures for patient care equipment are appropriate for sterilization or disinfection of instruments or devices contaminated with blood or other body fluids from persons infected with blood-borne pathogens, emerging pathogens, and bioterrorism agents, except prions (particularly difficult to remove). Prion diseases are a group of extremely rare neurodegenerative disorders that are transmissible, progressive and fatal . These diseases are caused by prions: infectious particles composed of abnormal proteins. Prion proteins are extremely hydrophobic and conventional decontamination techniques do not reliably remove them from medical devices. If a patient with 'definite', 'probable' or 'suspected' prion infection undergoes surgery involving tissues at high or medium risk of infectivity, then consideration should be given to using single-use instruments, quarantining or destroying instruments . In tissues considered to be of low risk, instruments can be sterilized and reused in a conventional manner .

There is ongoing research into sterilization techniques that can permanently eliminate prions. Options include strongly alkaline solutions, enzymatic detergents, and ozone/hydrogen peroxide plasma techniques .

Except for diseases caused by prions, it is not necessary to make changes in cleaning, disinfection or sterilization procedures .In addition, there are no data to show that antibiotic-resistant bacteria (eg, methicillin-resistant *Staphylococcus aureus,* vancomycin-resistant *Enterococcus faecium, and multidrug-resistant M. tuberculosis*) are less sensitive to liquid chemical germicides than antibiotic-sensitive bacteria under conditions and contact concentrations of currently used germicides .

Modern 3D imaging technologies and software can be of great help in the preoperative planning of dental implant surgery [. The planned implant position is transferred to the surgical area by using a surgical implant guide resulting in greater control of the implant position . Implant surgery is an invasive procedure, during which the surgical guide comes into contact with blood, damaged mucous membranes and bone. If the surgical guide is not properly sterilized, microorganisms can easily enter the surgical wound and adversely affect the success of the surgery and the life of the implant. Therefore, like all other instruments used in implant surgery, the surgical guide must also be sterilized to avoid infectionă[20-28] .

Antibiotic resistance is a growing problem worldwide, with approximately 2.8 million antibiotic-resistant infections occurring annually in the United States alone. These infections are associated with an increased risk of morbidity, mortality, and additional healthcare costs and result in approximately 35,000 deaths each year. While Gram positive bacteria such as *Staphylococcus aureus* and *Clostridium* methicillin-resistant *dikes* were previously of most concern in terms of antibiotic resistance, currently drug-resistant Gram-negative bacteria are increasing worldwide .

The Center for Disease Control (CDC) first developed a list of emerging threats related to antibiotic resistance in 2013 and updated that list in 2019. The list is organized by level of urgency. "Urgent threats" are those that refer to imminent problems and require immediate action to prevent and treat .

The cause of increasing resistance to antimicrobial substances is multi-factorial. A key factor in the emergence of resistance is a lack of judicious administration of antibiotics leading to overuse of antimicrobial substances, inadequate empirical coverage, and delays in accurate diagnosis, as well as ineffectiveness of therapy . As time passes, fewer and fewer effective antimicrobials are available to treat these infections, and thus the problem further escalates. This problem becomes particularly pressing in hospitals and acute care facilities. Among hospital-acquired infections, drug-resistant Gram-negative bacteria are becoming more prevalent. *Klebsiella pneumoniae, Pseudomonas aeruginosa, Escherichia coli,* and *Acinetobacter baumannii* account for the majority of Gram-negative nosocomial infections in the US and are becoming highly resistant to antibiotics .

There are a variety of mechanisms by which these bacteria become resistant, which include but are not limited to the production of β-lactamases and extended-spectrum β-lactamases, carbapenemases, and by increasing efflux activity .These bacteria are often resident in acute and long-term care facilities and are responsible for cases of pneumonia, catheter bloodstream infections, intra-abdominal infections, and urinary tract infections. These patient populations tend to be vulnerable to infections and often have multiple comorbidities, making them particularly dangerous .

A recent article identified multiple bacteria as being significantly less sensitive to antimicrobials when isolated in emergency departments compared to other hospital settings.To further complicate the matter, therapies that are effective in targeting these organisms are declining at an alarming rate. Progress over the last decade in the discovery of new antimicrobial substances, especially for Gram-negative bacteria, is extremely limited. Physicians were forced to rely on older antibiotics such as colistin and fosfomycin, which have severe side effects, and currently suffer from resistance phenomena . Given the increased morbidity, mortality, and pressure on the entire medical system that these organisms are responsible for, it is imperative that we focus on prevention, appropriate management of infections, and the development of new targeted antibacterial therapies[29-35].

Antibiotics must be used according to well-defined and reasoned indications.

2. Early identification of the microorganism that caused the outbreak of the disease.

3. Correct administration of the dose and frequency of administration of the antibiotic used, with the aim of maintaining an optimal concentration of antibiotics in the blood.

4. Prevention of adverse reactions and complications. In order to prevent allergic reactions, it is necessary to perform a skin test to determine the body's sensitivity to the antibiotic to be used. It is necessary to combine antibiotics that do not synergistically increase the general toxic effect on the macroorganism .

Before administering antibiotics, it is necessary to establish the functional state of the patient's liver, kidneys, heart, especially when antibiotics with a highly toxic effect will be used .

Determination of an antibacterial strategy: the antibiotic should not be used for more than 7-10 days, the same principle also applies to the use of antibiotics in different combinations .

In the past few years, new methods of disinfection and sterilization have been introduced in medical facilities. OPA is a chemical sterilizer that received FDA approval in October 1999. It contains 0.55 % 1,2-benzenedicarboxaldehyde. In vitro studies have demonstrated excellent microbicidal activity. Some authors revealed that OPA demonstrated superior mycobactericidal activity (5 log10 reduction in 5 min) compared to glutaraldehyde .

The FDA recently approved a high-level liquid disinfectant (superoxidized water) containing 650-675 ppm free chlorine and a new sterilization system using ozone. Because there are limited data in the scientific literature to evaluate the antimicrobial activity or material compatibility of these procedures, they have not yet been integrated into clinical practice in the United States .

Several methods are used to sterilize patient care items, including steam sterilization, ETO, hydrogen peroxide gas plasma, and a peracetic acid immersion system. Plasma-based sterilization was patented in 1987 and has been commercialized in the United States since 1993. Gas plasmas have been referred to as the fourth state of matter (liquid, solid, gas, and gas plasma) .Gas plasmas are generated in a closed chamber in a deep vacuum by using radio frequency or microwave energy to excite gas molecules and produce charged particles, many of which are in the form of free radicals. This process has the ability to inactivate a wide spectrum of microorganisms, including resistant bacterial spores. Studies have been performed against vegetative bacteria (including mycobacteria), fungi, viruses and spores. The effectiveness of all sterilization processes can be altered by lumen length, lumen diameter, inorganic salts, and organic materials[36-39] .

Healthcare-associated infections are an important source of morbidity and mortality. Pathogens associated with the patient's endogenous flora are believed to be the major source, but an estimated 20% are acquired through another method of transmission, such as the environment, cross-transmission by healthcare personnel, etc. The implementation of disinfection and sterilization by disinfectants and sterilization practices are essential to ensure that medical services and surgical instruments do not transmit infectious pathogens to patients. Although the basic principles of high-level disinfection of semicritical instruments (defined as those that touch mucous membranes) and critical items (defined as those that touch sterile tissue) have not changed, new practices, products, issues, technologies, and knowledge continue to be entered. In addition, substantial evidence in the literature supports the role of contaminated surfaces and non-critical patient care items in the transmission of several key healthcare-associated pathogens, including methicillin- resistant *Staphylococcus aureus*, vancomycin-resistant *Enterococcus*, *Acinetobacter*, *norovirus*, and *Clostridium difficile*. All these pathogens have been shown to persist in the environment for days to weeks (in some cases months), frequently contaminate environmental surfaces in the rooms of colonized or infected patients, transiently colonize the hands of healthcare personnel through contact with the patients' environment, are transmitted by healthcare personnel to patients and can cause outbreaks of pathogen transmission.

In this context, the present study on disinfection and sterilization methods used in current medical practice offers concrete directives for specialization, depending on the pathology of the patients for increased safety of the medical act.

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