



# Bacterial Contamination of Surfaces in the Surgical Rooms at Al-Mak Nimer University Hospital, Shendi Town-Sudan, 2023

Dafaalla AA<sup>1</sup>, Ahmed Ali A<sup>1\*</sup> and Jubara A<sup>2</sup>

<sup>1</sup>Department of Public Health, Shendi University, Sudan

<sup>2</sup>Department of Microbiology, Shendi University, Sudan

\*Corresponding author: Alhaj Saad Mohamed Ahmed Ali, Department of Public Health, Shendi University, Sudan, Email: alhajsm198@gmail.com

## Research Article

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## Abstract

**Background:** Bacterial Contamination in surfaces at surgical rooms is one of the most life-threatening sources of infection acquired in hospitals for patients. The study was conducted at El-Mak Nimer University Hospital in Shendi town from the beginning of October 2022 to January 2023 to isolate and identification of pathogenic bacteria in the surgical site environment.

**Material and Methods:** 30 Samples were taken by passing a cotton swab on the surfaces in surgical rooms, than incubated in the laboratory, isolated and conducted the necessary tests to identify the types of bacteria.

**Results:** Bacterial contamination was detect as 43.3% in surfaces samples, and pathogenic bacteria were 52%. By typing these pathogens were found: 69.23% *Staphylococcus aureus*, 23.07% *Pseudomonas* and 7.7% *Klebsiella*.

**Keywords:** Bacterial Contamination; Surgical Environment; Sudan

**Abbreviation:** CLED: Cystine Lactose Electrolyte Deficient.

## Introduction

Microbial contamination of hospital environment, especially in an operating theatre and other specialized units had continued to increase prevalence of nosocomial infections. When we was visited El-mak Nimer Hospital, we observed some patients undergoing surgery were exposed to infection of surgical sites for several reasons such as inefficiency of sterilization operations and others reasons.

## Study Terminology

### Surgery

In general, it is the one that occurs as a result of a break in the natural defensive barrier (skin) due to an intentional or

accident or as a result of a surgical procedure, which results in rupture and pressure on the tissue, and as a general rule any surgical procedure in which an incision occurs in the tissue is considered a surgical operation [1].

## Microbiological Contamination

Refers to the non-intended or accidental introduction of infectious material like bacteria, yeast, mould, fungi, virus, prions, protozoa or their toxins and by-products [2].

## A Nosocomial Infection

Also called (Hospital-Acquired-Infection) is defined as: An infection occurring in a patient in a hospital or other healthcare facility in whom the infection wasn't present or incubating at the time of admission. This includes infections acquired in the hospital but appearing after discharge, and also occupational infections among staff of the facility [2].

## Staphylococci

This genus is a gram-positive spherical cells that exist in the form of single globules, pairs, or grouped in the form of clusters. It can also exist in the form of short chains and most of its types are immobile. Glucose fermentation, and there are about 32 types [2].

The most important known species are staphylococcus aureus, which gives a positive coagulation enzyme reaction test, while staphylococcus epidermis and staphylococcus saprophytic don't have the ability to produce coagulation enzyme, and some strains have the ability to form a preservative or form a sticky layer that helps them resist antibacterial. Most species are facultatively anaerobic, but most strains prefer to grow in aerobic conditions. Also, this bacterial genus has the ability to ferment carbohydrates to obtain carbon and energy, and the bacterial type Staphylococcus aureus is considered one of the most important pathogenic opportunistic bacterial species and causes several infections, including wound infections, the formation of pustules, beggary, impetigo, as well as ulcers. This bacterial genus can also cause bone infection, And mastitis, meningitis, bacteremia, pneumonia, as well as pyoderma fatalist, and this bacterial genus causes food poisoning, and it is known that this bacterial genus constitutes the normal flora of the nose and skin in healthy people, where about 50% of newborns carry this bacterium in the nose. The bacterial type Staphylococcus saprophyticus causes urinary tract infections in women. And the bacterial type Staphylococcus epidermidis causes inflammation of the lining of the heart and sepsis as a result of infection with this type of bacteria [1].

## Streptococcus

This type of bacteria is Gram-positive and its cells are dilated globules and are often found in Diplococcic. They may exist singly or in the form of short chains. When grown in the laboratory on blood agar, it will result of incomplete decomposition of blood cells. Red blood cell, which is known as the alpha hemolytic type, as is the case in streptococcus viridians, and this decomposition is what distinguishes this bacterial type from group (A). This type of bacteria does not have spores. It is also non-motile and is able to ferment glucose sugar to produce lactic acid. It also does not secrete the enzyme catalase. It can be grown in laboratory when anaerobic environmental conditions are available in the presence of 5% carbon dioxide as a requirement that stimulates it to Growth, and this type of bacteria has the ability to self-transform its colonies, as the transparent colonies have the ability to exist and grow in the nasopharynx, while the dark colonies have the ability to exist and grow in the blood, this type of bacteria is found naturally in the

upper respiratory tract, and this type of bacteria can cause pneumonia, and has the ability to cause sinusitis, middle ear infection, and meningitis, and this type of bacteria can also cause osteoporosis, arthritis, and endocarditis. Heart disease, inflammation of the abdominal cavity, as well as cellular tissue infections, brain abscesses, bacteremia, and conjunctivitis. It is also considered the main cause of many severe infections in children and elderly people, as well as people who suffer from a defect in the immune system [1].

## Escherichia Coli

They are Gram-negative bacterial cells that do not form spores and are motile because they contain multiple flagella and a delicate case that gives them stickiness when grown on the appropriate nutrient media. They are also facultative anaerobes and have ability to ferment carbohydrates producing gas. Its cells are rods. The size of which ranges from about 2.0- 6.0 micrometers longitudinally. And about 1.1-1.5 in width and the apparent shape of the cells may be spherical or long filiform bacilli. This bacterial type has cilia that help it attach to the host cells, and these cilia differ in terms of structure in the different strains of Escherichia coli, and this bacterial type is responsible for the outbreak of most cases of diarrhea during the summer and some cases of diarrhea in children and cases of food poisoning, and this bacterial type is present as a natural inhabitant in the intestines of humans and animals, and sometimes it turns into pathogenic bacteria, and is considered the main cause of respiratory infections, and there are many strains of this type of bacteria that have the ability to cause diarrhea [1].

## Klebsiella

The cells of this bacterial type are facultatively anaerobic bacilli and don't have the ability to grow in anaerobic environmental conditions. The length of its cells ranges from about 1-2 micrometers and its width is about 0.5-0.8 micrometers. They are found singly, in pairs, or in the form of short chains. The ability to ferment the sugar lactose, and it is a non-motile bacteria, but there are species that have ciliates. This type of bacteria has the ability to grow in varying temperatures ranging from 12-43 degrees Celsius and is affected when exposed to moist heat at a temperature of 55 degrees Celsius for 30 minutes. And when the appropriate environmental conditions are available, it forms a large gelatinous preservative of polysaccharides. It is considered one of the main causes of pneumonia and results in abscess formation. These infections are often opportunistic and occur in people who suffer from chest diseases, diabetics and malnourished patients. Important in causing nosocomial infections, as it can cause urinary tract infection and sepsis, while the bacterial type *Klebsiella aerogenes* that causes nasal sclerosus known as granuloma that affects the nose

and pharynx, and sometimes chronic infections may lead to deformation of the airways. The bacterial type *Klebsiella ozaena* is present in the nasal mucosa and is considered one of the rare causes of respiratory system infections that lead to damage to the mucous membranes [1].

### **Pseudomonas**

The cells of this bacterial genus are aerobic bacillus with a size of 0.6 in width and 2 micrometers in length. They are Gram-negative, non-spore-forming, and are mobile by flagella (one or two flagella) located on the poles of the cell. Some strains of the bacterial type, *Pseudomonas aeruginosa*, maybe it is a preservative and is considered one of the most important pathogenic bacteria species out of 200 species of this genus. It has the ability to grow at a temperature of 37-42 degrees Celsius and secretes two soluble dyes, namely pyocyanin, which gives it a greenish yellow color. The dye is secreted abundantly in the food medium that contains a small amount of iron. There are two other types of dyes secreted by this bacterial genus, namely Puroprene, which gives it a red color, and Melanin, which gives it a brown color [1].

Contamination of operating rooms is one of the most life-threatening sources of infection for patients acquired in hospitals. Multiple sources have been identified responsible for contamination in hospitals, particularly in hospital room's surgical operations, where surface contamination is one of the most important causes of contamination in room's surgical operations, and the medical staff is still a major source of contamination. The first major developments in the prevention of infection at the surgical site were the mid-nineteenth century with the use of sterilization technique. Before the nineteenth century, surgical patients usually had a fever after surgeries, followed by purulent secretions from wounds, infection, and often death, but in the 1860s, the incidence of pathogenesis decreased due to wound infection after surgeries, thanks to the scientist Joseph Lister, who clarified the foundation of antiseptics, as these efforts led to a fundamental change in surgical medicine, as it became an activity accompanied by injury and death to an important branch of medicine that could help patients get rid of pathological suffering and prolong life [3]. Staphylococcus, Streptococcus, Escherichia coli, Klebsiella and Pseudomonas are the most common bacteria in surgical infections. In most cases, the source of infection is a bacteria on the surface of the patient's skin or contamination of the surgeon's hand or contamination of some surgical tools and transmission through the air or even due to the presence of germs inside the body and their spread to the wound site in cases of weak immunity [4].

Infections acquired during health care delivery, more appropriately called health care-associated infections "HAIs", are a significant public health problem around world.

It is estimated that 5% - 10% of patients admitted to acute care hospitals in developed countries, acquire one or more infections. In developing countries the risk of infection is 2-20 times higher and the proportion of patients infected can exceed 25%, Hospital hygiene is the state of a hospital which is safe, clean, free of contamination and pathogens, in which incidence of health care-associated infections "HAIs" are under monitoring and control [5].

Our study aimed to detect and identification of bacterial contamination because Assisting and identifying the sources of contamination within the hospital's surgical unit, Significantly reduce health costs for families and the hospital mortality and morbidity rate that occurs due to hospital infections and reducing the mortality and morbidity rate that occurs due to hospital infections.

## **Materials and Methods**

### **Study Design**

This study was conducted to detect and identification the pathogenic bacteria in surgical rooms' at El-mar Nimer University Hospital - Shendi Town from October 2022 to January 2023.

### **Study Area**

The hospital was established in the year 2002, The hospital has gained great strategic importance in the framework of localizing treatment at home after the real boom it witnessed after expanding and developing its medical services base in diagnosis and treatment, as the hospital provides high-level health services and advanced technology to a large number of the people of the region in the localities of Shendi, Al-Mutama, Al-Aberin and neighboring states, and increases the chances of hospitalization in the city of Shendi. As a result of the qualitative shift in various disciplines, the hospital has provided an important training facility for students of faculties of medicine and health sciences and the state and central ministries of health, providing the possibility of good and advanced training for medical and therapeutic cadres and frameworks.

### **Sampling Technique and Sample Size**

30 samples were taken by passing a cotton swab filled with sterile saline solution on the surgical tools and hands of surgeons and surgical beds in surgical sites.

### **Lab Process**

The samples were incubated on blood agar for 24 hours at temperature of 37 degrees Celsius, and growth was observed

on the dishes. Gram stain was used to identify the shape of the bacteria and distinguish between positive and negative bacteria by following the traditional method. All bacteria were incubated in cystine lactose electrolyte deficient (CLED) agar to test its ability to ferment the lactose. As the appearance of yellow colonies indicates that they ferment the lactose. A catalase test was also performed to distinguish between cocci. *Staphylococcus* spp, which is positive for this test, and *Streptococcus* spp, which is negative for this test, by mixing a pure colony with a hydrogen peroxide solution in a glass tube, the formation of direct air bubbles indicates the positivity of the test, and Coagulase test was also conducted to see the ability of the bacteria to secrete the Coagulase enzyme that works on coagulation of blood plasma, where it converts fibrinogen into fibrin, and the test was conducted mainly to distinguish pathogenic *Staphylococcus aureus*, which has ability to secrete this enzyme from the rest of the other non-pathogenic staphylococci. An oxidase test was also performed to distinguish *Pseudomonas* spp positive for this test from the rest of the genera of the Enterobacteriaceae family.

## Results

After incubating the samples drawn in blood agar, it was found that the growth rate of bacteria in the used surgical tools was 14.3%, while the percentage of bacterial non-growth was 85.7%. It was also found that the percentage of bacterial growth in the operating beds was 64.3%, and the percentage of no bacterial growth was 35.7%. The percentage of bacterial growth from samples drawn from the hands is 100%. Where the percentage of bacterial growth for all samples drawn was 43.3%, and the percentage of non-bacterial growth was 56.7%, as bacterial growth appeared in 13 samples out of 30 samples.

The percentage of gram-positive spherical bacteria was 40%, the percentage of gram-negative bacillus was 16% and the percentage of gram-positive bacillus was 44%.

After conducting a catalase test on gram-positive spherical samples, the percentage of staphylococcal bacteria was 100%. Where the proportion of pathogenic *staphylococcus aureus* bacteria was 90% and the percentage of other non-pathogenic staphylococcus bacteria was 10% after conducting the Coagulase test on them.

Oxidase test performed on Gram-negative bacillus samples. The percentage of positive bacillus bacteria for this test was 75% (*Pseudomonas*) and the percentage of negative bacillus bacteria for this test was 25% (*Klebsiella*).

Gram-positive bacillus species were identified by the shape of the colony, and the percentage of spore-forming

bacillus was 27.3% (Environmental Bacteria), and the percentage of non-spore-forming bacillus was 72.7% (Bacillus Form).

After conducting all the necessary tests to identify pathogenic bacteria, the percentage of pathogenic bacteria present in the samples was 52%, and the percentage of non-pathogenic bacteria was 48%.

The percentage of non-pathogenic bacteria contained 8.3% of non-pathogenic *Staphylococcus* spp, 25% of non-spore-forming Gram-positive bacillus (Environmental Bacteria), and 66.7% of spore-forming Gram-positive bacillus.

## Discussion

This study aimed to determine the presence of pathogenic bacteria on surfaces in operating rooms and to identify the most common types in order to clarify the risk that they can cause, especially if there is a lack of sterilization, which leads to the acquisition of various types of nosocomial infections.

It was found that the beds used during surgical operations contain the highest presence of bacterial contamination, and this increases the possibility of contamination of wounds, as they are the surfaces closest to the patient, and they are used after washing with soap mixed with an antiseptic after each operation without the use of Formalin, which is used after completing all scheduled surgeries during the day.

Also the results of this study showed that *Staphylococcus aureus* bacteria were the most common species that are considered pathogenic and cause many infections such as (wound inflammation, ulcers, bone inflammation, pyometra).

*Pseudomonas* bacteria have also been identified, which play a role in bacterial contamination and infection and cause, for example, (urinary tract infections and chest infections) and can be found in several places, including saline solution and some disinfectants.

*Klebsiella* bacteria also showed as little and that have been to cause infectious, such as pneumonia and some opportunistic infections in people with diabetes and chest diseases, the presence of these bacteria and their ability to cause infection of surgical sites.

In addition to the pathogenic bacteria that were identified and isolated, there was growth of non-pathogenic bacteria such as Gram-positive *Staphylococcus* spp and *Bacillus*. Although they are not pathogens, the isolation of these bacteria indicates the quality of sterilization in sensitive sites of nosocomial infection (surgical materials

and operating rooms) and subsidize hospital teams with regard to improving the hygiene and sterilization process with a view to reducing nosocomial infections. More studies of this type are needed in Sudan, with a view to verifying hospital contamination and, above all, protecting the health of citizens who need these services.

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