Ref: Ro J Infect Dis. 2023;26(4)
DOI: 10.37897/RJID.2023.4.5

Studying the level of hospital contamination with *Staphylococcus aureus*

Maytham Abas Makki, Dhay A. Azeez

Department of Biology, College of Science, Al-Muthanna University, Al-Muthanna Province, Sammawa, Iraq

ABSTRACT

Background and Objectives. *Staphylococcus aureus* bacteria is one of the most important types of antibiotic-resistant bacteria that cause hospital-acquired infections, so the source of this bacteria in the hospital must be determined for the purpose of controlling it and preventing its spread.

Materials and Methods. The study included collecting (296) samples from operating lobbies and wards in Al-Hussein Teaching Hospital. The isolates were distributed by (73) isolates out of (177) samples from wards and (64) isolates out of the original (119). A sample from operating theaters and from different locations for the period between October 2016 and until February 2017. Bacterial isolates were diagnosed. This was confirmed with the use of CHROM agar *Staphylococcus aureus* media.

Results. The results showed that the highest prevalence of bacteria was in the surgical ward by 64% and the lowest prevalence in the nose, ear and throat ward by 25%, while the prevalence rate was recorded at 40% in the urinary ward, 36.8% in the esotericism ward, and 36% in the fractures ward. Bacteria recorded a prevalence rate of 34.48% in the emergency ward. The highest prevalence of bacteria was on the floors of the wards by 51.16%.

Conclusions. The high rates of pollution in operating theaters compared to wards, and this may be due to the failure of patients and companions to follow the procedures imposed by the hospital, lack of commitment to attention to the number of companions and visiting times, or to the commitment to wearing bras, head covers and sterile shoes.

Keywords: *Staphylococcus aureus,* ENT operating theater, CHROMagar

INTRODUCTION

Contamination of hospitals with microbes, especially sensitive sections, such as surgical theaters, intensive care units and recovery units, is one of the problems facing patients and medical staff, and the spread of microbes in the internal environment of hospitals contributes to the occurrence of diseases and infections, which is a major cause of hospital infection [1].

The types of infections acquired through hospitals more than a century ago were distinguished as a critical problem affecting the quality of health care provided in hospitals, where 20% of this infection, represented by infection of surgical wounds, blood, urinary and respiratory systems, can be avoided. The air of the internal environment of hospitals is generally troubling, as this is related to many acute diseases, infections and allergies caused by such microorganisms, and these percentages give an indication of the degree of cleanliness of the internal environment of hospitals that carry various types of microorganisms. Fungal spores are one of the most important types of pathological factors that can be It is transmitted through the outside and inside air of the hospital environment [2].

In addition to its transmission through visitors, patients and air conditioners, assessing and determining the type, number and bifurcation of the different types of bacteria present in hospital rooms and lounges, especially the sensitive units such as halls, is of great importance and concern at the global level, as it has been found that 10% of the infection that affects patients is an infection Acquired by

Corresponding author:
Maytham Abas Makki
E-mail: ahmedalshewerd@gmail.com

Article History:
Received: 20 October 2023
Accepted: 28 December 2023

them while they are in hospitals, as such an infection may have serious consequences in terms of increased mortality, infection rate, length of stay of hospitalized patients, in addition to the increase in the total cost [3].

Contamination of surgical theaters is one of the most important sources threatening the lives of patients in hospital, especially cardiac surgery, organ transplant surgery, prostate surgery, and bladder tumors. Many sources responsible for contamination of surgical theaters, their ventilation systems and disinfection solutions have been identified in them, and some reports indicated the presence of types of conditions. The real environmental environment present in the water purification systems used in laboratories, which provided a wide-range opportunity for the spread of bacterial contaminants, as the movement of hospital staff between surgical rooms and halls and other parts of them without changing their clothes and shoes, as well as the arrival of patients to the surgical theaters without their commitment to conditions The health system before entering the surgical theaters is very important factors in contamination of operating rooms and theaters and the subsequent development of the types of infections acquired in hospitals after various surgeries. A large proportion of hospital acquired infections occur as a result of cross-contamination and the transmission of microorganisms through the hands of health care workers. Being a major source of microbial contamination [4].

Pseudomonas, *Staphylococcus aureus*, and *Klebseilla* sp. Opportunistic pathogens are rare to cause disease in healthy people, but are highly pathogenic in patients with poor defense mechanisms, causing bacteremia, Infections Eye and Ear infection. infections, skin infections, burn and wound infections, central nervous system infections, endocarditis, and bone and joint infections [5].

The pollution in hospitals due to these nurses has a satisfactory effect to worsen the condition of hospitalized people, as infections with these pollutants are common in all hospitals and cause many diseases. Pathogenic induced local invasion is correlated between the patient's condition and the microbial contamination. It is one of the important causes of hospital-acquired infections (Nosocomial infection) because of its presence in the hospital environment, especially when moisture is present and its spread from one patient to another and by hospital workers and its infection to patients with immune suppression or those who are treated with broad-spectrum antibiotics [6].

Staphylococcus aureus bacteria is a major and increasing health problem in all parts of the world because it causes many infections associated with hospitals, especially in intensive care units and burn units, and thus it is the largest cause of hospital-acquired infections, which have become constantly increasing due to resistance to staphylococcus bacteria. Aureus of all classes of known antibiotics [7].

This bacterium has the ability to remain on various surfaces from several weeks to several months, which increases the likelihood of medical personnel coming into contact with it and transferring it to patients unintentionally [8].

Therefore, measures to prevent this infection are very important, and given the lack of information about the prevalence of *Staphylococcus aureus* bacteria in the environment of Samawah city hospitals and the clinical importance that this bacteria pose in terms of its ability to cause disease and its multiple resistance to most known antibiotics and its possession of a group of factors The virulence represented by the excretion of a number of exogenous enzymes or toxins that act selectively on different host tissues such as Alkaline protease, Alkaline phosphatase Lecithenase, DNase gelatinase, Lipase, Coagulase, Elastase, Leukocidin, as well as iron carriers Siderphore and enterotoxin [9].

Hence the idea of this research, which includes studying the prevalence rates of *Staphylococcus aureus* in the lobby and the operating theatres of Al Hussein Teaching Hospital in the city of Sammawah.

MATERIAL AND METHODS

Were collected (296) sample of the lobbies and Operations galleries at Al Hussein Teaching Hospital, in the city of Sammawa, south-west of Iraq, samples divided by (177) a sample of lobbies and (119) sample of Operations galleries for the period from October 2016 and until February 2017. Sterile cotton swabs moistened with physiological saline were used to take swabs from the environment of lobby and operating theaters and from various locations including (beds, floors, tables, walls, devices and surgical instruments). Then the swabs were transferred within two hours to the laboratory and were implanted in the brain heart infusion broth, The samples were incubated at a temperature of 37°C for a period of 24 hours for the purpose of activation. Then the samples were implanted on the Mannitole salt agar media (Himedia). The cultures were incubated under aerial conditions of 37°C for a period of 24-48 hours [10], and after the onset of growth, the individual and fermented colonies were taken of mannitol, which appeared golden yellow for the purpose of diagnosis.

LABORATORY DIAGNOSIS

The samples were initially diagnosed by observing the culture characteristics of the developing col-

onies in terms of colony size, height, edges and color. They were purified by re-transplanting them to Nutrient Agar and then incubated at 37°C and for 24 hours after that, thin smears were made and stained. With a gram stain, and the cell shapes, arrangement, and staining power were observed with this stain [11,12].

And biochemical tests were performed, such as the Catalase test, the oxidase test, the free and linked Coagulase test, the blood hemolysis test and the ability to produce the enzyme that degraded the DNA (DNase test), according to what he mentioned. Each of [13,14]. The diagnosis was confirmed with CHRO-Magar *Staphylococcus aureus* according to the instructions of the provider (Pronadisa).

RESULTS

The results shown in Table 1, Figure 1 showed that the prevalence of staphylococcus aureus in the lobby environment of Al-Hussein Teaching Hospital was 41.24%, and the highest percentage was in the surgical ward 64.29%, followed by the urinary ward 40%, then the Esotericism ward 36.84%, then the ward Fractures 36%, followed by the emergency ward 34.48%, then the burns ward 28%, the lowest percentage was the ear, nose and throat Lobby by 25%.

As for Table 2, Figure 2, the results showed in the operating theaters that the rate of bacterial spread in them was 53.78%, the highest percentage The prevalence was recorded in the ENT ward of 64%, and the lowest rate was in the Surgical operating theater at 40%.

DISCUSSION

The prevalence of bacteria in the lobby of Al-Hussein Teaching Hospital was less than what was found [15] in Baghdad, where the rate was 46%, and much more than what was found [16] in Babylon, where the contamination rate was 38.88%.

The sites that were the most polluted in the hospital were the floors with a rate of 51.16%, followed

TABLE 1. The numbers and percentages of *Staphylococcus aureus* isolated from the hospital lobby

Lobby	Source of isolates No. of positive samples (total)				Pollution operating theater %
	Beds	Floors	Tables	Walls	
Esotericism	3 (8)	3 (9)	5 (10)	3 (11)	14 (38) 36.84%
Surgical	3 (10)	9 (11)	6 (10)	9 (11)	27 (42) 64.29%
Urinary	1 (2)	2 (3)	0 (2)	1 (3)	4 (10) 40%
(ENT)	1 (2)	0 (2)	1 (2)	0 (2)	2 (8) 25%
Burns	0 (6)	1 (6)	4 (6)	2 (7)	7 (25) 28%
Fractures	2 (6)	2 (6)	5 (7)	0 (6)	9 (25) 36%
Lobby Emergency	1 (7)	2 (8)	1 (6)	6 (8)	10 (29) 34.48%
No. of positive (Total) %	11 (42) 26.19%	19 (45) 42.22%	22 (43) 51.16%	21 (47) 44.68%	73 (177) 41.24%

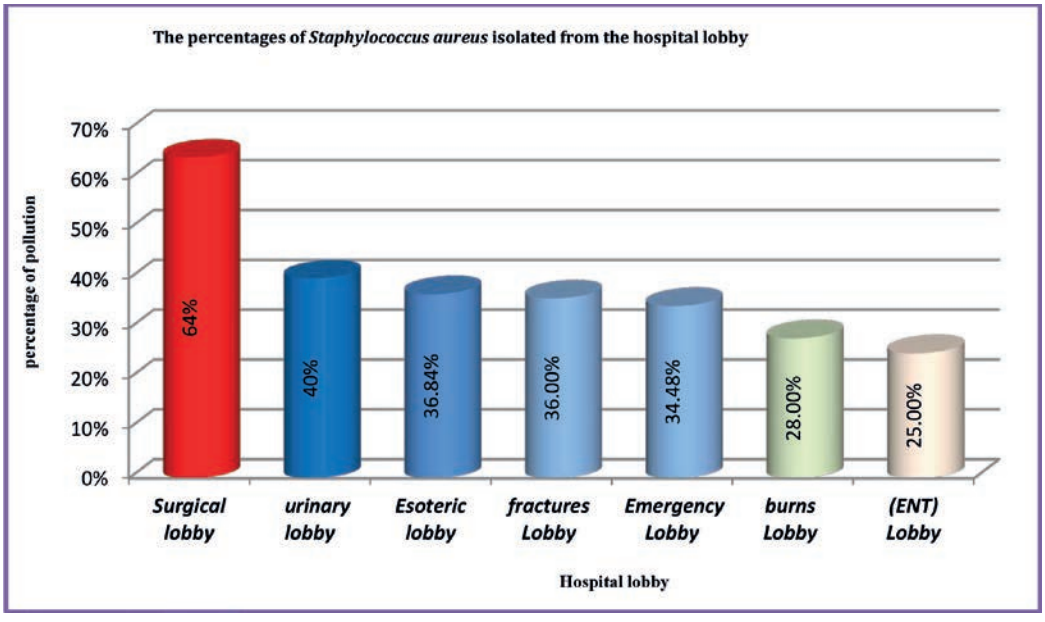

FIGURE 1. The percentage of *Staphylococcus aureus* isolated from hospital lobby

TABLE 2. The numbers and percentages of *Staphylococcus aureus* isolated from the hospital operating theater

Operating theater	Source of isolates No. of positive samples (total)					Pollution operating theater %
	Medical devices and tools	Walles	Tables	Floors	Beds	
Surgical	2 (5)	2 (5)	1 (5)	1 (5)	4 (5)	10 (25) 40%
Urinary	3 (4)	2 (4)	1 (4)	3 (4)	3 (4)	12 (20) 60%
(ENT) surgery	4 (5)	3 (5)	4 (5)	3 (5)	2 (5)	16 (25) 64%
Burns	2 (4)	3 (4)	3 (4)	2 (4)	1 (4)	11 (20) 55%
Fractures	1 (4)	4 (4)	2 (4)	1 (4)	2 (4)	10 (20) 50%
Emergency	1 (1)	1 (2)	1 (2)	1 (2)	1 (2)	5 (9) 55.55%
No. of positive (Total) %	13 (23) 56.52%	15 (24) 62.5%	12 (24) 50%	11 (24) 45.83%	13 (24) 54.16%	64 (119) 53.78%

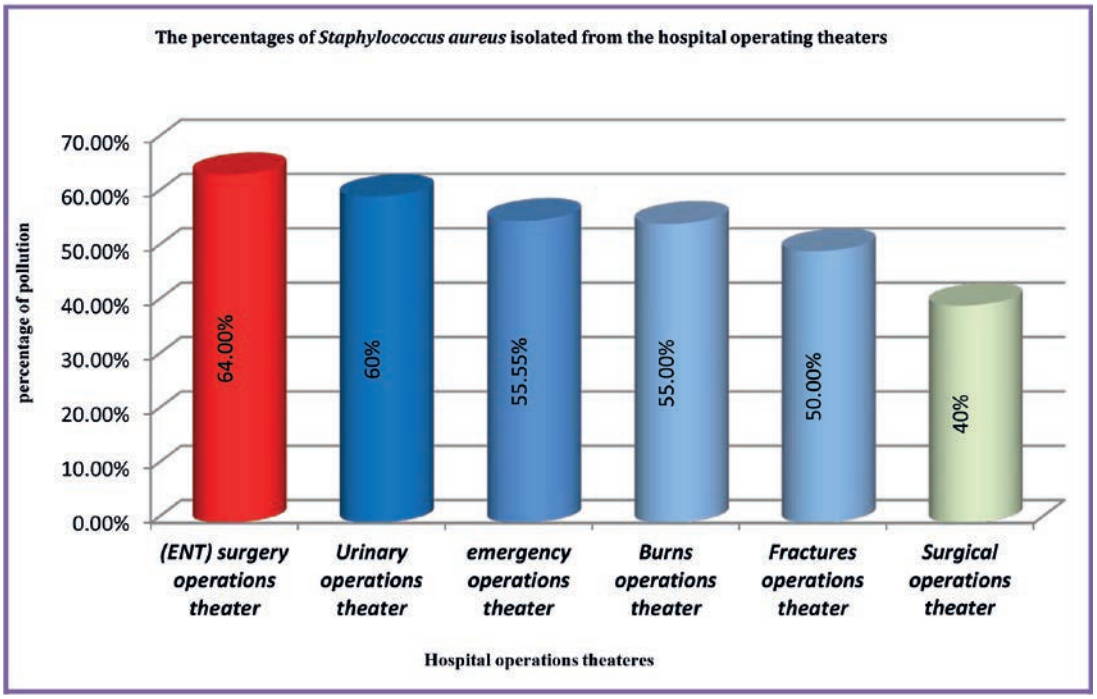

FIGURE 2. The percentage of *Staphylococcus aureus* isolated from operating theaters

by the beds with a pollution rate of 44.68% and this is consistent with what was stated by [17]. It indicated that the floors of the Hospital de Clínicas da Universidade Federal de Uberlândia in Brazil were the most polluted sites with a rate of 38.5%, followed by the beds with a pollution rate of 15.4%.

The results in Table 1 show that the highest level of contamination was in the floors of the wards, where the highest contamination rate for the floor of the fractures ward was 71.43%, followed by the burns ward 66.66%, then the surgical ward 60%, followed by the Esotericism ward and the ENT ward at 50% For each of them, and then the emergency ward, at a rate of 16.66%, while the floor of the urinary ward was free of contamination and the reason for the high level of contamination in the floor of the fracture wards was due to the large number of patients and companions in the patient's inpatient wards, which contributes to the transfer of bacteria and their durability on the floors of the ward, and this is consistent with what was stated by [18].

The highest percentage of beds contamination in the wards was in the surgical ward 81.82%, then the emergency ward 75%, followed by the urinary ward 33.33%, then the esotericism ward 30%, and then the burn ward 28.57%, while the fracture ward and the ENT ward were free from any contamination with *Staphylococcus aureus* this leads to the high rate of contamination of hospital ward beds with *Staphylococcus aureus* due to the high occupancy of the beds by patients, which leads to a shortage of time available for sterilization operations, as the bed linen and bedding are replaced only after the patient leaves the ward, and the rest of the bed, such as iron bars, is not sterilized since the *Staphylococcus aureus* has the ability to survive for several weeks to several months on various dry surfaces [19], this makes the beds a major reservoir for the

bacteria and thus is transferred to the fingers that touch these surfaces [20]. It poses a threat to patients' lives, as bacteria may be transferred to the patient himself. Therefore, sterilization of the parts of the bed (iron bars) is necessary to prevent the transmission of bacteria to the patient who is in contact with the bed.

As for the operating theaters, the study showed that the ENT ward was the most polluted 64%, and the tables and floors were the most contaminated sites 80%, and this may be due to the inefficiency of the sterilization methods used. As for the floors of the ward, the percentage of contamination was 60%. This may be due to the dropping of patient waste such as pus, secretions, etc. on the floors of the operating theater, which makes it a haven for bacteria to colonize.

CONCLUSION

The current study showed high rates of pollution in operating theaters compared to wards, and this may be due to the failure of patients and companions to follow the procedures imposed by the hospital, lack of commitment to attention to the number of companions and visiting times, or to the commitment to wearing bras, head covers and sterile shoes. Also, the inefficiency of sterilizers and the lack of concern for the sterilization of the wards to be periodic and intense is a reason for the spread of pollution in the operating theaters.

Conflict of interest: none declared
Financial support: none declared

REFERENCES

1. Greenwood O, Slack R., Peuther J. Medical Microbiology. 17th ed. London: Churchill Livingstone; 1997.
2. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Hospital Infection Control Practices Advisory Committee. *Infect Control Hosp Epidemiol.* 1999 Apr;20(4):250-78; quiz 279-80. doi: 10.1086/501620
3. de Jaeger A, Litalien C, Lacroix J, Guertin MC, Infante-Rivard C. Protected specimen brush or bronchoalveolar lavage to diagnose bacterial nosocomial pneumonia in ventilated adults: a meta-analysis. *Crit Care Med.* 1999 Nov;27(11):2548-60. doi: 10.1097/00003246-199911000-00037
4. Cupitt JM. Microbial contamination of gum elastic bougies. *Anaesthesia.* 2000 May;55(5):466-8. doi: 10.1046/j.1365-2044.2000.01329.x. PMID: 10792139.
5. Gorbach SL, Bartlett JG, Blacklow NR. Infectious Disease. 2nd ed., Philadelphia, W.B. Saunders, 1996;pp:1824-1837.
6. Millesimo M, de Intinis G, Chirillo MG, Musso T, Savoia D. Pseudomonas aeruginosa clinical isolates: serotypes, resistance phenotypes and plasmid profiles. *Eur J Epidemiol.* 1996 Apr;12(2):123-9. doi: 10.1007/BF00145496. PMID: 8817189.
7. Enright MC, Robinson DA, Randle G, Feil EJ, Grundmann H, Spratt BG. The evolutionary history of methicillin-resistant Staphylococcus aureus (MRSA). *Proc Natl Acad Sci U S A.* 2002 May 28;99(11):7687-92. doi: 10.1073/pnas.122108599. PMID: 12032344; PMCID: PMC124322.
8. Neely AN, Maley MP. Survival of enterococci and staphylococci on hospital fabrics and plastic. *J Clin Microbiol.* 2000 Feb;38(2):724-6. doi: 10.1128/JCM.38.2.724-726.2000. PMID: 10655374; PMCID: PMC86187.
9. Wilhelm S, Tommassen J, Jaeger KE. A novel lipolytic enzyme located in the outer membrane of Pseudomonas aeruginosa. *J Bacteriol.* 1999 Nov;181(22):6977-86. doi: 10.1128/JB.181.22.6977-6986.1999. PMID: 10559163; PMCID: PMC94172.
10. El–Sayed SB, Nasr RA, Shaheen MA. Risk of colonization of methicillin resistante Staphylococcus aureus (MRSA) and vaconymycin-resistant Enterococci (VRE) in patients admitted to pediatric intensive care unit of Ain Shams University hospital. *J Egypt Med Lab Sci.* 2005;14(2):1-10.
11. Looney WJ. Small-colony variants of Staphylococcus aureus. *Br J Biomed Sci.* 2000;57(4):317-22. PMID: 11204864.
12. Johnson AG, Ziegler RJ, Lukasewycz OA, Hawley LB. Board Review Series Microbiology and immunology. 4th ed., Lippincott Williams and Wikins, Walters Kluwer Com., USA. 2002;pp: 88.
13. Holt JG, Krieg NR, Sneath PH, Staley JT, William ST. Broad of trustees of Berg's manual of determinative bacteriology. 9th ed. Williams and Wilkins publication Baltimor, USA. 1994;pp:42-43.
14. Mac Faddin JF. Biochemical Tests for Identification of Medial Bacteria. 3rd ed., Lippincott Williams and Wikins, Walters Kluwer Com., London. 2000; pp:484-485, 58,106-110.
15. Al-Nasiri IK. Study the spread of methicillin resistant Staphylococcus aureus (MRSA) in labour room in Baghdad and its resistance to antibiotic. M.Sc. Thesis. College of Science. Al-Mustansiriah University. 2004.
16. Al-Saadi KA. The Selective Pressure Effect of Antiseptics on the Patterns of Resistance in Staphylococcus aureus. Journal of Kerbala University, 2001;9(4):299-304. https://www.iasj.net/iasj/article/18944
17. Carvalho KS, Melo MC, Melo GB, Gontijo-Filho PP. Hospital surface contamination in wards occupied by patients infected with MRSA or MSSA in a Brazilian university hospital. *Rev Ciênc Farm Básica Apl.* 2007;28(2): 159-163. https://rcfba.fcfar.unesp.br/index.php/ojs/article/view/518/516
18. Al-Khafaji ZA. The Contamination of Wards and Operating Rooms of Al- Hussein General Hospital in Karbala City by Methicillin Resistant Staphylococcus aureus (MRSA). Journal of Kerbala university, 2012;10(1):162-168. https://iraqjournals.com/article_60605_0.html
19. Lemmen SW, Häfner H, Zolldann D, Stanzel S, Lütticken R. Distribution of multi-resistant Gram-negative versus Gram-positive bacteria in the hospital inanimate environment. *J Hosp Infect.* 2004 Mar;56(3):191-7. doi: 10.1016/j.jhin.2003.12.004. PMID: 15003666.
20. Duckworth GJ, Jordens JZ. Adherence and survival properties of an epidemic methicillin-resistant strain of Staphylococcus aureus compared with those of methicillin-sensitive strains. *J Med Microbiol.* 1990 Jul;32(3):195-200. doi: 10.1099/00222615-32-3-195. PMID: 2374157.