Archives of Razi Institute, Vol. 76, No. 6 (2021) 1671-1676

DOI: 10.22092/ari.2021.356365.1831

Original Article

Study of Bacterial Contamination in Operating Theatres at Al-Hussein Teaching Hospital in Al-Samawah, Iraq

Mutib, H. H[1*], Oleiwi, S. R[2], Majeed Hameed, D[1], Suhail Hussein, S[3]

1. University of Al-Muthanna, College of Nursing, Samawah, Iraq
2. Al-Safwa University College, Nursing Department, Karbala, Iraq
3. Al-Muthanna Governorate Health Department, Samawah, Iraq

Received 3 October 2021; Accepted 25 October 2021
Corresponding Author: haider.mutaab@mu.edu.iq

Abstract

The continuing bacterial contamination in hospitals operating units and theaters has an important role in the spread of hospital infections. The current study evaluated the level of bacterial contamination in the operating theatres at Al-Hussein Teaching Hospital in Al-Samawah, Iraq. For the purpose of sample collection from surgical equipment surfaces, the swab plate method conducted by nurses and laboratory workers was used to collect the samples in the operating theater. The samples were then transferred to the laboratory unit for diagnosis by standard methods. The present study found different rates among operating theatres. According to bacterial contamination rate, especially for the operating theatre in emergency wings with 334 contaminated isolates, the highest rates of contaminated bacterial isolates were *Staphylococcus epidermidis* (n=171; 26.1%), *Bacillus* species (spp.) (n=118; 18%), *S. aureus* (n=111; 16.9%), *Klebsiella* spp. (n=92; 14%), *Enterobacter spp*. (n=82; 12.5%), *P.aurogenosa* (n=24; 3.7%), and *Escherichia coli* (n=23; 3.7%). Despite the use of all methods of sterilization among the hospital wards, especially the surgical halls in the hospital wards, bacterial contamination is still widespread among these units. It was noted that the bacteria isolated in this study posed a risk as pathogenic bacteria.

Keywords: Antibiotic resistance, Bacterial contamination, Operating theatres

1. Introduction

Bacterial contamination from operating theatres has a clear and tangible effect on the spread of infection in hospitals, especially hospital-acquired infections (1, 2). Bacterial contamination in operating theatres would be considered one of the most life-threatening sources of nosocomial infection for patients. Nosocomial infection occurred especially in heart and transplant surgeries, cystoscopy, transurethral resection of prostate, as well as bladder tumors. Several responsible reservoirs for hospital contamination have been reported, particularly for the operating theatre bacterial contaminations that include unfiltered air, ventilation systems, antiseptic solutions, and cold surgical device. Operating theaters are an integral part of healthcare around the world; however, surgeries are also associated with a high risk of complications and death from contamination (3, 4). In previously published studies, it was shown that most hospital-acquired infections were pathogenic bacteria resistant to many drugs, such as *Pseudomonas* species (spp.) and *Staphylococcus aureus* (5, 6). Many studies indicate that the bacteria involved in contaminating operating theaters are *Enterobacter spp.* (about 8.5%) (7, 8), *Escherichia coli* (about 4.0%), and *S. epidermidis* (about 8.3%) (9). Therefore, the current study aimed to investigate the percentages and types of bacterial contaminations involved in the operating

theatres of Al-Hussein Teaching Hospital, Iraq; moreover, it was attempted to provide a contamination model in the operating theatres of the government hospitals across Iraq.

2. Materials and Methods

2.1. Study Design

A laboratory investigation-based cross-sectional study was carried out at the operating theatres of Al-Hussein Hospital in Al-Samawah, Iraq, during 2020. Al-Hussein Hospital is situated in the center of Al-Samawah and provides in/outpatient care. There are five operating theatres in the hospital for surgical services (general, private wings, as well as gastroenterology, ophthalmology, and emergency wards).

2.2. Sample Collection

The sample swabs were obtained from the surgical instrument surfaces, such as gauze, probes, scissors, forcipes, blades, needles, and scrub practitioners. Moreover, other samples were collected from floors, walls, sinks, door handles, water taps, trolleys, and arms using swabs with and without charcoal media for the transport of facultative anaerobic and aerobic microorganisms. Individually packaged swabs (BD Culture Swab MaxV+) were used to collect samples by the laboratory staff and transported to the microbiology laboratory within 3 h of collection (10). The swabs were inoculated to sterile peptone water and then subjected to subculture to MacConkey agar, blood agar, nutrient agar, and thioglycolate broth. After an incubation period of 18-24 h at 37°C in aerobic and anaerobic conditions, the plates were investigated for visible growth. Subculture was conducted for Cloudy thioglycolate broth to MacConkey and blood agar and then incubated as described. The isolated bacteria were diagnosed by reference methodology (11-13) and an identification system using mass spectrometry for bacterial diagnosis technology (Vitek MS, BioMérieux). Surface samples were collected in the morning time after disinfection and before the beginning of operations.

2.3. Statically Analysis

Statistical analysis was carried out in IBM SPSS software (version 20.0), and categorical variables were expressed as frequency and percentage (%).

3. Results and Discussion

A total of 656 isolates of contaminated bacteria (both Gram-positive and negative) were recovered from different surfaces of surgical stuff and equipment in five surgical operating theatres of Al-Hussein Teaching Hospital during one year (2020). Table 1 tabulates that *Pseudomonas aeruginosa* isolates were roughly equal in terms of isolation percentages in most of the five operating theatres, while it was noticed that Gram-positive isolates (*S. aureus*) had a high different percentages among operating theatres, especially operating theatre 1 (general operating theatre with 75 contaminated isolates).

The surgical operating theatre of emergency wards (Oper 5) achieved a high contamination rate with *Enterobacter spp.*, *Bacillus spp.*, *Klebsiella spp*., and *S. epidermidis*, compared to the rest of operating theatres for contaminated bacterial isolates. According to this table, isolation percentages are very low with regard to *S. pneumoniae*, *S. epidermidis*, *Enterococcus faecalis*, *S. thoraltensis*, *Acinetobacter spp.*, *Citrobacter spp*., and general *Streptococcus spp*. isolates (Figure 1).

In Iraq, various studies have found different percentages of contaminated bacteria (Gram-positive and negative). According to a study conducted in Al-Yarmouk Teaching Hospital in Baghdad, Iraq, the contaminated bacterial isolates within three years included *P. aurogenosa* (n=195; 35.8%), (n=137; 43.4%), and (n=48; 53.3%), followed by *E. coli* (n=141; 25.9%), (n=115; 30.0%), and (n=28; 39.8%), respectively (14).

Another study was conducted in two operating theaters at the main units of Abubakar Tafawa Balewa University Teaching Hospital, Bauchi Nigeria, in 2015. The results explained that the isolation rates of *Staphylococci* (n=33; 38.8%) and *S. aureus* (n=24; 28.2%) predominated in both units, followed by *Bacillus spp.* (n=8; 9.4%),

Klebsiella pneumonia (n=4; 4.7%), *Acinetobacter spp.* (n=1; 1.2%), *Enterobacter spp.* (n=1; 1.2%), and *Enterococcus spp*. (n=4; 4.7%) (15).

The present study showed that emergency operating theatres had a high number of both Gram-positive and negative contaminated isolates (n=334), followed by general operating theatre with frequent contaminated isolates (n=134), and the private operating theatre (n=74) with frequent contaminated isolates. The rest of the operating theatres (gastroenterology and ophthalmology) had 63 and 55 bacterial isolates, respectively (Figure 2).

Table 1. Distribution of positive bacteria isolates in each operating theatre of Al-Hussein Teaching Hospital, Al-Samawah, Iraq

Operating theatres	Oper 1		Oper 2		Oper 3		Oper 4		Oper 5		
No. examinations	420		420		420		420		420		
	No.	%	No.	%	No.	%	No.	%	No.	%	Total
Negative isolates	290	69	346	82.4	365	86.9	357	85	86	20.5	1444
P. aeruginosa	6	1.4	4	0.95	3	0.7	5	1.2	6	1.4	24 (3.7%)
S. aureus	75	18	13	3.1	5	1.2	12	2.9	6	1.4	111(16.9%)
E. coli	2	0.5	8	1.9	3	0.7	4	0.95	6	1.4	23 (3.5%)
Enterobacter spp.	4	0.95	5	1.2	2	0.5	2	0.5	69	16.4	82 (12.5%)
Bacillus spp.	8	1.9	10	2.4	12	2.85	9	2.1	79	18.8	118 (18%)
Klebsiella spp.	7	1.7	3	0.7	3	0.7	1	0.2	78	18.6	92(14%)
S. epidermidis	28	6.7	21	5.0	19	4.5	26	6.2	86	20.5	180(27.4%)
S. pneumonia	0	0	2	0.5	0	0	0	0	1	0.2	3 (0.2%)
Enterococcus faecalis	0	0	1	0.2	0	0	0	0	2	0.5	3 (0.2%)
S. thoraltensis	0	0	1	0.2	0	0	2	0.5	0	0	3 (0.2%)
Acinetobacter spp.	0	0	2	0.5	3	0.7	0	0	0	0	5(0.76%)
Citrobacter spp.	0	0	1	0.2	0	0	2	0.5	0	0	3 (0.2%)
Streptococcus spp.	0	0	3	0.7	5	1.2	0	0	1	0.2	9 (1.4%)
Total positive isolates	130	31.1	74	17.6	55	13.1	63	15.1	334	79.4	656/2100

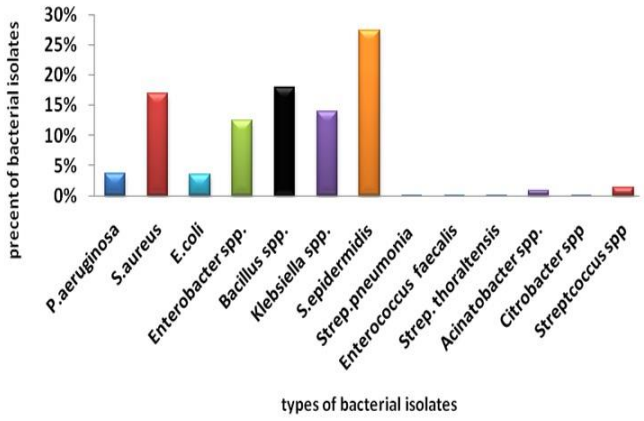

Figure 1. Percentages of positive bacteria isolates in operating theatres

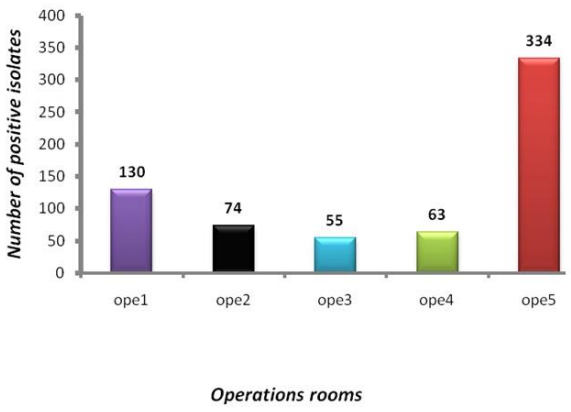

Figure 2. Total positive bacteria isolates according to operating theatres

The bacterial contamination in the operating theatres (surgical item/equipment) is still a high impact factor and a major contributor to the increase of infections at the site of the operating unit and during the surgery process. The concomitant negative effects include prolonged hospitalization, as well as an increase in medical cost, and even difficulty of managing the patients' care that lead to the elevation of morbidity and mortality rate (16-18).

Bacterial contamination of equipment and inanimate items (projector, operating couch, anesthesia machine, floor, wall, suction machine, gauze, surgical instrument, and iodine), showed high contamination rates of *Bacillus spp.* (n=21; 28%) and *S. epidermidis* (n=19, 25.3%) isolates from operating floors, while in the operating couch, it was estimated at 14.7% (n=48). All operating theaters were contaminated by *S. epidermidis* (n=19; 39.5%) and *S. aureus* (n=10; 20.3%). Moreover, the contamination percentages of projectors, anesthesia machines, walls, and suction machines were 12.6% (n=41), 18.7% (n=61), 10.1% (n=33), and 14.1% (n=46), respectively (Figure 3). The most contaminated isolates were *S. aureus* and *S. epidermidis*, while few pathogens were recovered from gauze, surgical instruments, and iodine.

Similar studies have reported different contamination rates of *Pseudomonas spp*. (23.9%) and *Bacillus spp.* (17.5%) from floors (7), and 1.8% for iodine contamination (19).

The antibiotic resistance style exhibited a relatively high resistance for some antibiotics, especially *P. aeruginosa* that resist Nafcillin and Gentamicin (100%). Similarly, *E. coli* was resistant to Claforan and Ceftazidime (100%). The other isolates exhibited different resistance to other antibiotics (Table 2). Such operating theatres, in which bacteria were isolated, must apply disinfecting methods. The nurses and laboratory workers should accomplish the requirement for a high level of hygiene that leads to reducing more bacterial contaminations. Similar results were obtained from a previously conducted study (20). Despite the use of all methods of sterilization among the hospital wards, especially the surgical halls in the hospital wards, bacterial contamination is still widespread among these units. It was noted that the bacteria isolated in this study posed a risk as pathogenic bacteria that can be reduced by developing the disinfection and cleaning methods periodically.

Table 2. Antibiotic resistance pattern of bacterial isolates of the present study

Antibiotic/bacteria	*P. aeruginosa* No. (27)	*S. aureus* No.(58)	*E. coli* No. (18)	*Enterobacter spp.* No. (14)	*Bacillus spp.* No. (66)	*Klebsiella spp.* No. (10)	*S. epidermidis* No. (114)
	R%	R%	R%	R%	R%	R%	R%
Nafcillin	100	100	16.6	35.7	100	40	50
Nalidixic acid	37	60.3	50	42.9	33.3	50	69.3
Colistin	74	34.5	88.9	57	37.9	80	50
Claforan	85.1	60.3	100	100	27.3	70	55.3
Amoxicillin	29.2	100	50	50	22.7	40	18.4
Ceftazidime	92.5	86.2	100	50	60.6	100	18.4
Coftriaxone	22.2	32.8	33.3	35.7	18.2	20	8.7
Chloramphenicol	55.6	55.2	77.8	50	37.9	50	29
Amikacin	74	60.3	88.9	78.5	33.3	40	22.2
Gentamicin	100	89.6	50	64.2	45.5	70	22.8
Trimethoprim	59.2	68.9	55.5	50	22.7	20	20.1
Tobramycin	48.1	68.9	50	35.7	15.1	50	17.5

R=Resistance, No.=number

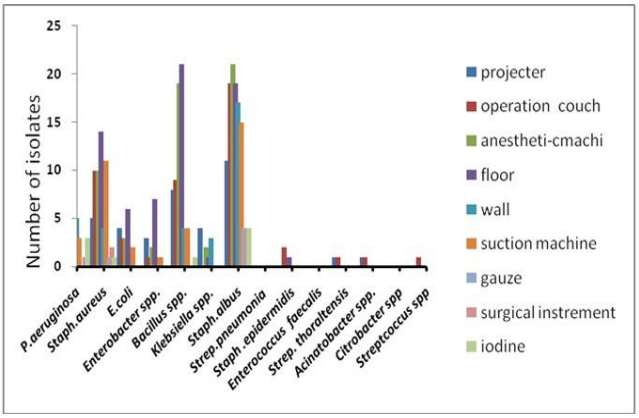

Figure 3. Distribution of bacterial isolates according to operating theater equipment and furniture

Authors' Contribution

Study concept and design: H. H. M.
Acquisition of data: S. R. O.
Analysis and interpretation of data: D. M. H.
Drafting of the manuscript: S. S. H.
Critical revision of the manuscript for important intellectual content: H. H. M.
Statistical analysis: S. R. O.
Administrative, technical, and material support: H. H. M.

Ethics

The present study was approved by the Ethics Committee of the University of Al-Muthanna, College of Nursing, Samawah, Iraq.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

1. Alfa MJ, Lo E, Olson N, MacRae M, Buelow-Smith L. Use of a daily disinfectant cleaner instead of a daily cleaner reduced hospital-acquired infection rates. Am J Infect Control. 2015;43(2):141-6.
2. Dancer SJ. Controlling hospital-acquired infection: focus on the role of the environment and new technologies for decontamination. Clin Microbiol Rev. 2014;27(4):665-90.
3. McHugh S, Hill A, Humphreys H. Laminar airflow and the prevention of surgical site infection. More harm than good? Surgeon. 2015;13(1):52-8.
4. Spagnolo A, Ottria G, Amicizia D, Perdelli F, Cristina ML. Operating theatre quality and prevention of surgical site infections. J Prev Med Hyg. 2013;54(3):131.
5. Akhtar N. Hospital acquired infections in a medical intensive care unit. J Coll Physicians Surg Pak. 2010;20(6):386-90.
6. Tesfaye T, Berhe Y, Gebreselassie K. Microbial contamination of operating Theatre at Ayder Referral Hospital, Northern Ethiopia. Int J Pharm Sci Res. 2015;6(10).
7. Matinyi S, Enoch M, Akia D, Byaruhanga V, Masereka E, Ekeu I, et al. Contamination of microbial pathogens and their antimicrobial pattern in operating theatres of peri-urban eastern Uganda: a cross-sectional study. BMC Infect Dis. 2018;18(1):1-9.
8. Merdaw MA, Abdul-kareem J. Microbial contamination in the operating theatres in Iraq. 2019.
9. Ensayef S, Al Shalchi S, Sabbar M. Microbial contamination in the operating theatre: a study in a hospital in Baghdad. E Mediterr Health J. 2009;15(1):219-223.
10. Coughtrie A, Whittaker R, Begum N, Anderson R, Tuck A, Faust S, et al. Evaluation of swabbing methods for estimating the prevalence of bacterial carriage in the upper respiratory tract: a cross sectional study. BMJ open. 2014;4(10):005341.
11. Becker K, Skov RL, von Eiff C. Staphylococcus, Micrococcus, and other catalase-positive cocci. Manual Clin Microbiol. 2015:354-82.
12. Logan NA, Hoffmaster AR, Shadomy SV, Stauffer KE. Bacillus and other aerobic endospore-forming bacteria. Manual of Clinical Microbiology, 10th Edition: American Society of Microbiology; 2011. p. 381-402.
13. Wauters G, Vaneechoutte M. Approaches to the identification of aerobic Gram-negative bacteria. Manual Clin Microbiol. 2015:613-34.
14. Hayyawi AH, AL-Rawi SK, Assi MS, Mohammed AM, Al-Mulimawi RM, Fouad YA, et al. Survey of the Bacterial Contamination in the Environment of the Operating Theaters over Two Years' Time in a Multi-specialty AL-Yarmouk Teaching Hospital in Baghdad/Iraq. Public Health. 2015;22(7):211.
15. Mohammed A ea. Bacterial contamination of operation theatres at a tertiary hospital in Bauchi, northern

Nigeria. Eur J Pharm Med Res. 2017;4(4):182-8.
16. Kownhar H, Shankar EM, Vignesh R, Sekar R, Velu V, Rao UA. High isolation rate of Staphylococcus aureus from surgical site infections in an Indian hospital. J Antimicrob Chemother. 2008;61(3):758-60.
17. Organization WH. World Alliance for Patient Safety. WHO guidelines for safe surgery. 2008.
18. System NNIS. National Nosocomial Infections Surveillance (NNIS) system report, data summary from January 1992 through June 2004, issued October 2004. Am J Infect Control. 2004;32:470-85.
19. Danchaivijitr S, Dhiraputra C, Rongrungruang Y, Srihapol N, Pumsuwan V. Microbial contamination of antiseptics and disinfectants. J Med Assoc Thai. 2005;88(10):S133-9.
20. Okon K, Osundi S, Dibal J, Ngbale T, Bello M, Akuhwa R, et al. Bacterial contamination of operating theatre and other specialized care unit in a tertiary hospital in Northeastern Nigeria. Afr J Microbiol Res. 2012;6(13):3092-6.