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# Epidemiological Study of Bacterial Contamination in Operation Rooms at Al-Nasiriyah City, Iraq

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**Abstract**

Bacterial contamination in operating rooms is a critical element in the transmission of illnesses within hospitals, especially hospital-acquired infections. It is regarded as one of the most severe and life-threatening sources of nosocomial infections. This study examined the diagnostic outcomes of 1,832 bacterial culture swabs obtained from the Bacterial Contamination Unit at Al-Nasiriya Teaching Hospital. The collection comprised specimens collected from ten operating theaters from October 2023 till January 2024, facilitating a thorough evaluation of microbial prevalence across diverse surgical departments. The findings indicated that the predominant contamination occurred in general surgery and orthopedic surgery rooms, with Escherichia coli (E. coli) at 40.9%, followed by Enterobacter spp. at 29.5% and Staphylococcus aureus at 23.9%. The least prevalent pathogen was Klebsiella spp (1.2%). The current study underscores the significance of infection control systems in preventing the cross-transmission of nosocomial infections, which can lead to contamination and infection in critically sick patients.

**Key words: Bacteria, Contamination, Operation rooms**

**الملخص**

يعد التلوث البكتيري في غرف العمليات عاملاً حاسماً في انتقال الأمراض داخل المستشفيات، لا سيما العدوى المكتسبة داخلها. ويُعتبر من أخطر مصادر العدوى المكتسبة في المستشفيات وأكثرها تهديداً للحياة. فحصت هذه الدراسة نتائج التشخيص لـ (1832) مسحة بكتيرية مأخوذة من وحدة مكافحة التلوث البكتيري في مستشفى الناصرية التعليمي. شملت الدراسة عينات جُمعت من عشر غرف عمليات خلال الفترة من أكتوبر 2023 إلى يناير 2024، مما أتاح تقييماً شاملاً لانتشار الميكروبات في مختلف الأقسام الجراحية. أشارت النتائج إلى أن التلوث السائد كان في غرف الجراحة العامة وجراحة العظام، حيث بلغت نسبة الإشريكية القولونية (**E. coli**) 40.9%، تليها أنواع البكتيريا المعوية (**Enterobacter spp**.) بنسبة 29.5%، ثم المكورات العنقودية الذهبية (**Staphylococcus aureus**) بنسبة 23.9%. أما أقل مسببات الأمراض انتشاراً فكانت أنواع الكليبسيلا (**Klebsiella spp**.) بنسبة 1.2%. تؤكد الدراسة الحالية على أهمية أنظمة مكافحة العدوى في منع انتقال العدوى المكتسبة في المستشفيات، والتي يمكن أن تؤدي إلى التلوث والعدوى لدى المرضى المصابين بأمراض خطيرة..

**الكلمات المفتاحية :** البكتيريا، التلوث، غرف العمليات.

## Introduction

Because of the hospital environment's microbial pollution, the number of nosocomial infections (NIs) has been steadily increasing. However, one of the most frequent and dangerous causes of NIs is operating room contamination (OR) (1). ORs, also known as surgical theatres, are the heart of surgical procedures, a unit within a hospital. They are designed to provide the patient with a sterile and infection-free environment. However, there is a risk of exposure to infectious agents, such as

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*Staphylococcus aureus* (including MRSA), *Pseudomonas aeruginosa*, and *Streptococcus* spp. (2). They affect the superficial skin, but in cases of severe infection, they lead the infection to deeper tissues, and the organs or contents (muscle layer, fascia, soft tissues, and blood vessels) that are exposed during the surgical procedure increase the risk of infection, eventually resulting in surgical site infection (SSI). There may be several postoperative complications, such as a delay in the healing of the wound or opening of the wound completely or partially due to SSI. To reduce contamination of pathogens, we practice preventive strategies with their advancements, like the practice of double gloving, which is used to reduce the risk of needle stick and other sharp injury traumas. Control of contamination in airflow systems can be done using vertical laminar flow with high efficiency particulate air (HEPA) filters, which remove 0.3 mm particles with an efficiency of 99.9%. Heating, ventilation, and air conditioning (HVAC), which controls the temperature, relative humidity, and air current (3).

Up to one-third of patients undergoing surgery may develop SSIs, which are the second most common healthcare-associated illness (HAI) in low- and middle-income nations, according to recent research by the World Health Organization (WHO). SSIs are still the second most common kind of HAI in both Europe and the USA, despite having a decreased prevalence in high-income nations (4,5).

Several sources of contamination have been reported as responsible for hospital contamination, particularly bacterial contamination in OR, which includes unfiltered air, ventilation systems, disinfectant solutions, and cold surgical devices (6,7,8). Although operating rooms are an essential component of healthcare worldwide, there is a significant danger of problems and even death from contamination during surgery (9).

The most common HAIs are catheter-associated urinary tract infections (CAUTI), SSI, central line-associated bloodstream infections (CLABSI), ventilator-associated pneumonia, and *Clostridioides difficile* infections (CDI). Various studies show that the most common microorganisms involved in such cases are MRSA, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Escherichia coli (E. coli*), and *Enterobacter* spp (10, 11, 12). Contamination by microorganisms can be minimized by Increased efforts are needed to reduce the rate of HAI and SSI in the ORs and creating protocols that define criteria related to the work process, allowing for systematic and frequent analysis of infection prevention and control practices in ORs (13,14).

## Methods

### Study Design

A cross-sectional study was conducted to identifying the bacterial contamination occurring at the operating theaters in Al-Nasiriyah Teaching Hospital during the period from October 2023 till January 2024.

### Samples Collection

The data gathering strategy entailed obtaining records for 1,832 bacterial culture swabs during the year 2023. Specimens were collected monthly from the Bacterial Contamination Unit at Al-Nasiriya Teaching Hospital, specifically from five operating theaters catering to the General, Laparoscopic (Nador), Neurosurgery, Vascular, and Urology departments. All samples were formally diagnosed and identified by the hospital's Bacterial Contamination Unit before data collecting, ensuring that the isolates were verified according to the unit's standardized diagnostic standards for subsequent statistical analysis.

### Data Analysis

Statistical analysis was carried out in SPSS software (version 26), based in using Chi-square

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at *p*. value ≤0.05 and categorical variables were expressed as frequency and percentage (%).

**Results**

**Distribution of swabs according to the study period**

Table (1) showed that the majority of swabs were taken during the 2023 in February and October with 16.10% and 12.55%, respectively (*p>0*.05). No swabs were taken in July and August.

**Table (1): Swabs Classification According to the study period.**

| Month | Swab | |
|---|---|---|
| | No. | % |
| January | 159 | 8.68 |
| February | 295 | 16.10 |
| March | 70 | 3.82 |
| April | 144 | 7.86 |
| May | 144 | 7.86 |
| Jun | 144 | 7.86 |
| July | 0 | 0.00 |
| August | 0 | 0.00 |
| September | 72 | 3.93 |
| October | 230 | 12.55 |
| November | 177 | 9.66 |
| December | 177 | 9.66 |
| **Total** | 1832 | 100 |
| **Cal. $\chi^2$= 13.3 Tab. $\chi^2$ = 19.68 DF= 11 *p*. value 0.148$^{non\text{-}sig}$** | | |

**Distribution of swabs according to the Operation Rooms**

Table (2) represented number of swabs taken from each operation rooms included in the present study. The results revealed that highest percentages (20.36% and 10.21%) of swabs were taken from operation room 6 (Cardiothoracic Surgery), and 10 swabs (10.21%) in (urological surgery room). On the other hand, the lowest swabs percentage was noticed in (Orthopedic Surgery Room 8**)** with (8.34%) only (*p>0*.05).

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**Table (2): Swabs Percentages According to the Operation Rooms.**

| Operating room | Swab | |
|---|---|---|
| | No. | % |
| General Surgery Room1 | 156 | 8.52 |
| General Surgery Room 2 | 162 | 8.84 |
| Laparoscopic Surgery Room 3 | 161 | 8.79 |
| Laparoscopic Surgery Room 4 | 162 | 8.84 |
| Neurosurgery Room 5 | 163 | 8.90 |
| Cardiothoracic Surgery Room 6 | 373 | 20.36 |
| Orthopedic Surgery Room 7 | 154 | 8.41 |
| Orthopedic Surgery Room 8 | 153 | 8.35 |
| Urological Surgery Room 9 | 161 | 8.79 |
| Urological Surgery Room 10 | 187 | 10.21 |
| **Total** | 1832 | 100 |
| **Cal. $\chi^2$= 11.4 Tab. $\chi^2$ = 16.92 DF= 9 *p*. value 0.249$^{non\text{-}sig}$** | | |

**Distribution of Contaminated swabs according to the study period**

The present study results revealed, with a high significant difference, that the highest percent of contaminated swabs were found during October, April and May with 28.41%, 21.59% and 20.45%, respectively (Table 3).

**Table (3): Contaminated Swabs Percentages According to the study period.**

| Month | Number of total swabs | Number of contaminated swabs | % |
|---|---|---|---|
| January | 159 | 4 | 4.54 |
| February | 295 | 7 | 7.94 |
| March | 70 | 0 | 0.00 |
| April | 144 | 19 | 21.59 |
| May | 144 | 18 | 20.45 |
| Jun | 144 | 4 | 4.55 |
| Juley | 0 | 0 | 0.00 |
| August | 0 | 0 | 0.00 |
| September | 72 | 3 | 3.41 |
| October | 230 | 25 | 28.41 |
| November | 177 | 4 | 4.55 |
| December | 177 | 4 | 4.55 |
| **Total** | 1832 | 88 | 100 |
| **Cal. $\chi^2$= 37.0 Tab. $\chi^2$ = 15.51 DF= 8 *p*. value <0.001$^{sig}$** | | | |

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**Distribution of Contaminated swabs according to the Operating Rooms**

As illustrated in table (4), the highest percent of contaminated swabs were found in operation room 7 (orthopedic surgery room) with (18.18%). On the other hand, the lowest percentages were noticed in Laparoscopic Surgery Room 3 and Cardiothoracic Surgery Room 6 with a percentage of 5.68% for both ($p>0.05$).

**Table (4): Contaminated Swabs Percentages According to the Operation Rooms.**

| Operating rooms | Number of total swabs | Number of contaminated swabs | % |
|---|---|---|---|
| General Surgery Room1 | 156 | 12 | 13.64 |
| General Surgery Room 2 | 162 | 12 | 13.64 |
| Laparoscopic Surgery Room 3 | 161 | 5 | 5.68 |
| Laparoscopic Surgery Room 4 | 162 | 6 | 6.82 |
| Neurosurgery Room 5 | 163 | 8 | 9.09 |
| Cardiothoracic Surgery Room 6 | 373 | 5 | 5.68 |
| Orthopedic Surgery Room 7 | 154 | 16 | 18.18 |
| Orthopedic Surgery Room 8 | 153 | 8 | 9.09 |
| Urological Surgery Room 9 | 161 | 6 | 6.82 |
| Urological Surgery Room 10 | 187 | 10 | 11.36 |
| **Total** | 1832 | 88 | 100 |
| **Cal. $\chi^2$= 11.4 Tab. $\chi^2$ = 16.92 DF= 9 p. value 0.245$^{non\text{-}sig}$** | | | |

**Distribution of bacterial species according to the Operating Rooms**

Table (5) showed that most isolated bacterial species was *E. coli* in in operation room 7 from total contaminated swabs (40.9%), followed by *Enterobacter* (29.5%) and *Staphylococcus aureus* (23.9%), while lower contaminated pathogen was *Klebsiella* (1.2%).

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Table (5): Classified Contaminated Swabs According to Operation Room were Taken and the Type of Growth.

| Operating rooms | Number of contaminated swabs | *Staphylococcus* | *E. coli* | *Enterobacter* | *Pseudomonas* | *Klebsiella* |
|---|---|---|---|---|---|---|
| General Surgery Room1 | 12 | 5 | 4 | 2 | 1 | 0 |
| General Surgery Room 2 | 12 | 3 | 6 | 2 | 1 | 0 |
| Laparoscopic Surgery Room 3 | 5 | 0 | 4 | 1 | 0 | 0 |
| Laparoscopic Surgery Room 4 | 6 | 1 | 3 | 2 | 0 | 0 |
| Neurosurgery Room 5 | 8 | 4 | 1 | 3 | 0 | 0 |
| Cardiothoracic Surgery Room 6 | 5 | 2 | 1 | 1 | 0 | 1 |
| Orthopedic Surgery Room 7 | 16 | 4 | 7 | 3 | 2 | 0 |
| Orthopedic Surgery Room 8 | 8 | 0 | 6 | 2 | 0 | 0 |
| Urological Surgery Room 9 | 6 | 1 | 1 | 4 | 0 | 0 |
| Urological Surgery Room 10 | 10 | 1 | 3 | 6 | 0 | 0 |
| **Total** | 88 | 21 | 36 | 26 | 4 | 1 |
| **%** | ** | 23.9 | 40.9 | 29.5 | 4.5 | 1.2 |
| | **Cal. $\chi^2$= 46.8** | **Tab. $\chi^{22}$ = 50.97** | **DF= 36** | **p. value 0.107$^{non\text{-}sig}$** | | |

**Discussion**

Microbial contamination in operating theaters is a continual problem that increases the incidence of surgical site infections (SSIs) (15). The environment harbors diverse microorganisms, including bacteria, fungi, and viruses (17, 18, 19). This study focused on detecting bacterial contamination in OR, the results of cultured swaps that taken from operating rooms showed the highest percentage of bacterial contamination records in February and October of the year 2023 at general surgery room 1,2 and orthopedic surgery room 7 in Al-Nasiriya Teaching Hospital.

The statistical analysis revealed a highly significant correlation between the month of sampling and the rate of bacterial contamination ($\chi 2$ = 15.51, DF= 8, p. value <0.001), with the highest prevalence recorded in October (28.41%), followed by April (21.59%) and May (20.45%). This seasonal peak in contamination levels can be attributed to several environmental and operational factors. These findings are in agreement with Mutib et al. (2022) and Merdaw, and Abdul-kareem (2018) who observed similar seasonal trends in bacterial prevalence within surgical settings in the Southern region of Iraq. In Southern Iraq, October and April are times of change when the weather is mild and the relative humidity is higher than in the very dry summer or very cold winter. These settings create the best environment for common surgical infections like Staphylococci and Gram-negative bacteria to live and grow. Research indicates that bacterial survival on inanimate surfaces markedly increases when humidity levels vary during these transitional months (20, 21).

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In addition, the rise in contamination during these months may also be linked to a rise in the number of elective procedures. During times of moderate weather, patients and surgical teams generally prefer to have their surgeries planned. The increase in theater occupancy, frequent door opening, and higher staff turnover all lead to more skin scales and respiratory droplets being shed. These are the main ways that bacteria settle on surfaces and equipment (22).

High levels of gram-negative bacterial contamination were found in inanimate objects and equipment, including operating couches, anesthetic machines, floors, walls, suction machines, and surgical instruments. E. coli (40.9%) the main contaminated bacteria that isolated from all surgical rooms with different percentages, especially in orthopedic surgery room and general surgery rooms. In this instance, the source of contamination is typically exogenous from surgical personnel and inanimate objects, or endogenous from the patients' normal skin flora. This outcome is in line with research done in the operating rooms of the Al Sader Teaching Hospital in Babylon, Iraq (23) and at the medium-complexity surgical center of a philanthropic hospital in the eastern part of the State of Mato Grosso do Sul, in the municipality of Três Lagoas. There was a greater prevalence of E. coli. (24). And inconsistent with the study conducted in Erbil which reported that E. coli constituted 19% of the bacterial isolates (25) and other study conducted by Meskani N et al., that have reported E. coli not appearing among the top isolates (26).

Enterobacter spp. was the second most common isolate with high percentage in urological surgery room. This bacterium is an opportunistic pathogen that has a combination of features such as the ability to survive and spread in hospital environments, multiple virulence factors and the resistance to commonly used antibiotics (27, 28). The Gram-positive bacteria (S. aureus) also have a greater propensity to cause contamination in the operating rooms. This finding aligns with multiple studies that have documented elevated levels of S. aureus in the ORs, such as a study conducted at a hospital in Northen Nigeria (27), and a study in Shendi City, Sudan (29).

These data are supported in a study by Mutib et al., that revealed a high contamination rate with Enterobacter spp (21). Furthermore, another study showed that the anesthesia work area and the intravenous stopcock are contaminated with potentially harmful, multi-drug-resistant bacteria, including S. aureus and vancomycin-resistant enterococci (VRE), during the administration of general anesthesia. Increased nosocomial infection rates and a marked rise in surgical mortality were linked to this contamination (30). The lower contaminated pathogens were pseudomonas and Klebsiella. These findings contradict with a study conducted by Alramli. et al., that revealed a high percentage of Klebsiella and Pseudomonas in the ORs at Benghazi Medical Center (31).

**Conclusions**

The prevalence of bacterial contamination in the operating room at Al-Nasiriyah City is found to be low, and the most commonly isolated contaminated pathogens were E. coli, Enterobacter, and S. aureus. Assessing the rate of infection control and prevention standards compliance by the hospital's healthcare staff may be made easier by the adherence to the environmental and cleanliness audit system. In order to lower microbial contamination and the possibility of NIs transmission in this hospital, it is necessary to enhance and strictly adhere to conventional precautions.

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