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Original article

Environmental Contamination and Antimicrobial Resistance Patterns in Hemodialysis Units at Tripoli University Hospital

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Abstract
Continuing care Patients receiving hemodialysis for end-stage renal failure have increased risks of bloodstream-associated infections because of their weakened immune systems and the use of catheters to control their blood flow. Staphylococcus species are a common cause of hemodialysis catheter-related bloodstream infections. This study aimed to identify the source of bacterial contamination of dialysis wards and contamination of hemodialysis equipment and their antimicrobial resistance patterns. Swabs were used for collecting all of the samples, which were then sent to the lab for microbiological testing. In this data, the hemodialysis device has fewer microorganisms than the surrounding environment of the patient. However, the majority of Staphylococcus species were detected on the hemodialysis beds (n=9), particularly on regions that healthcare staff often touched. The most common type of Staphylococcus species found was coagulase-negative Staphylococcus. Even more unexpectedly, methicillin resistance (MRSA) was found in the of Staphylococcus species ، followed by Bacillus spp, which were located in the dialysis area and staff room, where Bacillus subtilis (21%), Bacillus cereus (16%), while the least were Bacillus pumilus (6%) and Bacillus licheniformis (5%), additionally present Gram-negative rods were Klebsiella pneumonia (60%) and Escherichia coli (40%). This result implies that the related microorganisms in hemodialysis devices are substantially polluted. This study can be used to evaluate the risk of infection by contamination and to create a cleaning method that will help hemodialysis patients stay away from bloodstream infections.
Keywords. *Healthcare-Associated Infection, Hemodialysis Patients, Tripoli University Hospital.*

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Introduction

Healthcare-associated infections are a potential risk to patient safety and constitute a major cause of morbidity and mortality. contamination of environmental surfaces with various pathogens and the persistence of these pathogens on surfaces can be an important and frequent source of transmission of infectious agents through the frequent hand touching of HCWs (1). In dialysis units, infection is the first cause of hospitalization and the second most common cause of mortality among haemodialysis (HD) patients after cardiovascular disease. HD patients are exposed to different types of infections, which include bloodstream infections and localized infections of the vascular access (catheters and grafts), blood-borne infections with hepatitis B virus (HBV), hepatitis C virus (HCV), and/or human immunodeficiency virus (HIV), and airborne infections like tuberculosis. Sources of infections could be contaminated water, equipment, environmental surfaces in the treatment area, and patients with infections who pose a risk to other nearby patients being treated in the dialysis unit. The increased risk for contracting healthcare-associated infections (HAIs) among HD patients is mainly due to immune-compromised status, frequent and prolonged blood exposure during HD treatments through the vascular access and extracorporeal circuit, and frequent contact with healthcare workers who frequently move between patients and between machines (2).

Different studies have confirmed that transiently contaminated hands of the HCW are the main route of transmission of healthcare-associated infections (3). However, HCWs' mobile phones provide a reservoir for these potential pathogens. Despite the high possibility of being contaminated, mobile phones are rarely clean and are often touched during or after examination of patients and handling of specimens without proper hand washing. These mobile phones become exogenous sources of infection, not only for the patients but also a potential health hazard for workers as well as for family members (4). Nosocomial infections, also referred to as healthcare-associated infections (HAI), are infections acquired during the process of receiving health care that were not present during the time of admission. They may occur in different areas of healthcare delivery, such as in hospitals and long-term care facilities. HAI is the most common adverse event in health care that affects patient safety. They contribute to significant morbidity, mortality, and financial burden on patients, families, and healthcare systems. The emergence of multidrug-resistant organisms is another complication seen with HAI (5).

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Hospital-acquired infections appeared before the origin of hospitals and became a health problem during the miraculous antibiotic era. Due to these infections, not only the costs but also the use of antibiotics increased with an extended hospitalization. This resulted in elevated morbidity and mortality (6). Opportunistic bacterial infections occur when there is a breakdown of the host's immune system functions (7). Multidrug-resistant bacteria are commonly seen in HAI and are associated with significant mortality. One study found that approximately 20% of all reported pathogens show multidrug-resistant patterns (8). Common Gram-positive organisms include coagulase-negative Staphylococci, *Staphylococcus aureus*, *Streptococcus* species, and *Enterococcus* species (e.g., *faecalis, faecium*). Of all HAI-associated pathogens, *C.difficile* accounts for the most commonly reported pathogen in US hospitals (15%) of all infections with a reported pathogen). Common Gram-negative organisms include species of the *Enterobacteriaceae* family, including *Klebsiella pneumoniae* and *Klebsiella oxytoca*, *Escherichia coli*, *Proteus mirabilis*, and *Enterobacter* species, *Pseudomonas aeruginosa*, *Acinetobacter baumanii*, and *Burkholderia cepacian*. *Acinetobacter baumanii* is associated with high mortality within the intensive care setting owing to its inherent multidrug-resistant properties. Multidrug-resistant bacteria are commonly seen in HAI and are associated with significant mortality. One study found that approximately 20% of all reported pathogens show multidrug-resistant patterns. Notorious pathogens include methicillin-resistant *Staphylococcus aureus* (MRSA) (5).
Profound health care challenges confront societies with an increase in prevalence of end-stage renal disease (ESRD), which is one of the leading causes of morbidity and mortality throughout the world. These patients have frequent hospital visits and more extended hospital stays, which make them more vulnerable to nosocomial infections (9). The quality of life of hemodialysis patients is affected significantly; there is a change in lifestyle and habits that affects both themselves and their families. In addition, the physical health, personal relationships, and their social and economic status are greatly affected (10).
Infection is the most common cause of hospitalization and the second most common cause of mortality among hemodialysis (HD) patients, after cardiovascular disease. Sources of infections could be contaminated water, equipment and environmental surfaces in the treatment area and patients with infections who pose a risk to other nearby patients being treated in the dialysis unit (11). Previous studies suggested that the vascular access for hemodialysis is the major risk factor for bacteremia in patients with end-stage renal disease (12). Infection control protocols in dialysis units continue to be the most crucial step in preserving a healthy environment and preventing the spread of infection among immunocompromised patients (13). One of the most important methods for the evaluation of the disinfection policies is by detecting the load and the types of microorganisms that existed in the hospital environment by swabbing surfaces and equipment to perform environmental cultures. Aerobic colony count should be < 5 colony forming unit (cfu)/cm^2 on frequent hand touch environmental surfaces in hospitals (14).
Bacterial infection is among the most contributor microorganisms that responsible for 95% of infection in hospitals, in which the resistant bacterial species are the most prominent one (15). however, Multidrug-resistant organisms, including methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), and multidrug-resistant gram-negative bacteria, are a major public health threat, especially in the population of patients on maintenance hemodialysis (16). This study was conducted to determine the associated bacterial contamination in hemodialysis unit at Tripoli University Hospital, and to investigates the antimicrobial resistance patterns of isolated bacteria.

Methods

Sample collection

This study was conducted from December 2024 to February 2025. 150 Samples were collected aseptically with sterile swabs moistened with sterile normal saline and by rolling over the exposed surfaces. Swabs were taken from devices, equipment, staff phones, and nasal swabs from patients and health care workers also were taken, all specimen were collected under aseptic conditions by using PPE (personal protected equipment). followed by Questionnaires that were taken from both patients and staff. Ethical approval has been obtained from the Head of Training Department at Tripoli University Hospital. The Signed consent forms for this research study were received from all participants.

Sample inoculation

After collection, the samples were immediately transported to the Dallas laboratory and inoculated on 5% sheep blood agar, Mac-Conkey's agar, Chocolate agar, and sabouraud agar were incubated aerobically at 37°C for 24 hours. After incubation, plates were examined for growth and colonial morphology of the isolates. Gram-positive and Gram-negative bacteria were identified as per standard microbiological procedures.

Antibiotic susceptibility

Antibiotic sensitivity was tested using the Kirby-Bauer disc diffusion method on Mueller-Hinton agar according to CLSI antibiotic disc susceptibility testing guidelines (17). The antimicrobial agents tested were

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erythromycin (15µg), tetracycline (10µg), cefoxitin (30µg), ceftriaxone (30 µg), ciprofloxacin (5µg), Amoxicillin (30µg), Cefotaxime (30µg), and cefixime (10µg).

RESULT

In dialysis patients, females were more prevalent than males, and their ages ranged from 20 years to more than 60 years. Most of the patients have been receiving hemodialysis three times a week for more than two years. Based on the questionnaire, only 5% of patients had undergone bacterial culture testing. It was revealed that the majority of dialysis patients were unaware of their previous bacterial infection. The majority of HCWs had 4-6 years of experience in the dialysis department, indicating relatively experienced in their field.

Out of 150 swabs, (n=53) showed no bacterial growth, whereas (n=85) showed bacterial growth. These were separated into gram-positive (n=80), gram-negative (n=5), as well as some fungal isolates (n=12).

Table 1. Distribution of Result of culture among study population

Result of culture	Frequency	Percent
Bacterial Growth	85	57.0
No bacterial growth	53	35.0
Fungi	12	8.0

Among the 85 (57%) bacterial growth samples, coagulase-negative *staphylococcus* was the most common organism in the gram-positive group with 30 (38%), followed by *S.aureus* with 11 (14%), *B.subtilus* with 17 (21%), *B.Cereus* with 13 (16%), and *B.pumilus* with 5 (6%). while *B.licheniforms* was less common with 4 (5%), and only 5 (6%) of the isolates were gram-negative. However, *K.pneumoniae* 3(60%) was the most common organism, followed by *E.coli* 2 (40%), as shown in Table 2.

Table 2. Distribution of bacteria types of isolates

Gram-Positive Bacteria N=80 (94%)	Frequency	Gram-Negative Bacteria N=5 (6%)	Frequency
CoNS	30 (38%)	*K. Pneumoniae*	3 (60%)
S.aureus	11 (14%)	*E.coli*	2 (40%)
B.subtilis	17 (21%)	-	-
B.cereus	13 (16%)	-	-
B.licheniformis	4 (5%)	-	-
B.pumilus	5 (6%)	-	-

Among the Gram-negative bacterial isolates (n=5, 6% of total bacterial isolates), *K.pneumoniae* was the most frequently identified species, accounting for 60% of the isolates. *E.coli* made up the remaining 40% (Figure 1).

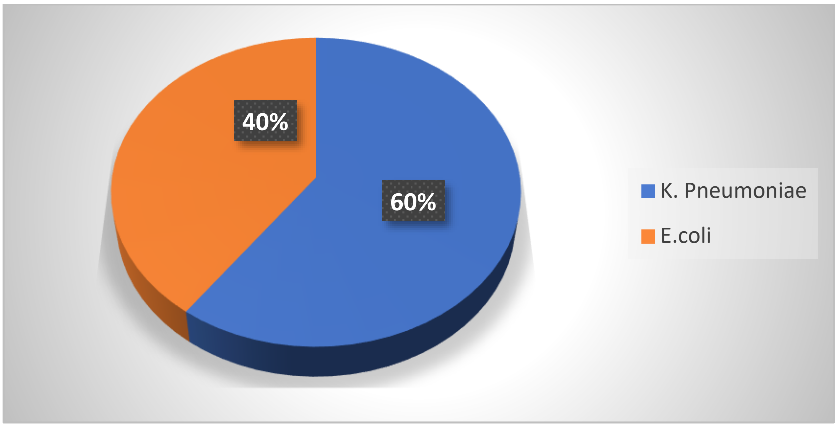

Figure 1. The frequency of Gram-negative bacteria

Table 3. Type of organism isolated from Nasal swabs of patients and employment

Source	Type of Organism
Nose	CoNS, *S.aureus*, *B.cereus*, Fungi

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Table 4. Types of Antimicrobial agent used for selected microorganisms:

Type of organism	AMC	CRO	CIP	E	TE	CTX	CFM	FOX
CoNS (n=11)	S(11) - -	S(10) R(1) -	S(10) R(1) -	S(3) R(8) -	S(6) R(5) -	S(11) - -	S(6) R(4) I(1)	S(11) - -
S.aureus	R	R	S	S	R	R	R	R
B.cereus	R	R	R	R	R	R	R	-

CoNS was the most frequently isolated organism from multiple sites. *S. aureus* was detected on phones, hands, and chairs, while *B.cereus* appeared on chairs and treatment fridges, afterwards antibiotic were use *S.aureus* displayed variable resistance, especially to Erythromycin (E), Cefixime(CFM) and Cefoxitin(FOX). *E.coli* and *K. pneumoniae* showed mixed sensitivity, with resistance noted to Cefotaxime(CTX) and Cefixime (CFM), while another organism showed sensitivity to most antibiotic used as shown in Tables(5&6).

Table 5. Type of organism isolated from Phones, hands, chairs, table of employment, fridge of treatment and sinks

Source	Type of Organism Identified
Phone	CoNS, *S.aureus* , *B.subtilus*
Hands	CoNS, *S.aureus*
Chairs	CoNS, *b.cereus*
Table	*K.pnemoniae, b.subtilus*
Fridge of Treatment	*B.cereus, Fungi*
Water Supply	No growth
Car of Medications	No growth
Sink	*E.coli* , *B.subtilis*

Table 6. Types of antimicrobial agents used for selected microorganisms

Type of Organism	AMC	CRO	CIP	E	TE	CTX	CFM	FOX
CoNS(n=8)	S(8) - -	S(5) R(2) I(1)	S(5) R(3) -	S(4) R(4) -	S(7) R(1) -	S(7) R(1) -	S(1) R(7) -	S(8) - -
S.aureus(n=3)	S(1) R(2)	S(1) R(2)	S(2) R(1)	R(3) -	S(2) R(1)	S(1) R(2)	- R(3)	- R(3)
E.coli	S	R	S	R	I	R	S	-
K.pnemoniae	S	I	S	S	S	I	R	-
B.subtilus(n=3)	S(2) R(1)	S(3) -	S(3) -	S(2) R(1)	S(3) -	S(3) -	S(1) R(2)	- -
B.cereus(n=3)	S(3) - -	S(3) - -	S(3) - -	S(1) R(2) -	S(1) R(1) I(1)	S(3) - -	S(3) - -	- - -

A set of swabs was taken from the devices, beds, and tables before and after sterilization as another step to ensure efficiency of sterilization, some organisms persisted even after sterilization, including *S. aureus*, *E.coli*, *K.pneumoniae*, *B.cereus*, and fungi As shown in Table (7).

Table 7. Microbial Growth on Surfaces Before and After Sterilization

Surface	Sterilization Status	
	Before	After
Equipment	*K.pneumoniae, S. aureus*, CoNS, *B.subtilis, B.cereus, B.licheniformis, B.pumilus*, Fungi .	*S.aureus*, CoNS ,*B.pumilus, B.subtilis*, Fungi .
Beds	CoNS, *B.subtilis* , *B.cereus, B.pumilus*, Fungi	*E.coli, K.pneumoniae S.aureus* ,CoNS ,*B.subtilis, B.cereus*,
Tables	*S.aureus* ,*B.subtilis* , *B.cereus, B.licheniformis, B.pumilus* ,Fungi	*B.cereus, S.aureus*, CoNS

Before sterilization, the equipment showed that CoNS was resistant to Amoxicillin (AMC), Erythromycin(E), Cefotixime (CTX), and Cefixime (CFM). however, *S. aureus* showed full resistance to Erythromycin(E), cefoxitin (FOX), and cefixime (CFM). Furthermore, *B. subtilis* exhibited partial resistance to several antibiotics, while *B. cereus* and *B. pumilus* showed resistance to Erythromycin(E) and some cephalosporins. On the other hand, after sterilization, CoNS exhibited resistance to Amoxicillin (AMC), Erythromycin(E), and Tetracycline (TE), while *S.aureus* and *B.subtilus* showed resistance to most antibiotics as shown in Tables (8&9).

Table 8. Types of Antimicrobial agent used for selected microorganisms (Equipment before sterilization)

Type of Organism	Before sterilization							
	AMC	**CRO**	**CIP**	**E**	**TE**	**CTX**	**CFM**	**FOX**
CoNS	R	S	S	R	S	R	R	S
S. aureus (n=2)	S R	S R	S R	- R (2)	S (2) -	S R	- R (2)	- R(2)
K. pneumoniae	S	S	S	R	S	S	S	-
B. subtilis (n=5)	S (5) - -	S (4) R (1) -	S (4) R (1) -	S (2) R (3)	S (4) - I (1)	S (3) R (1) I(1)	S (1) R (3) I(1)	- - -
B. cereus(n=2)	S (1) - I (1)	S (2) - -	S (2) - -	- R(2) -	S (2) - -	S (2) - -	S (2) - -	- - -
B. pumilus(n=2)	S (1) R (1)	S (1) R (1)	S (2) -	- R (2)	S (2) -	S (1) R (1)	S (1) R (1)	- -
B. licheniformis	S	S	S	S	S	S	S	-

Table 9. Types of antimicrobial agents used for selected microorganisms (Equipment after sterilization)

Type of Organism	After sterilization							
	AMC	**CRO**	**CIP**	**E**	**TE**	**CTX**	**CFM**	**FOX**
CoNS	R	S	S	R	R	I	I	S
S.aureus	R	S	S	R	R	S	R	R
B.subtilis	R	R	S	R	R	R	R	-
B.cereus	S	S	S	S	S	S	S	-

Before sterilization, beds exhibited that coagulase-negative staphylococci (CoNS) were partially resistant to several antibiotics, including Ceftriaxone (CRO), Erythromycin (E), Tetracycline (TE), and Cefixime (CFM). *B.subtilis* showed resistance to most of the antibiotics tested, particularly Ceftriaxone (CRO), Erythromycin (E), Cefotaxime (CTX), and Cefixime (CFM). In contrast, *B.cereus* was mostly sensitive to the antibiotics, while *B.pumilus* demonstrated general sensitivity with limited resistance to Erythromycin (E), Cefotaxime (CTX), and Cefixime (CFM). Following sterilization, CoNS developed resistance to most antibiotics, especially Amoxicillin (AMC), Erythromycin (E), Tetracycline (TE), and Cefixime (CFM). Both *S.aureus* and *B. subtilis* exhibited resistance to several of the tested antibiotics. *B. cereus* remained largely sensitive, with resistance observed only against Erythromycin (E). *K.pneumoniae* was resistant to most of the antibiotics used, while *E.coli* were sensitive to the majority of the antibiotics tested, as shown in Tables (10&11).

Table 10. Types of antimicrobial agents used for selected microorganisms (Beds before sterilization)

Type of Organism	Before sterilization							
	AMC	**CRO**	**CIP**	**E**	**TE**	**CTX**	**CFM**	**FOX**
CoNS(n=5)	S (5) -	S (4) R (1)	S (5) -	S (3) R (2)	S (4) R (1)	S (5)	S (3) R (2)	S (5)
B. subtilis	S	R	S	R	I	R	R	-
B. cereus(n=2)	S (2) - -	S (2) - -	S (2) - -	- R (2) -	S (1) - I (1)	S (2) - -	S (2) - -	- - -
B. pumilus (n=2)	S (2) -	S (2) -	S (2) -	S (1) R (1)	S (2) -	S (1) R (1)	S (1) R (1)	- -

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Table 11. Types of antimicrobial agents used for selected microorganisms (Beds after sterilization)

Type of Organism	After sterilization							
	AMC	**CRO**	**CIP**	**E**	**TE**	**CTX**	**CFM**	**FOX**
CoNS (n=3)	- R (3) -	S (2) R (1) -	S (3) - -	- R (3) -	- R (3) -	S (2) - I (1)	- R (3) -	S (3) - -
S. aureus	R	R	S	R	R	R	R	R
K. pneumoniae	R	S	S	R	R	S	R	-
E. coli	S	S	S	R	R	S	S	-
B. subtilis	R	R	S	R	R	I	R	-
B. cereus	S	S	S	R	I	S	S	-

Before sterilization, *S.aureus* on the tables exhibited resistance to the majority of antibiotics tested. *B.subtilus* displayed varying resistance, with almost full sensitivity to antibiotics used; *B. cereus* showed mixed susceptibility patterns, while *B.pumilus* was resistant specifically to Erythromycin (E) and Cefixime (CFM). Following sterilization, coagulase-negative staphylococci (CoNS) showed sensitivity to most antibiotics. In contrast, *S.aureus* continued to exhibit resistance to multiple antibiotics. Additionally, *B.cereus* developed resistance to several antibiotics as shown in Tables (12 &13).

Table 12. Types of antimicrobial agents used for selected microorganisms (Tables before sterilization)

Type of Organism	Before sterilization							
	AMC	**CRO**	**CIP**	**E**	**TE**	**CTX**	**CFM**	**FOX**
S. aureus (n=2)	- R (2)	- R (2)	S (2) -	S (1) R (1)	S (2) -	- R (2)	- R (2)	- R (2)
B. subtilis (n=6)	S (5) R(I) -	S (5) - I(1)	S (6) - -	S (3) R (2) RI(1)	S (4) R (1) I (1)	S (6) - -	S (5) R (1) -	- - -
B. cereus (n=2)	S (1) R (1) -	S (1) - I(1)	S (2) - -	- R (1) I (1)	S (1) R (1) -	S (2) - -	S (1) R (1) -	- - -
B. pumilus	S	S	S	R	S	S	R	-
B. licheniformis (n=3)	S (3) - -	S (2) R (1) -	S (3) - -	- R (2) I (1)	S (1) R (2) -	S (2) R(1) -	S(2) R (1) -	- - -

Table 13. Types of antimicrobial agent used for selected microorganisms (Tables after sterilization)

Type of Organism	After sterilization							
	AMC	**CRO**	**CIP**	**E**	**TE**	**CTX**	**CFM**	**FOX**
CoNS	S	S	S	R	I	S	R	S
S. aureus	R	R	S	R	S	I	R	R
B. cereus	R	R	S	R	R	S	R	-

Discussion

Multiple complications and compromised immune function make patients with end-stage renal disease (ESRD) susceptible to opportunistic infections. Hemodialysis patients are susceptible to infection transmission due to the passive nature of dialysis therapy and the narrow area between their beds. In order to stop the spread of pathogens in dialysis facilities, it is critical to implement suitable infection control measures (18). The bacteria were isolated from several locations after swabs were taken from the staff room and hemodialysis unit. Machines and dining tables were the most isolated places, followed by beds. Interestingly, they have been found even after sterilization, which puts patients at serious risk. Environmental surfaces, objects, and medical devices, such as blood pressure cuffs, stethoscopes, electronic thermometers, infusion pumps, and hemodialysis machines, can act as potential reservoirs for nosocomial pathogens that can be transferred from healthcare workers' hands to patients in the absence of proper hand hygiene, according to a study by Jeehan and colleagues (19). This supports the findings of the current study. The findings demonstrated that 94% of the bacteria were Gram-positive, including Staphylococcus (53%) along with *Bacillus* (49%). However, *B. subtilis* was found to be more abundant than other species (21%).

followed by Gram-negative bacteria, which were less frequent. Of them, *E. coli* (40%) and *K.pneumoniae* (60%) were identified. They were present both before and after sterilization, even though they exhibited considerable antibiotic resistance.

In hemodialysis patients, Staphylococci are a prominent cause of bacteremia, particularly when infections related to vascular access are present (20). However, it was discovered that CoNS accounted for 38% and S. aureus for 14%. This study is consistent with a study in Morocco conducted by Samira Jawhar in 2021, and a study by Shimohata et al. in 2019 that revealed a rise in CoNS isolates, with S.aureus accounting for a small portion (21,22). In recent years, the speed of diffusion of antimicrobial resistant (AMRs) responsible for both nosocomial and community-based infections, has reached alarming levels (23). For the detection of MRSA, cefoxitin disk diffusion is a suitable replacement for oxacillin disk diffusion, according to previous investigations. This approach is more accurate in identifying *S. aureus* strains that are resistant (24,25). The cefoxitin disc diffusion method was also used in the current study to identify Methicillin-resistant *Staphylococcus aureus* (MRSA).

MRSA is particularly significant in the medical field since it has developed resistance to β-lactam antibiotics. According to this study, MRSA was the least common bacterium identified from staff phones in the hemodialysis unit (8.33%). Conversely, methicillin-susceptible *Staphylococcus aureus* (MSSA) (21.73%) and MRSA (21.73%) were the most common organisms recovered from staff phones in a hemodialysis unit in an Iranian investigation (26). According to the numbers of *B. subtilis* (21%), *B. cereus* (16%), *B. pumilus* (6%), and *B. lichiniformis* (5%), the *Bacillus* species isolated from the dialysis unit were present in gradual amounts. This was in contrast to a study conducted in Egypt in 2022 (27).

Klebsiella pneumoniae is rapidly becoming known for its resistance properties to most of the last-line antibiotics that are usually used. It is especially problematic in hospitals, where it causes a range of acute infections. The increasing trends in the isolation rate of *K. pneumoniae* are of much concern (28). The results of this investigation showed that there were gram-negative isolates of *E. coil* and *K. pneumoniae,* which is in agreement with a study by Chikere and colleagues that reported the bacteria that were isolated from different sources were *E. coli* 4 (7.1%) and *K. pneumoniae* 3 (5.3%) (29).

The current study showed a high prevalence of antibiotic-resistant organisms, *S.aureus*, which was fully resistant to Cefixime, Cefoxitin, and Amoxicillin. while Tetracycline and ciprofloxacin were the most effective antibiotics against *S.aureus*, however, one of the *S.aureus* isolated from the phones was resistant to all antibiotics. Their *B.cereus* isolates showed high resistance to Erythromycin ،of particular concern, *B.cereus* was isolated from the nasal specimen of a patient exhibiting resistance to all tested antimicrobial agents, additionally, the presence of *E.coli* in sink and *K.pneumoniea* on tables and device is significant, as it may indicate fecal contamination or poor surface hygiene, *E.coli* isolated were resistance to Erythromycin, Ceftriaxone, Cefotaxime, while *K.pnuomniea* were one of isolates was resistant to Cefixime and other resistant to Erythromycin. *S. aureus* showed resistance to most drugs tested but among them Ciprofloxacin was sensitive; E. coli was Highly sensitive to Ciprofloxacin. Two isolates from *K.pneumoniae* were mix sensitive to Cefixime and more sensitive to Ciprofloxacin; these results contradict a study conducted in Kitui County, 2024 (30). Coagulase-negative *staphylococcus* isolates were more sensitive to antibiotics used: cefotaxime, ciprofloxacin, and erythromycin, which contradicts another study conducted by Mostafa Ali 2014(31).

Antibiotic susceptibility testing was conducted on the samples collected after sterilization. Notably, several bacterial isolates demonstrated resistance to multiple antibiotics. Such as, S.aureus exhibited resistance to Amoxicillin, Erythromycin, and Cefoxitin. Also, Coagulase-negative staphylococci (CoNS), isolated from bed surfaces, showed resistance to the majority of antibiotics tested. Similarly, B.subtilis, isolated from both bed surfaces and equipment, was also resistant to most of the antibiotics. Furthermore, K.pneumoniae displayed resistance to Erythromycin, Tetracycline, Cefixime, and Amoxicillin. In contrast, E.coli showed low levels of antibiotic resistance ،these results highlight the importance of infection control in healthcare settings.

According to a study done in Egypt in 2024, there is a mismatch between what is known and what is actually done in terms of infection management. Work overload and a staffing shortfall caused a vacuum that needed to be filled with additional resources and innovative solutions. It is necessary to conduct a thorough examination of the infection control measures and disinfection methods. Every healthcare facility must provide healthcare staff with specialized training on infection control guidelines and environmental cleaning and disinfection (14). Anyway, some of those involved in this search were donning PPE and following the recommended cleaning and disinfection procedures. Bacterial infections are common in hemodialysis units because some people do not take the necessary steps to stop the spread of infectious agents in medical settings, such as washing their hands and wearing personal protective equipment.

Conclusion

Health care environments play a crucial role in the transmission of environmental contamination infections. These pathogens can be transmitted from person to person or by touching inanimate items, particularly articles that come into direct contact with patients, Methicillin-resistant *Staphylococcus aureus* (MRSA) and highly drug-resistant Gram-negative bacilli are among the numerous isolates from hemodialysis beds, tables, and equipment that exhibit multidrug resistance. This complicates treatment and increases the risk of severe outcomes. Understanding the prevalence of bacteria, their resistance to antibiotics, and their association in hemodialysis unit environments can provide a comprehensive picture of their prevalence and the risk of healthcare-associated infections. This research indicates a deficiency in cleaning and disinfection protocols, the use of disinfectants, and the lack of infection control in the dialysis room. Further studies should be carried out to identify the specific types of bacterial and fungal infections that are most prevalent in the dialysis units, to determine the most effective disinfectant to be used.

Conflict of interest. Nil

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