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Original article

Bacterial Profile and Their Antimicrobial Susceptibility Pattern of Isolates Recovered from Intensive Care Units of Libyan Hospitals

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Abstract
Presence of Bacterial contamination in hospital environments, particularly intensive care units, poses a serious threat to global public health in the world with high morbidity and mortality rates. Of more concern is the emergence of multidrug-resistant bacteria on medical devices, inanimate surfaces, health care providers, and patients in the intensive care unit, which could lead to further cross-contamination and infection. This study aimed to assess the bacterial profile and their antimicrobial susceptibility patterns of bacterial isolates from the intensive care unit of the Emergency unit, internal medicine, and coronary unit of Misurata Central Unit of Misurata, Libya. A unit-based cross-sectional study was conducted on three Intensive Care units from 1st December 2024 to 27th December 2024. In this project, a total of 102 swab samples from the intensive care unit environment were collected using cotton swabs. Standard Microbiological techniques to include culture methods and Gram stain, were employed for the identification of the isolates. Antimicrobial susceptibility tests for bacterial isolates were performed by using the Kirby-Bauer disk diffusion method. In the total of 102 swab samples, bacterial growth was observed in 19.6% (20/102) of the total samples. Out of the total bacterial growth recovered, the Coronary care unit had the highest, 50% (10/20), followed by the Emergency unit 35% (7/20), and the Internal medicine unit had 15% (3/20). The most frequently found isolate was Staphylococcus aureus 75% (15/20), followed by Streptococcus pyogenes 15% (3/20), Pseudomonas aeruginosa 5% (1/20), and E coli 5% (1/20). Results of the antibiotic susceptibility pattern revealed that most of the isolates are multidrug-resistant. Results from this study showed bacterial contamination of the ICU environments and their resistance patterns, which suggest that patients are prone to hospital-associated infection. It is recommended that strict sterilization of intensive care units be standardized and the hygiene of hospital workers be enforced to prevent transmission of infection in hospital environments.
Keywords. *Hospital-Associated Infection, Antibiotic Resistance, ICU, Public Health, Misurata, Libya*

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Introduction

Microbes are ubiquitous, and their presence on the environmental surfaces of the Intensive Care Unit (ICU) is of great concern and a threat to the treatment outcomes of patients. ICUs are ranked as the top units that house Hospital-Associated Infections (HAI) [1]. This accounts for the fact that the patients are vulnerable due to factors such as immunosuppression, exposure to invasive procedures, administration of many drugs, as well as distortion of normal microbiomes in the host [2]. Of concern is that the outcomes of infections in ICUs tend to have devastating clinical outcomes of morbidity and mortality [3]. The ICU environments are contaminated by ICU staff, physicians, and the general hygiene of the environment, which could lead to the spread of resident pathogens from different hospital wards to ICUs. Common HAIs in ICUs include bacteremia, pneumonia, and urinary tract infections [4]. The prevalence of HAIs varies globally, with higher rates often observed in developing countries [5]. Across the world, the infection rates in ICUs differ, with 5–10% in the developed world, while higher in the developing world, more than 50% in developing [5]. The likelihood of the high burden, weak infection control protocol, and lack of standard sterilization procedure contributes to the increased contamination of such an important hospital unit.

There is are wide range of bacterial pathogens that cause different infections in ICUs, which include *Staphylococcus aureus*, *Escherichia. coli*, *Streptococcus pyogene*, *Pseudomonas aeruginosa*, *Clostridium difficile* and *Acinetobacter baumannii*. These pathogens are often resistant to multiple antibiotics, making treatment more difficult and further complicating infection management [6]. In addition, some of the pathogens are ranked critical priority pathogens due to their public health implications [7].

Previous studies have reported high contamination rates in ICUs globally, with bacterial isolates showing worrying multidrug resistance patterns [8, 9]. This study aimed to assess the bacterial contamination and antimicrobial susceptibility patterns in ICUs of Misurata Central Hospital, Libya, to inform targeted infection control strategies.

Methods

Study area

The project was conducted from three ICUs Departments of Emergency, Internal Medicine unit, and Coronary Unit of Misurata Central Hospital, Misurata, Libya. Intensive care Units' surfaces and equipment, including inanimate objects, medical devices, were used for the project.

Collection of the Samples and Data

A total of 102 swab samples were collected from different parts of the Intensive Care Units of Misurata Central Hospital. One swab specimen was collected from each object in the ICUs from 1st December 2024 to 20th December 2024. Each sample collected followed standard microbiological method and used dry swab sticks were rolled over the medical devices and inanimate surfaces such as bed rails, bedside tables, door handles, ventilator, blood pressure cuffs, vital signs monitor, central venous catheters, ECG, and other surfaces.

Identification of bacterial isolates

First, using collected swabs sticks streak on MacConkey, blood, and Chocolate petri-dish to determine bacterial colonies. This allowed for the growth of bacterial isolates and further confirmatory identifications such as morphological colony identification, hemolytic characteristics, Gram staining, and biochemical tests such as catalase, oxidase, indole test, and coagulase test as described in Chesbrough [10].

Antibacterial susceptibility testing

Antimicrobial susceptibility and resistance profile of *Escherichia coli* isolates will be determined by strain growth zone diameter using the disc diffusion method of Kirby-Bauer (1966) as described by the Clinical Laboratory Standard Institute [11]. Ten (10) antimicrobial agents were used in this study, including Septrin (30µg), Chloramphenicol (30µg), Sparfloxacin (10µg), Ciprofloxacin (30µg), Amoxacillin (30µg), Augmentin (10µg), Gentamycin (30µg), Pefloxacin (30µg), Tarivid (10µg), and Streptomycin (30µg). The antibiotic disks were placed on the surface of Muller-Hinton agar, sufficiently separated from each other to avoid overlapping of inhibition zones. After 30 seconds of pre-diffusion, the plates were incubated at 37 °C for 24 hours, after which the diameter of inhibition zones was measured with a meter rule, and the inhibition diameter for each isolate and each antimicrobial agent was measured. Any bacterial strain that resist to a minimum at least three (3) different classes of antibiotics it's multi drug resistance (MDR), any bacterial strain remain susceptible to only one or two class of antibiotics it is extensive drug resistance (XDR) and any bacterial strain resistance to all sub classes in all classes of antibiotics it is pan drug resistance (PDR) [11].

Results and discussion

A total of 102 swab samples were collected from three different intensive care units of Misurata Central Hospital; namely, Emergency Unit, internal medicine unit, and coronary unit. Bacterial growth was observed in 19.6% (20/102) of the total samples. Out of the total bacterial growth recovered, the Coronary care unit had the highest, 50% (10/20), followed by the Emergency unit 35% (7/20), and the Internal medicine unit had 15% (3/20).

Results from this study revealed the presence of bacterial isolates in all the ICUs in the hospital study, with the Coronary care unit having the highest, followed by the Emergency unit, and Internal medicine with the lowest bacterial growth. This

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indicates the ability of bacteria to grow on different surfaces and environments. And the presence of high bacterial counts in the ICU of the Coronary care unit could be due to the number of patients, the sterilization and disinfection methods in the unit, as well as the healthcare workers in the unit. Microbes are ubiquitous in nature and use several strategies to resist the disinfection process. The cross contamination of bacterial isolates could be due to the fact that human body harbor microbiomes and the number of bacteria range more than 4×10^4 CFU/cm^2 to 1×10^6 CFU/cm^2, , therefore it is possible to contaminate the ICU environments, and this fact is supported by the skin squamous contains viable microorganisms and can contaminate patient gowns, bed linens, bedsides and other objects in the ICU environment as reported by previous studies [9,12]. Results from the current study showed overall bacterial contamination of 19.6% (20/102), which is relatively similar results of study conducted in Tripoli hospital by Asma et al, [13] which indicated 58% (58/100) of bacterial contamination of ventilators of ICUs, and another study by Muluneh et al., [9] from Ethiopia showed similar pattern with total swab of 180 and revealed 79.4% (143/180). Another Libyan study conducted at Trauma Hospital in Tripoli showed 21.8% (79/363) bacterial contamination of devices used in ICU [14]. This could be due to the sample size and application of standard hygiene in the hospital. Regardless of the prevalence of bacterial growth, ICUs should be free from bacterial contamination. The results from this study showed that the three ICUs in Misurata Central Hospital were directly or indirectly harboring important potential bacterial pathogens of public health concern, such as *Staphylococcus aureus, Pseudomonas aeruginosa, E. coli,* and *Streptococcus pyogenes* that would increase the chance of hospital-associated infection (Figure 1).

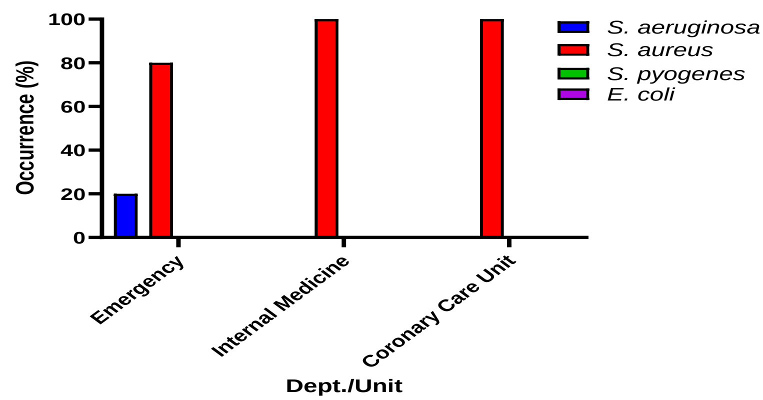

Figure 1. Distribution of bacterial isolates based on the ICU unit.

The results from this study showed that the three ICUs in Misurata Central Hospital were directly or indirectly harboring important potential bacterial pathogens of public health concern, such as *Staphylococcus aureus, Pseudomonas aeruginosa, E. coli,* and *Streptococcus pyogenes,* which would increase the chance of hospital-associated infection. The results from this study are in agreement with the report of Muluneh et al. [9] from Ethiopia, where pathogens such *as CoNS, S. aureus, E. coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, A. baumannii, Enterobacter, and Salmonella* spp were reported. Other studies showed similar patterns of bacterial isolates [13,15]. The variations in bacterial distribution across the ICUs could be influenced by factors such as infection control practices, healthcare worker practices, sterilization techniques, and the number of visitors.

Analysis of major pathogens and their drug resistance patterns from three different ICUs of Misurata Central Hospital, using eleven (11) antibiotics, is revealed in Table 1.

Six isolates of S. aureus from across the ICUS were 100% resistant to all antibiotics (11/11) tested, while P. aeruginosa from the Emergency unit department was also 100% resistant, and in a similar pattern, S. pyogenes revealed 100% resistance to all the antibiotics. In a similar pattern, S. aureus was 90.9% resistant, while E. coli was more susceptible, 45.5% to the antibiotic tested, followed by S. pyogenes, 36.4%.

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Table 1: Antimicrobial susceptibility pattern of bacterial isolates isolated from three ICUs

Site of sample	Department	Name of bacteria	Antibiotics Sensitivity	Antibiotics resistance
Surface	ICU emergency department	*P.aeruginosa*	no	DA/FOX/VA/E/DO/CXM/CTX/CIP/P/AMC/IMP
ECG	ICU emergency department	*S.aureus*	IPM 10mg	DA/FOX/VA/E/DO/CXM/CTX/CIP/P/AMC
Vital signs monitor	Icu emergncy	*Strepto. pyogens*	Not found	IMP/CXM/E/VA/FOX/CTX/DO/DA/P/AMC/AK
Blood pressure cuffs	ICU emergency department	*s.aureus*	Not found	IMP/CXM/E/VA/FOX/CTX/DO/DA/P/AMC/AK
Ventilators	Emergency	*Staph. Aureus*	Not found	IMP/CXM/E/VA/FOX/CTX/DO/DA/P/AMC
Ventilators	Internal medicine	*Staph. Aureus*	AK++/CIP+/VA++	AMC/CTX/CXM/FOX/DO/DA/AMC/IMP
Ventilators	Internal medicine	*Satph.Aureus*	VA+++/AMC++/AK++	CTX/CXM/FOX/DO/DA/IMP/CIP
Door handles	Internal medicine	*Staph.Aureus*	Not found	IMP/CXM/E/VA/FOX/CTX/DO/DA/P/AMC/AK
Beside tables	Coronary care unit	*Staph.aureus*	Not found	IMP/CXM/E/VA/FOX/CTX/DO/DA/P/AMC/AK
Bed rails	Coronary care unit	*Staph.aureus*	VA++/AMC+++/AK++	IMP/CXM/E/FOX/CTX/DO/DA/P
Vital sings monitor	Coronary care unit	*Staph.aureus*	AMC++/CIP+	VA/CTX/P/CXM/FOX/DA/DO/AMC/IMP/AK
Ventilators	Coronary care unit	*Staph.aureus*	AMC++/CIP+++/VA+	CTX/P/CXM/FOX/DA/DO/IMP/AK
Bed rails	Coronary care unit	*Staph.aureus*	Not found	IMP/CXM/E/VA/FOX/CTX/DO/DA/P/AMC/AK
Door handles	Coronary care unit	*Staph.aureus*	Not found	IMP/CXM/E/VA/FOX/CTX/DO/DA/P/AMC/AK
Door handles	Coronary care unit	*E. coli*	FOX++/CTX++/VA+++/CIP+++/DA++	P/CXM/DO/IMP/AMC
Vital signs monitor	Coronary care unit	*Strepto.pyogenes*	AK++/IMP+/AMC+/CTX+	P/CXM/DO/DA/FOX/VA/

***IMP**: Imipenem ➣ **CXM**: Cefuroxime ➣ **E**: Erythromycin ➣ **VA**: Vancomycin ➣ **FOX**: Cefoxitin ➣ **CTX**: Cefotaxime ➣ **DO**: Doxycycline ➣ **DA**: Clindamycin (Dalacin is a common brand name)➣ **P**: Penicillin ➣ **AMC**: Amoxicillin-Clavulanic Acid (Augmentin is a common brand name) ➣ **AK**: Amikacin.*

In this study, the results indicated striking multidrug resistance by most of the bacterial isolates colonizing different surfaces of the studied ICUs. This is an indication of the possible spread of drug-resistant nosocomial bacterial pathogens in the hospital. Of particular concern is total resistance exhibited by *S. aureus, P. aeruginosa,* and *S. pyogenes* from across the different ICUs while E. coli is milder resistant to the tested antibiotics. The results of the current study revealed a high level of resistance in the studied ICUs. The high resistance rates might be associated with antibiotic abuse and prolonged ICU stays.

The multidrug pattern of the isolates is higher than reported and calls for concern. A study revealed a relatively lower multidrug resistance (MDR) of 39% of the total isolates [14]. Like this study, Ibrahim et al. [8] reported different antibiotic resistance with rates exhibited by ceftazidime, gentamicin, amikacin, and ertapenem, while *A. baumannii* were the most frequent multidrug-resistant (94%), and in a similar vein, the highest resistance rates in Gram-positive strains were observed toward ampicillin, oxacillin, ampicillin/sulbactam, and Cefoxitin, representing 90% of total MDR Gram-positive isolates. In a comparative study of prevalence of multidrug resistance in ICUs and operation theater of Benghazi and Tripolin hospitals, most of the isolates were considered multi-drug resistant as they resistant to most or all the antibiotics (15 antibiotics) with gram negative been predominant and contrary to this study, S. aureus S. were susceptible to amikacin (100%), and resistance to cefotaxim (100) and also P. aeruginosa showed varying degree of resistance to imipenem 42% and ceftazidim 82% [16].
The high resistance nature of the isolates in different hospitals reveals the rate of emergence of resistance by bacteria and could be influenced by drivers such as empirical treatment and prescription of broad-spectrum antibiotics, long use of antibiotics, and transmission of resistant pathogens in the environment.

Conclusion
The ICUs of Misurata Central Hospital were contaminated with various bacterial isolates, some of which are potentially pathogenic. The study revealed the multidrug-resistant nature of the bacterial isolates. These findings underscore the need for strict adherence to antibiotic stewardship and the reinforcement of infection control practices in hospitals in Misurata and throughout Libya. Molecular detection of the circulating resistant genes could give a better understanding for proper surveillance and monitoring.

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