Study of Antibiograms in Intensive Care Unit Patients at a Tertiary Care Hospital

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Background and aim: Antibiograms are reports summarizing the rates of bacterial antibiotic susceptibility inside a specific institution over the course of a calendar year. This study aims to ascertain the prevalence and types of pathogens as well as their antibiotic susceptibility and resistance at surgical and emergency Intensive care units (ICUs) at Zagazig University Hospitals.

Methods: A one-year retrospective analytical study was conducted from January to December 2022, with a total of 16,914 clinical isolates acquired from different clinical specimens from surgical and emergency ICUs at Zagazig University Hospitals.

Results: Gram-negative bacteria were the most commonly identified pathogens (84.27%), with *Klebsiella pneumonia* being the most often detected one with a 39.01% incidence, followed by *Escherichia coli* with a 14.56% incidence. *Staphylococcus species* were recovered from 2649 isolates, with *hominis* being the most common. Gram-positive bacteria were the most commonly isolated organisms in blood cultures, while *K. pneumoniae* was the most commonly isolated pathogen in sputum, urine, and wound cultures. Colistin is the most effectively used antibiotic, with sensitivity for K. pneumoniae, E. coli, P. aeruginosa, and Acinetobacter of 95, 89, 92, and 85%, respectively. As regards the sensitivity to tigecycline, it was 87% for E. coli, 76% for *Acinetobacter*, and 75% for *K. pneumonia*. However, the sensitivity of carbapenem for these organisms was remarkably low.

Conclusion: Our study provided local baseline epidemiological data that reveals the scope of our tertiary care hospitals` ICU infection problem. It provides valuable information on common microbial infections and their antimicrobial susceptibilities.

INTRODUCTION

Infections are an important public health concern, causing significant mortality and morbidity in patients who are hospitalized. They affect 7–12% of hospitalized patients worldwide, involving over 1.4 million individuals suffering from hospital-acquired infectious complications **[1]**. Inadequate infection control procedures in developing nations exacerbate the problem, which is aggravated by poor sanitation, insufficient resources, shortage of monitoring, and lack of knowledge about nosocomial diseases **[2]**.

The most prevalent infections in intensive care units (ICUs) are hospital-acquired and they have a major negative impact on the outcomes of patients as well as the treatment cost. As a result, timely administration of proper antibiotics is a vital component of these patients' treatment and can save their lives. On the other hand, antibiotic resistance is spreading at frightening rates globally **[3]**.

Antimicrobial resistance (AMR) is a larger problem that involves resistance to medications used for treating various forms of infections, including those caused by bacteria, fungi, and parasites **[4]**. Because of the seriousness of critical diseases, ICUs are regarded as the hub of AMR emergence; patients are at a greater risk of getting infected due to the usage of invasive medical devices (e.g., endotracheal tubes, vascular and urine catheters) as well as excessive antibiotic use along with a variety of infection control procedures. As a result, infection treatment in the ICU has become more challenging, and ICU clinicians need to have routinely updated antibiograms to make prudent decisions concerning the use of empirical medicines while awaiting culture findings **[5]**.

Antibiograms are defined as reports that brief the rates of antibiotic susceptibility inside a specific institution during a period of one year. Antibiograms are utilized to monitor bacterial resistance and adjust empirical prescriptions for antibiotics **[6]**. Because of the high frequency of AMR and the wide difference in the microorganisms` prevalence and antibiotic susceptibility between ICUs; an ICU-specific antibiogram must guide empirical use of antibiotics. Moreover, new local patterns in bacterial resistance should be examined regularly **[7]**. The current study aims to determine different pathogens as well as their antibiotic susceptibility and resistance at surgical and emergency ICUs at Zagazig University Hospitals.

METHODS

Study design and ethical consideration:

This cross-sectional retrospective study was conducted in the surgical and emergency intensive care units of Zagazig University Hospitals between January and December 2022. The files of 16,914 clinical isolates acquired from different clinical specimens were analyzed. The surgical ICU has 32 beds, and the emergency ICU has 20 beds. During the study period, all the patients admitted to these ICUs exhibited infection-related manifestations.

Inclusion and exclusion criteria

Inclusion criteria included the first isolate culture of a specific species, patient or analysis period, diagnostic isolates, verified final results, and antimicrobial drugs that were routinely examined, while surveillance cultures, screening isolates, duplicated bacterial isolates and isolates with intermediate sensitivity were excluded.

Microbiological workup

- Culture specimens are collected from different sites, including sputum, central venous line, surgical wounds, peritoneal fluid, cerebrospinal fluid, pleural fluid, bronchoalveolar lavage, endotracheal secretions as well as urine and blood samples
- Within 1-2 hours of collection, all samples were processed in the Clinical Pathology Department's Microbiology Diagnostics Unit.
- The automated Bact/ALERT3D microbial identification system (BioMerieux Inc., Durham, USA) was used to perform blood cultures and allow them to incubate for a period of 7 to 10 days. Positive blood culture bottles as well as other isolated samples were cultured for a period of 24 to 48 hours at 37 °C on blood agar, chocolate agar, MacConkey, and Sabouroud agars. Identification to the species level was performed through morphology of the colonies on blood, MacConkey, and Sabouroud agar plates (oxoid, UK), Gram-stained films, biochemical reactions involving coagulase, catalase, oxidase, motility, methyl red, Voges-Proskauer, indole, citrate, urease tests and confirmation with the microbial detection system (VITEK® 2 COMPACT, bioMérieux, USA) (regarding the manufacturer’s instructions).

Antibiotic susceptibility testing: it was performed with the help of the VITEK® 2 compact system (Biomerieux, Marcy l’etoile, France) using Vitek 2 susceptibility cards (GN 71, GN 204) for the gram-negative bacteria, (GN 222) for the resistant gram-negative bacteria, (GP 67) for the gram-positive bacteria and (AST/Y S07) for the yeast. The results were classified as sensitive (S), intermediate (I), or resistant (R) using the Clinical and Laboratory Standards Institute (CLSI) 2022 criteria. The antibiogram was created in compliance with the Clinical and Laboratory Standards Institute's (CLSI) guidelines [8].

Statistical analysis

Excel 2010 (Microsoft Corporation, USA) was used for statistical analysis. The absolute frequencies and percentages of annual bacterial frequencies and antibiotic sensitivity rates were calculated.

RESULTS

During the study period, 16914 isolates were acquired from different clinical specimens from various ICUs. Positive sputum isolates were the most common infection site in our ICUs (31.7%) then blood cultures and pus isolates at 23.4% and 22.2% respectively **(Table 1)**.

Gram-negative bacteria were the most commonly identified pathogens (84.27%), with *Klebsiella pneumoniae* being the most often detected Gram-negative bacteria with a 39.01% incidence, followed by *Escherichia coli* with a 14.56% incidence **(Table 2)**.

Gram-positive *species* were recovered from 2649 isolates, with *Staph. hominis* being the most common (n = 1146, 45.4% of Staph. Isolates and 6.77% of total isolates (Table 2). *Staph. haemolyticus* was the second most common Staphylococcal isolate (n = 580, 22.9% of Staph. Isolates and 3.42% of total isolates,), followed by *Staphylococcus aureus* which was isolated in 20.1% of Staphylococcal isolates, 2.99% of all isolates, n=507. Methicillin-resistant Staphylococcus aureus (MRSA) was detected in 18.19% of *Staphylococcal* isolates (2.7% of all isolates, n = 459 isolates), but Methicillin-sensitive Staphylococcus aureus (MSSA) was found in just 1.9% of *Staphylococcal* isolates (n = 48 isolates, 0.28% of all isolates) in our investigation **(Figure 2).**

Gram-positive bacteria were the most commonly isolated organisms in blood cultures, while *K. pneumoniae* was the most commonly isolated pathogen in sputum, urine, and wound cultures **(Table 3a, 3b).**

Antimicrobial susceptibility testing results

In our investigation, the antibiotic sensitivity of the most often isolated gram-negative infections was extremely variable, revealing that colistin is the most effectively used antibiotic, with sensitivity for *K. pneumoniae, E. coli, P. aeruginosa, and Acinetobacter* of 95, 89, 92, and 85% respectively. As regards the sensitivity to tigecycline, it was 87% for E. coli, 76% for *Acinetobacter*, and 75% for *K. pneumonia.* However, the sensitivity of carbapenem for these organisms was remarkably low. The sensitivity of *K. pneumoniae* was 14% for imipenem and 13% for meropenem, that of E. coli was 48% for imipenem and 42% for meropenem, and that of P. aeruginosa was13% for imipenem and 16% for meropenem while the sensitivity of *Acinetobacter* was 10% for imipenem and 9% for meropenem) **(Figure 3).**

Vancomycin sensitivity was 95% for gram-positive S. hominis and 87% for MRSA (Fig. 3), while linezolid sensitivity was 100% for MRSA and 98% for S. hominis and Tigecycline sensitivity was 100% for both. Fungal infection in our data was less than 1%, predominantly *C. albicans* (0.05% vs. 0.01% C. tropicalis), with antifungal sensitivity of about 100% for micafungin, caspofungin, and amphotericin B, while other antifungals' sensitivity was lower as shown in **(Figure 4)**.

Table (1): Positive samples prevalence in emergency and surgical ICUs.

Items	**EICU (n=9914)**	**SICU (n=7000)**	**Total (n= 16914)**
Blood culture Number (%)	1835 (10.8%)	2123 (12.5)	3958(23.4%)
Sputum Number (%)	2940 (17.3%)	2430 (14.4%)	5370(31.7)[a]
Urine Number (%)	749 (4.4%)	1160 (6.9%)	1909(11.3%)
Pus Number (%)	3028 (17.9%)	731 (4.3%)	3759(22.2%)
Pleural fluid Number (%)	75 (0.4%)	0 (0%)	75 (0.44%)
Peritoneal fluid Number (%)	169 (1%)	28 (0.17%)	197 (1.16%)
CSF Number (%)	186 (1.1%)	220 (1.3%)	406 (2.40%)
BAL Number (%)	14 (0.08%)	7 (0.04%)	21 (0.12%)
CVC tip Number (%)	886 (5.2%)	286 (1.7%)	1172(6.9%)
Vaginal swab Number (%)	32 (0.19)	0 (0%)	32 (0.19%)
Stool Number (%)	0 (0%)	15 (0.09%)	15(0.09%)

ICU: intensive care unit, EICU: Emergency intensive care unit, SICU: surgical intensive care unit, BAL: bronchoalveolar lavage, CSF: cerebrospinal fluid.
The data were presented in the form of a number and a percentage. Positive sputum isolates were the most prevalent infection.

Table (2): The incidence of pathogens isolated from emergency and surgical ICUs

Items	**EICU (n=9914)**	**SICU (n=7000)**	**Total (n=16,914)**
Microorganisms			
Gram-negative Number (%)	8551(50.55%)	5704(33.72%)	14,255(84.27%)
Acinetobacter baumanii	1345(7.95%)	546(3.22%)	1891(11.18%)
Burkholderia cepacia	27(0.159%)	20(0.118%)	47(0.277%)
Klebsiella aerogenes	116(0.68%)	10(0.06%)	126(0.74%)
E. coli	1295(7.65%)	1168(6.9%)	2463(14.56%)
Enterobacter cloacae	29(0.17%)	29(0.17%)	58(0.34%)
Klebsiella pneumonia	3829(22.63%)	2770(16.37%)	6599(39.01%)[a]
Proteus mirabilis	771(4.56%)	448(2.64%)	1219(7.20%)
Providencia stuartii	59(0.35%)	46(0.27%)	105(0.62%)
P. aeruginosa	1080(6.38%)	667(3.94%)	1747(10.32%)
Gram-positive Number (%)	1329(7.86%)	1320(7.80%)	2649(15.66%)
Enterococci	41(0.24%)	75(0.44%)	116(0.68%)
Staph. Aureus	276(1.63%)	231(1.36%)	507(2.99%)
Staph.hominis	640(3.78%)	506(2.99%)	1146(6.77%)
Other staph.	390(2.3%)	480(2.83%)	870(5.14%)
Streptococci	6(0.03%)	4(0.023%)	10(0.059%)
Yeasts Number (%)	7(0.041%)	3(0.018%)	10(0.059%)
Candida albicans	5(0.029%)	3(0.018%)	8(0.047%)
Candida tropicalis	2(0.011%)	0(0%)	2(0.011%)

The data were presented in the form of a number and a percentage. The most commonly encountered Gram-negative bacteria was *the Klebsiella pneumoniae*

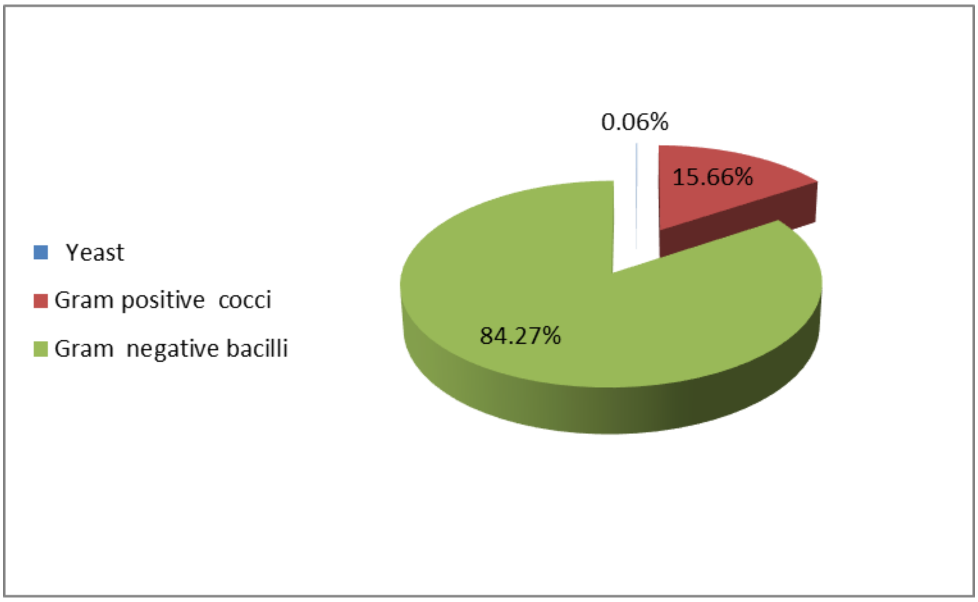

Figure 1: Incidence of different pathogens isolated from emergency and surgical ICUs.

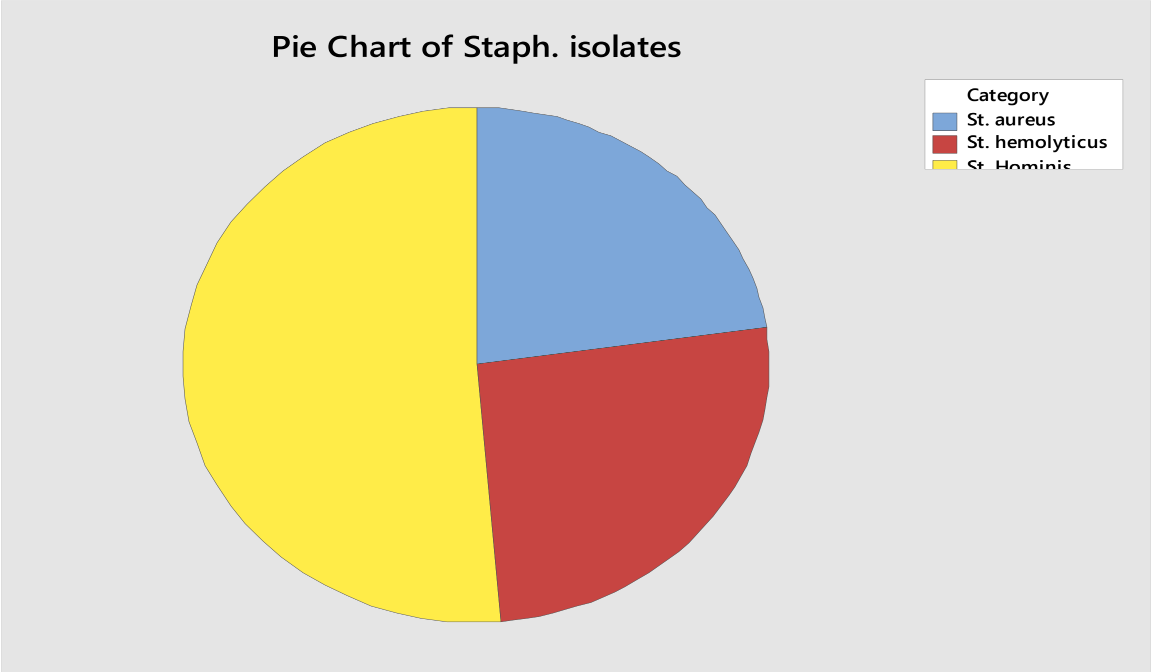

Figure 2: The incidence of different staphylococcus species.

Table (3): The incidence of different pathogens in various clinical samples.

Culture (n = 16,914)	**Gram-negative organisms (n = 14,255)**								
	Acinetobacter baumannii complex	***Burkholderia cepacia***	***Enterobacter cloacae***	***E.col***	***Klebsiellapneumonia***	***Klebsiella aerogenes***	***Proteus mirabilis***	***Pseudomonas aeruginosa***	***Providencia stuartii***
Blood Culture	513	0	15	270	967	0	139	126	0
CVC tip	114	16	0	168	537	16	80	99	31
Sputum	745	11	43	815	2764	48	238	376	60
CSF	84	0	0	0	38		0	218	
Pus	287	0	0	639	1491	62	569	547	0
Urine	103	20	0	450	716	0	162	343	14
BAL	3	0	0	6	10	0	0	2	0
Stool	0	0	0	0	0	0	15	0	
Peritoneal fluid	14	0	0	83	29	0	16	36	0
Pleural fluid	28	0	0	32	15	0	0	0	0
Vaginal	0	0	0	0	32	0	0	0	0
Total	1891	47	58	2463	6599	126	1219	1747	105

Table 3 (continue): The incidence of different pathogens in various clinical samples

Culture (n =16914)	Gram-positive organisms (n =2649)				Candida (n=10)	
	Staph Aureus	***Other staph***	***Streptococcus***	***Enterococcus***	***Candida albicans***	***Candida tropicalis***
Blood culture	138	1708	0	78	3	1
CVC tip	54	47	0	10	0	0
Sputum	139	131	0	0	0	0
CSF	36	30	0	0	0	0
Pus	97	48		19	0	0
Urine	34	52	0	9	5	1
BAL	0	0	0	0	0	0
Stool	0	0	0	0	0	0
Peritoneal fluid	9		10	0	0	0
Pleural fluid	0	0	0	0	0	0
Vaginal	0	0	0	0	0	0
Total	507	2016	10	116	8	2

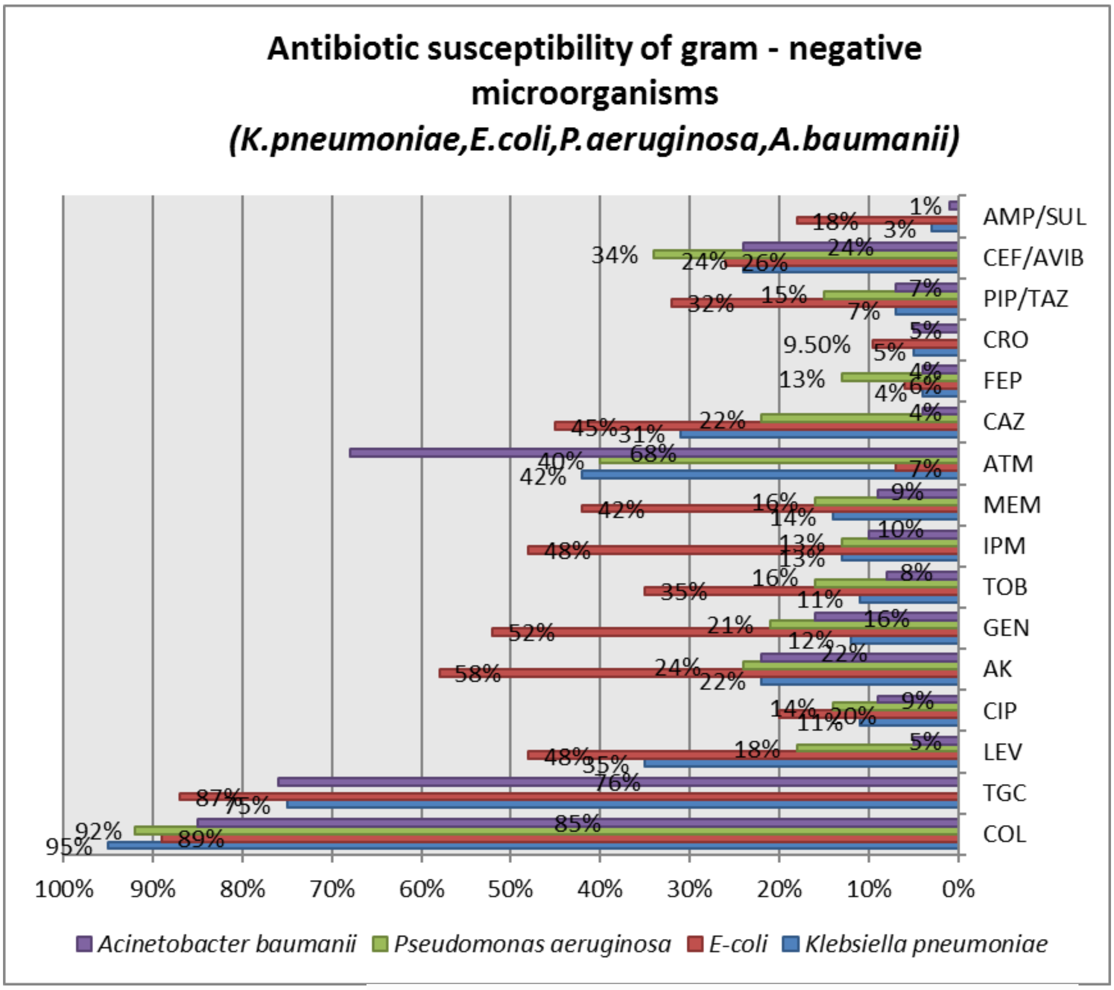

Figure 3: Susceptibility of Gram-negative bacteria to different antimicrobial agents

AMP: Ampicillin, AMP/SUL: Ampicillin Sulbactam ,CEF/AVIB :Ceftazidime Avibactam, PIP/TAZ :Piperacillin Tazobactam , CRO :Ceftriaxone, FEP :Cefepime, CAZ :Ceftazidime, ATM :Aztreonam, MEM :Meropenem , IMP: Imipenem, TOB :Tobramycin , GEN :Gentamycin, AK :amikacin ,CIP :ciprofloxacin, LEV :levofloxacin , TGC :Tigecylcine, COL :Colistin.

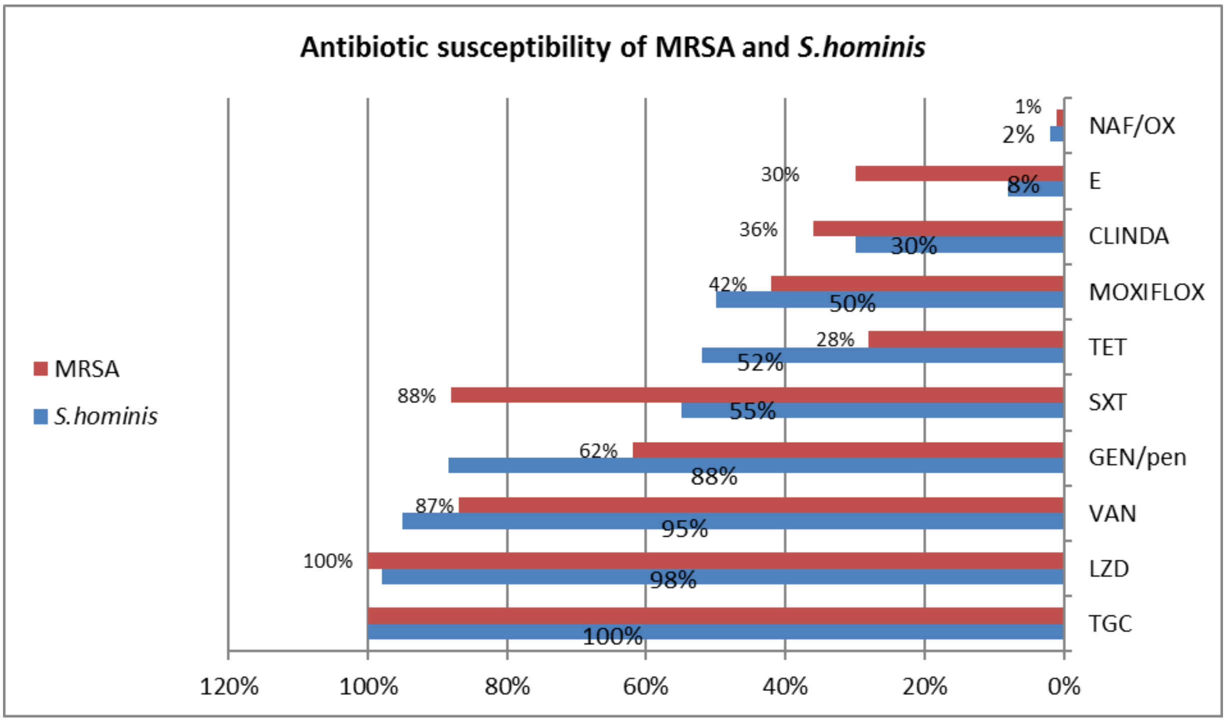

Figure 4: Bar chart showing gram-positive bacteria's susceptibility to various antimicrobial agents

MRSA: Methicillin-resistant *Staph. aureus*
NAF/OX: Nafcillin/Oxacillin, E: Erythromycin, CLINDA: Clindamycin, MOXIFLOX: Mmoxifloxacillin, TET: Tetracycline, SXT: Sulfa-Trimethoprim, GEN/pen: Gentamycin/Penicillin, VAN: Vancomycin, LZD: Linezolid, TGC: Tigecycline

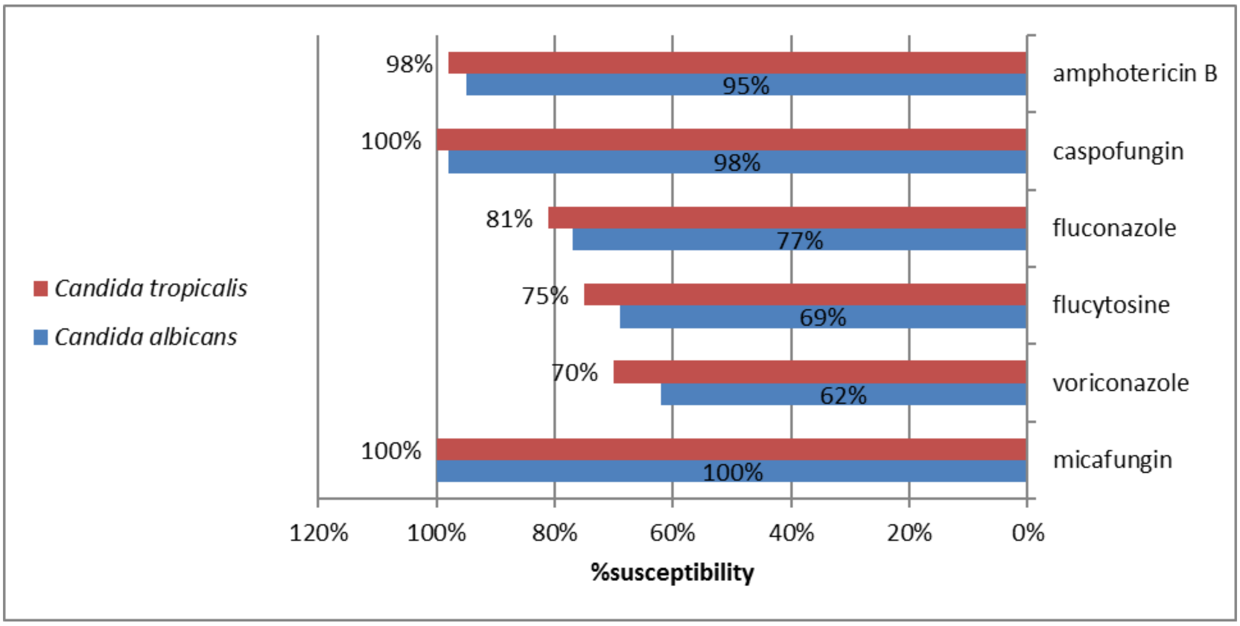

Figure 5: Bar chart showing Antifungal susceptibility of Candida species

DISCUSSION

Antibiograms are frequently used to help choose the best empirical antibiotic treatment for a suspected microbial infection. This is the first study to provide antibiogram analysis and offer epidemiological data on microorganisms and drugs that are available for surgical and emergency ICUs at Zagazig University Hospitals.

Our findings revealed that sputum specimens showed the most common infection (31.7%) in our surgical and emergency ICUs at Zagazig University Hospitals during the study period, even though the commonest nosocomial infection globally is the catheter-associated urinary tract infection (CAUTI) which constitutes 40% of all HAIs [9]. This may be elucidated through the fact that our study only included ICU patients and not all hospitalized patients, in addition to the well-known high use of mechanical ventilation, which is frequently used in patients with critical illnesses **[10]**. Furthermore, some research results found that teaching hospitals had a higher incidence of device-associated infections (DAI) as compared to nonteaching hospitals **[11, 12]**.

Negm et al. also discovered that positive sputum isolates were the most common in different intensive care units, such as emergency, pulmonary, and pediatric units. Based on clinical, radiological, and laboratory results; local observation of these units revealed that ventilator-associated pneumonia was found to be the most prevalent **[13]**. In the study by Shao et al., 64.75% of all nosocomial infections were respiratory tract infections, with urinary tract infections accounting for 9.4% and bloodstream infections accounting for 7.96% **[14]**.

In contrast to our findings, Shebl et al. discovered in their analysis of 554 bacterial isolates that specimens of urine had the greatest prevalence of all isolates (41.5%, n = 230), followed by blood (23.1%, n = 128), whereas sputum samples had the lowest occurrence (17%, n = 94) **[15]**. According to Klevens et al., over 30% of all infections treated in intensive care units, are due to urinary tract infections **[16]**. This highlights the importance of reviewing clinical practices for infection localization. It is mandatory to focus more on lowering the frequency of invasive procedures as much as possible or attempting to restrict the duration of these procedures when possible **[17]**.

Infections caused by gram-negative microorganisms have recently been found to be on the rise around the world. Our findings revealed that the most prevalent pathogens recovered were Gram-negative pathogens (84.27%), this could be attributed to their widespread presence in the hospital environment. Furthermore, their antibiotic resistance may contribute to their survival and spread. K. pneumoniae, a gram-negative bacteria, was the most often identified (39.01%).

This was consistent with Harbade et al. who discovered that gram-negative bacilli caused the vast majority of ICU-acquired illnesses, with Klebsiella pneumonia being the most commonly isolated pathogen **[19]**. Our findings were also consistent with Tabah et al.***'s*** study, which found that gram-negative bacteria were the most commonly encountered pathogens (59.0%) **[17]**, as well as that of Wang et al **[20]** which stated that Gram-negative bacteria were determined to be the most abundant isolates (68.4%) but the last two studies disagreed with our results regarding the most prevalent microorganism; Klebsiella spp. being the most prevalent gram-negative bacillus according to Tabah et al.**[18]** and Acinetobacter (31.6%) dominating, followed by Pseudomonas aeruginosa (13.4%), according to Wang et al. **[20]**. This discrepancy may be attributed to differences in the source of infection.

Antibiotics are among the primary cornerstones of modern medicine, and they serve a crucial role in the prevention as well as the treatment of infectious diseases. Identifying bacterial infections and selecting an antibiotic that is effective against that specific organism is crucial for successful bacterial infection treatment **[21]**. Unreasonable antimicrobial usage is the most significant contributor to the rising risk of resistance, particularly in developing nations **[22]**. It is important to note that antimicrobial treatment needs to consider information on the local incidence of pathogenic microorganisms and their antibiotic resistance pattern, contrary to global standards.

K. pneumoniae was the most frequent microbe in our study (39.01%) and showed a significant level of resistance to carbapenem (86% to meropenem and 87% to imipenem), whereas a study by Qadeer et al. discovered a lower level of resistance (56% to meropenem and 55% to imipenem) **[23]**. However Sheth et al. discovered 100% carbapenem sensitivity **[24]**, and Rajan et al. found 28.13% carbapenem resistance **[25]**. In the current investigation, there was a strong pattern of resistance to third-generation cephalosporins (95% for ceftriaxone) and fourth-generation cephalosporins (96% for cefepime). Aminoglycosides also demonstrated 88% and

78% for gentamicin and amikacin, respectively. By our results, 3rd-generation cephalosporins (94% to ceftazidime, 82% to ceftriaxone, and 70% to cefoperazone/sulbactam) and aminoglycosides (61% to gentamicin, 48% to amikacin) also exhibited a significant pattern of resistance in Qadeer et al.'s study **[23]**. In Gunjal et al.'s study also, there was 60% amikacin resistance and 80% gentamicin resistance **[26]**. In our investigation, colistin was the most efficient antibiotic, which had 5% resistance then followed by tigecycline, which had 25% resistance. In Qadeer et al.'s investigation, the antibiotic discovered to be the most efficient against multidrug-resistant *Klebsiella* was tigecycline, with 100% sensitivity **[23]**.

E. coli, the second most prevalent bacterium in our study (14.56%), demonstrated 11% and 13% resistance to colistin and tigecycline, respectively, as well as substantial resistance to the cephalosporins with 91.5% for ceftriaxone (third-generation) and 94% for cefepime (fourth-generation). This is consistent with Qadeer et al.'s study results of 33% tigecycline resistance in *E. coli*, as well as significant resistance to 3rd-generation cephalosporins (93% for ceftazidime and 90% for ceftriaxone). Furthermore, Al Mohammady et al. found more than 90% *E. coli* resistance to third-generation cephalosporins **[27]**. Resistance to carbapenem was 52% with imipenem and 58% with meropenem. According to this study's results, Qadeer et al. revealed that carbapenem resistance is just 10%. **[23]**. This might be due to different isolates among these studies. According to Gunjal et al., 28.10% of *E. coli* isolates were amikacin-resistant and 48.20% were gentamicin-resistant, which are near to our results; resistance to both amikacin and gentamicin being 42% and 48%, respectively. **[26]**. Colistin demonstrated 11% resistance to E. coli in this investigation.

Our findings demonstrated that carbapenem resistance is quite common among Acinetobacter (third most common bacteria 11.18%); 90% for imipenem, and 91% for meropenem. The investigation by Qadeer et al. revealed complete carbapenem resistance **[23]**. Another study conducted by Negm et al. found that carbapenem resistance was prevalent among Acinetobacter, with 79.9% imipenem resistance and 79.7% meropenem resistance **[13]**. In contrast, Rajan et al. discovered 52% carbapenem resistance in Acinetobacter. **[25]**. This difference can be due to the small number of patients in the Rajan et al. study which included 501 from medical ICUs and 195 patients from surgical ICUs.

Acinetobacter was resistant to cephalosporins with 95% for ceftriaxone (third-generation) and 6 % for cefepime (fourth-generation), amino-glycosides with gentamycin and amikan resistance of 84%, 78% respectively, and quinolones resistance of 91% for ciprofloxacin and 95% for levofloxacin in our investigation. By our results, Acinetobacter was found to be extremely resistant to 3rd-generation cephalosporins (100% for ceftazidime), aminoglycosides with 97% for gentamicin and 95% for amikacin, and fluoroquinolones (100% for ciprofloxacin) in Qadeer et al.'s study **[23]**.

In this study, Colistin was the most effective medication, with 15% resistance, followed by tigecycline (24%). Colistin was the most successful medicine in Qadeer et al.'s research, in agreement with our research results, with only 3% resistance **[23]**. Similarly, Rajan et al. **[25]** found colistin to be efficient against *Acinetobacter*, whereas the antibiotic tigecycline was discovered to be most efficient against Acinetobacter by Hasan et al. **[28]**.

In our study, *Pseudomonas*, the fourth most common gram-negative bacteria (10.32%), demonstrated carbapenem resistance with 87% for imipenem and 84% for meropenem. *Pseudomonas* resistance to carbapenems was found to be significantly substantial, as our results, in a study conducted by Negm et al **[13]** (82.7% for Imipenem and 84.7% for meropenem). Our results were disagreeing with those of Qadeer et al.'s investigation which stated that Pseudomonas demonstrated decreased carbapenem resistance (59% imipenem/ meropenem) **[23]**. Rakheeet al. **[28]** whose results discovered 20.8% imipenem resistance to *Pseudomonas* and Rajan et al. **[25]** who identified 12.9% resistance to carbapenems among *Pseudomonas*. Which are also discordant with our results. Differences in the number of patients and sources of the infection may explain such discrepancy.

Pseudomonas demonstrated also substantial resistance to cephalosporins with 100% for ceftriaxone and 87% for cefepime whereas aminoglycosides demonstrated resistance with 79% for gentamicin and 76% for amikacin. In agreement with our results *Negm et al.'s* study **[13]**, demonstrated strong *Pseudomonas* resistance to cephalosporins with 100%for ceftriaxone and 86.2% for cefepime whereas aminoglycosides showed resistance with 80.4% for to gentamicin and 78.2% to amikacin. On the other hand, Radji et al. discovered that ceftriaxone had a resistance rate of 60.9% and that amikacin, with a resistance rate of 15.6%, was the highly efficient antibiotic against Pseudomonas [30]. Colistin was determined to be the highly efficient antibiotic against *Pseudomonas* in our study, with a resistance rate of only 8%.

Staph. hominis (coagulase-negative staphylococci) was the most frequent gram-positive organism, which accounted for 43.2% of all gram-positive organisms, and had 95% and 98% sensitivity to vancomycin and linezolid, respectively. *Staph. aureus* (coagulase-positive *Staphylococci)* accounted for 19.1% of the total organism, whereas MRSA accounted for 90.5%, and showed 87% and 100% susceptibility to vancomycin and linezolid respectively. Vancomycin resistance in MRSA may be attributed to its extended and subsequent use in empirical therapy. Negm et al. agreed with our results stating that coagulase-negative *Staphylococcus* (CoNS) (26.43%) was the most frequently isolated gram-positive organism, followed by *Staph. aureus* (19.24%) **[13]**, whereas ***Chidambaram et al.*** found that among gram-positive isolates, *Enterococcus* (4.79%) was the most commonly isolated, followed by *Staphylococcus aureus* (3.7%) **[31]**.

In our study, fungal growth accounted for less than 1% of the total. In contrast, Savanur et al. discovered fungal development in 15.1% of the cases **[32]**. This disparity may be attributable to false-negative reports in our institution, which may be connected to a lack of information regarding the importance of fungal investigations in surgical and emergency ICUs.

Because our hospital is a referral tertiary care facility, the high frequency of resistance found in our investigation could be attributed to prior antibiotic use, prior gram-negative bacterial infections, an unsuitable antibiotic treatment, and patients arriving with severe sepsis and this enhances the chance of the development of multidrug-resistant organisms. This high frequency of resistance is concerning since it necessitates constant surveillance to analyze the sensitivity and resistance pattern at certain levels, which could aid in the selection of the optimal antimicrobial treatment.

Given the large, dangerous, and alarming occurrence of antimicrobial resistance as well as the limited options for empirical antibiotics, a comprehensive antimicrobial resistance campaign should be made a national priority. This program includes carrying out infection-control policies, the antimicrobial stewardship program, quality, and education. Using existing antibiogram data, antibiotics will be the only solution for our intensive care units. Combinations and the provision of newly accessible antibiotic generations in our facility until the antimicrobial stewardship program is fully implemented, not only within our hospital ICUs but in all Egyptian healthcare institutions.

Our research was hampered by a lack of clinical information to discriminate between infections acquired in hospitals and the community, as well as the data needed to distinguish between actual infection and colonization.

CONCLUSION

In conclusion, the current study provided local baseline epidemiological data that reveals the scope of our tertiary care hospital's ICU infection problem and can be used to track trends via the construction of cumulative antibiograms and evaluate the effectiveness of preventive measures shortly. It also showed the problem of high ICU infection rates in Zagazig University Hospitals. To protect the potential of the existing antimicrobial drugs, this local prevalence analysis will help build efficient antimicrobial stewardship. For instance, the use of carbapenem-sparing strategies is highlighted by the high resistance of gram-negative bacteria to the drug. Additional prospective multicenter epidemiological studies in multidisciplinary ICUs are needed to appropriately employ antimicrobial stewardship as a strategy for reducing antibiotic resistance in intensive care units across the nation.

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HIGHLIGHTS

- Provide local baseline epidemiological data that reveals the scope of our tertiary care hospital's ICU infection problem and can be used to track trends via the construction of cumulative antibiograms and evaluate the effectiveness of preventive measures soon.
- Help build efficient antimicrobial stewardship. For instance, the use of carbapenem-sparing strategies is highlighted by the high resistance of gram-negative bacteria to the drug.
- Additional prospective multicenter epidemiological studies in multidisciplinary ICUs are needed to appropriately employ antimicrobial stewardship as a strategy for reducing antibiotic resistance in intensive care units across the nation.

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