ORIGINAL ARTICLE

Controlling Antibiotic resistance through antibiotic stewardship at Al-Hussin University Hospital

Naglaa G. Abo El Azayem , Hossam F. M. El Zamek, Mohammed H. Y. M. Sokkar *

Department of Clinical Pathology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: ***Among the most deadly types of hospital-acquired infections, those involving central venous catheters account for over half of all cases. These infections lead to longer hospital stays, higher medical bills, and even death for patients. The majority of current methods for preventing catheter-associated infections involve the use of antibiotics; however, due to the worldwide increase in antibiotic resistance, these medications are often rendered useless.***

The aim of the work: ***Is to help clinicians select the best empiric antimicrobial treatment in emergency cases or after major surgery to achieve more rapid administration of effective antimicrobial therapy and decrease multidrug resistance.***

Patients and Methods: ***This descriptive observational study involved 200 patients admitted to different intensive care units (ICUs) at Al-Hussin University Hospital. These patients were exposed to bacterial infections, and samples were collected. All samples were subjected to bacterial culture and antibiotic sensitivity testing.***

Results: ***The study was conducted on 200 patients, including Gram-negative (76%) and Gram-positive (24%) isolates. The most common isolated bacteria were Klebsiella spp. (45.5%) followed by E. coli (23%), then methicillin-sensitive Staphylococcus aureus (MSSA) (13.5%), methicillin-resistant Staphylococcus aureus (MRSA) (10.5%), and Pseudomonas spp. (7.5%). This study showed 98.08% Colistin (CL) susceptibility and 95.28% Tigecycline (TGC) susceptibility for Klebsiella spp., in addition to 96.82% Colistin susceptibility and 97.34% Tigecycline susceptibility for E. coli.***

Conclusion: ***Colistin and Tigecycline should be considered as the most effective drugs. The antibiotic stewardship committee should meet monthly for follow-up and every three months to present updates to hospital management and updates on antibiograms if necessary.***

Keywords: Antibiotic resistance; Antibiotic stewardship; Antibiogram

1. Introduction

Optimizing the use of antimicrobials in healthcare settings is the goal of antimicrobial stewardship, a set of coordinated interventions. Antimicrobial stewardship initiatives are primarily spearheaded by physicians with training in infectious diseases and clinical pharmacists, but clinical microbiologists can also be essential in this effort.[1] Antibiotics are potent medications that fight diseases that were once lethal. Antibiotics have several side effects, as do all potent medications. However, patients continue to be susceptible to the negative effects and do not gain any benefits from antibiotics if they are taken needlessly. Not only that, but antibiotics change the infectious agent's makeup, which causes bacteria to evolve or mutate, creating new strains that can withstand the antibiotics used now.[2] Antibiotic resistance has emerged as a major concern for human health worldwide in the modern era.[3] Bacteria have evolved various resistance mechanisms that allow them to evade antibiotics, further exacerbating the problem.[4] Misuse of antibiotics is prevalent and can reach alarming proportions when prescribed without a clear indication. The availability of antibiotics as over-the-counter (OTC) medications for both humans and animals contributes to the rise and dissemination of drug-resistant infections.[5]

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* Corresponding author at: Clinical Pathology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt.
E-mail address: sokkar02016@gmail.com (M. H. Y. M. Sokkar).

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Reducing antibiotic use, improving patient care, and providing cost-effective healthcare are the goals of antimicrobial stewardship. In many healthcare facilities, antimicrobial stewardship programs have demonstrated encouraging outcomes. Reported benefits include a decrease in Clostridium difficile infections, an improvement in dosing for patients with renal impairment, a decrease in death rates, a reduction in antimicrobial resistance, and cost savings for hospitals.[6] The aim of the work: Help clinicians select the best empiric antimicrobial treatment in emergency cases or after major surgery, to achieve more rapid administration of effective antimicrobial therapy, and to decrease multidrug resistance. Methods: All samples were subjected to bacterial culture and antibiotic sensitivity testing.

This study aimed to decrease multidrug resistance, expedite the delivery of effective antimicrobial therapy, and assist doctors in making the best empiric treatment decisions in emergency situations (e.g., following a major operation or an accident).

2. Patients and methods

This study was carried out from April 2023 to May 2024, in the Microbiology Laboratory Unit of the Clinical Pathology Department at the Al-Hussein University Hospital. In this study, 200 patients admitted to different ICUs were investigated. Each patient has a full history including age, sex, marital status, residence, occupation, complaint, family history, and history of previous antibiotic use 2 weeks ago before admission, history of immunosuppressive drugs, diabetes mellitus or chemotherapy. Physical examination was also done. All samples were cultured on blood agar, MacConkey agar, Sabouraud Dextrose agar, or Cystine-lactose-electrolyte-deficient agar (CLED). The samples were incubated aerobically at 37°C for 18 to 24 hours, in the first 30 minutes after collection. The Kirby-Bauer Method was conducted for antibiotic susceptibility tests using the disc diffusion method. To ensure even growth and inoculum distribution across the entire plate, a 15cm diameter petri dish with Muller-Hinton agar was swabbed in three directions. Then, within 15 minutes of inoculation, antimicrobial discs were applied, the plate was inverted and incubated at 37°C for 18-24 hours.

Statistical Analysis

A statistical application developed for social science research, SPSS version 24, was used to examine the data. The mean ± standard deviation (SD) was used to express numerical data. The frequency and percentage were used to convey the qualitative data. To check if the quantitative data were normal, the Shapiro-Wilk and Kolmogorov-Smirnov tests were used. To compare two means (for correctly distributed data), the independent-sample t-test of significance was utilized. Non-parametric data were compared using the chi-square test.

A positive stomach biopsy culture was linked to certain risk factors that were identified using multivariate logistic regression analysis.

For probability (P-value), a value below 0.05 was considered significant, a value below 0.001 was considered extremely significant, and a value over 0.05 was considered insignificant.

3. Results

The data of the 200 patients included in this study are presented in the following tables. Table (1) shows that 152 (76%) isolates from these patients were Gram-negative isolates and 48 (24%) were Gram-positive isolates. There were 91 isolates (45.5%) of Klebsiella spp., 46 isolates (23%) of E. coli, 15 isolates (7.5%) of Pseudomonas spp., 48 isolates of Staph (24%); 27 isolates (13.5%) of them were MSSA and 21 isolates (10.5%) were MRSA.

Table 1. Description of isolated organism in all studied patients.

		Studied patients (N = 200)	
Gram stain	Gram-negative	152	76%
	Gram-positive	48	24%
Isolated organism	*E Coli*	46	23%
	Klebsiella	91	45.5%
	Pseudomonas	15	7.5%
	MSSA	27	13.5%
	MRSA	21	10.5%

As regards the correlation between sample type and antibiotic sensitivity results in Klebsiella spp. , the best sensitivity results in Klebsiella spp. isolates were obtained from CL (88 isolates, 98.08%) and TGC (86 isolates, 94.5%). In urine samples (n = 21), Nitrofurantoin (NIT) was sensitive in 13 isolates (61.9%) (Table 2).

Table 2. Correlation between sample type and antibiotic sensitivity results in Klebsiella spp.

	KLEBSIELLA SPP. (N = 91)	SAMPLE TYPE					
		Blood (N = 51)		Sputum (N = 19)		Urine (N = 21)	
SENSITIVE ANTI-BIOTICS	Azithromycin(ATM)	2	3.9%	1	5.3%	0	0%
	Cefepime (CPM)	7	13.7%	2	10.5%	0	0%
	Cefoxitin (FOX)	10	19.6%	8	42.1%	5	23.8%
	Ceftazidime (CAZ)	0	0%	2	10.5%	0	0%
	Ceftriaxone (CIR)	0	0%	0	0%	0	0%
	Cefaclor (CF)	2	3.9%	0	0%	2	9.5%
	Piperacillin (PRL)	0	0%	0	0%	1	4.8%
	Norfloxacin (NOR)	0	0%	0	0%	0	0%
	Ciprofloxacin (CIP)	1	2%	0	0%	0	0%
	Levofloxacin (LEV)	3	5.9%	2	10.5%	3	14.3%
	NIT	-----	------	------	------	13	61.9%
	Ipimenem (IPM)	0	0%	0	0%	0	0%
	Meropenem (MEM)	0	0%	0	0%	0	0%
	Amikacin (AK)	2	3.9%	0	0%	1	4.8%
	TGC	50	98%	16	84.2%	20	95.2%
	CL	50	98%	18	94.7%	20	95.2%

As regards the correlation between sample type and antibiotic sensitivity results in E.Coli., the best sensitivity results with E.Coli isolates obtained from CL (44 isolates, 95.6%), TGC (44 isolates, 95.6%) , Imipenem (IPM) and Meropenem (MEM) (43 isolates, 93.47%). In urine samples (n = 11), NIT was sensitive in 9 isolates (81.8%) (Table 3).

Table 3. Correlation between sample type and antibiotic sensitivity results in E.Coli.

E.COLI (N = 46)	SAMPLE TYPE					
	Blood (N = 25)		Sputum (N = 10)		Urine (N = 11)	
SENSITIVE ANTI-BIOTICS						
ATM	1	4%	0	0%	1	9.1%
CPM	13	52%	10	100%	9	81.8%
FOX	14	56%	10	100%	10	90.9%
CAZ	0	0%	2	20%	2	18.2%
CIR	0	0%	0	0%	0	0%
CF	0	0%	0	0%	0	0%
PRL	4	16%	0	0%	0	0%
NOR	2	8%	0	0%	2	18.2%
CIP	6	24%	0	0%	1	9.1%
LEV	1	4%	1	10%	0	0%
NIT	-----	------	-----	------	9	81.8%
IPM	24	96%	9	90%	10	90.9%
MEM	24	96%	9	90%	10	90.9%
AK	3	12%	2	20%	2	18.2%
TGC	24	96%	10	100%	10	90.9%
CL	24	96%	9	90%	11	100%

As regards the correlation between sample type and antibiotic sensitivity results in gram-positive isolates, there was a significant difference (p-value = 0.027) in the percentage of (LEV) sensitive sputum samples (9 patients, 60%) when compared with blood samples (29 patients, 87.9%) (Table 4) .

Table 4. Correlation between sample type and anti-biotic sensitivity results in gram positive isolates.

GRAM POSITIVE ISOLATES (N = 48)	SAMPLE TYPE				X^2	P-VALUE
	Blood (N = 33)		Sputum (N = 15)			
SENSITIVE ANTI-BIOTICS						
FOX	17	51.5%	10	66.7%	0.96	0.327 NS
CIR	22	66.7%	8	53.3%	0.78	0.376 NS
LEV	29	87.9%	9	60%	4.8	0.027 S
Linezolid (LZ)	31	93.9%	12	80%	2.1	0.143 NS
AK	8	24.2%	1	6.7%	2.09	0.148 NS
Gentamycin (CN)	28	84.8%	13	86.7%	0.027	0.869 NS
CTX	17	51.5%	10	66.7%	0.96	0.327 NS
Amoxicillin clavulanic acid (AMC)	17	51.5%	10	66.7%	0.96	0.327 NS
Vancomycin (VA)	25	75.8%	12	80%	0.1	0.746 NS
Clindamycin (DA)	26	78.8%	13	86.7%	0.42	0.517 NS
Erythromycin (E)	28	84.8%	13	86.7%	0.027	0.869 NS
Penicillin (P)	3	9.1%	0	0%	1.45	0.228 NS
TGC	32	97%	15	100%	0.46	0.496 NS

As regards the study carried out at Al-Hussin University Hospital, Klebsiella spp. was the most organism isolated from different ICUs with the best sensitivity results were obtained from CL (96.7%) and TGC (94.5 (Table 5).

Table 5. Cumulative Antibiogram at Al-Hussin University Hospital during the period between April 2023 and May 2024.

	COLISTIN	TIGECYCLINE	NITROFURANTOIN	CEFEPIME	LEVOFLOXACIN	CEFACLOR	PIPERACILLIN	IMIPENEM	MEROPENEM
KLEBSIELLA SPP. 91 CASE	88 96.7%	86 94.5%	13 59%	9 9.9%	8 8.8%	4 4.4%	1 1.1%	0 0%	0 0%
E. COLI 46 CASE	44 95.7%	44 95.7%	9 81.8	32 69.6%	2 4.3%	0 0%	4 8.7%	43 93.47%	43 93.47%
PSEUDOMONAS 15 CASE	13 86.7%	15 100%	6 100%	5 33.3%	15 100%	12 80%	11 73.3%	14 93.3%	14 93.3%
	Cefoxtin	Amoxicillin clavulanic acid	Tigecycline	Linezolid	Gentamycin	Erythromycin	Vancomycin	Clindamycin	Levofloxacin
STAPHYLOCOCCUS AUREUS 48 CASE	27 56.2%	27 56.2%	47 97.9%	43 89.5%	41 85.4%	41 85.4%	37 77.0%	39 81.2%	38 79.1%

As regards the correlation between sample type and antibiotic sensitivity results in MSSA, the best sensitivity results with MSSA isolates were obtained from (FOX), (CTX), (AMC) and TGC (27 isolates, 100%) LEV (17 isolates, 62.9%) (LZ) (24 isolates, 88.8%) (CN) and (E) (22 isolates, 81.5%) (VA) (21 isolates, 77.7%) (Table 6).

Table 6. Correlation between sample type and anti-biotic sensitivity results in MSSA.

MSSA (N = 27)	SAMPLE TYPE					
	Blood (N = 17)		Sputum (N = 10)		Urine (N = 0)	
SENSITIVE ANTI-BIOTICS						
FOX	17	100%	10	100%	----	----
CIR	6	35.3%	3	30%	----	----
LEV	13	76.5%	4	40%	----	----
LZ	15	88.2%	9	90%	----	----
AK	3	17.6%	0	0%	----	----
CN	14	82.4%	8	80%	----	----
CTX	17	100%	10	100%	----	----
AMC	17	100%	10	100%	----	----
VA	13	76.5%	8	80%	----	----
DA	12	70.6%	8	80%	----	----
E	14	82.4%	8	80%	----	----
P	3	17.6%	0	0%	----	----
TGC	17	100%	10	100%	----	----

As regards the correlation between sample type and antibiotic sensitivity results in MRSA, the best sensitivity results with MRSA isolates were obtained from LEV and CIP (21 isolates, 100%) and

TGC (20 isolates, 95.2%) LZ, CN, DA and E (19 isolates, 90.5%) and VA (16 isolates, 76.2%) (Table 7).

Table 7. Correlation between sample type and anti-biotic sensitivity results in MRSA.

MRSA (N = 21)		SAMPLE TYPE					
		Blood (N = 16)		Sputum (N = 5)		Urine (N = 0)	
SENSITIVE ANTI-BIOTICS	FOX	0	0%	0	0%	----	----
	CIR	16	100%	5	100%	----	----
	LEV	16	100%	5	100%	----	----
	LZ	16	100%	3	60%	----	----
	AK	5	31.3%	1	20%	----	----
	CN	14	87.5%	5	100%	----	----
	CTX	0	0%	0	0%	----	----
	AMC	0	0%	0	0%	----	----
	VA	12	75%	4	80%	----	----
	DA	14	87.5%	5	100%	----	----
	E	14	87.5%	5	100%	----	----
	P	0	0%	0	0%	----	----
	TGC	15	93.8%	5	100%	----	----

4. Discussion

In this study, 200 patients were evaluated. There were 152 Gram-negative isolates (76%) and 48 Gram-positive isolates (24%) of all studied patients. There were 91 isolates (45.5%) of Klebsiella spp., 46 isolates (23%) of E. coli, 15 isolates (7.5%) of Pseudomonas, 48 isolates of Staph (24%); 27 isolates (13.5%) of them were MSSA and 21 isolates (10.5%) were MRSA. This study was concordant with the study of Negm et al.,[7] conducted at Zagazig University Hospitals, which revealed that the majority of pathogens were Gram-negative bacteria (74.41%). Of them, Klebsiella pneumoniae was the most common, with an incidence of 33.51%, followed by Escherichia coli with a manifestation of 19.3%. This study also agreed with the one conducted by Tahia et al.,[8] which has also been applied at Zagazig University Hospitals and demonstrated that Gram-negative bacteria were the most commonly identified pathogens (84.27%), with Klebsiella pneumoniae being the most often detected one with a 39.01% incidence, followed by Escherichia coli with a 14.56% incidence. Also, this study was in agreement with Tahsin Salam, et al.,[9] which demonstrated that isolates of Escherichia coli (24.71%) but not concordant with isolates of Acinetobacter spp. (20%), isolates of Klebsiella spp. (14.12%), and isolates of Pseudomonas spp. (30.59%). But this study was not concordant with Garima Gautam, et al.,[10], the most prevalent organisms recovered from different clinical specimens were Acinetobacter spp. (33.12%), Klebsiella pneumoniae (20.89%), and Escherichia coli (13.8%). In terms of Gram-positive bacteria, Staphylococcus aureus (16.78%) and Enterococcus spp. (3.73%) were the most prevalent. In addition, not everyone agreed with this study. Manoj et al.,[11] study showed that gram-negative bacteria were most frequently found; specifically, E. coli, Pseudomonas aeruginosa, and Klebsiella spp. were the most and least frequently isolated organisms, respectively.

Regarding the description of antibiotic sensitivity results in Klebsiella spp. Isolates, this study was concordant with the study of Tahia, et al.,[8] which has been applied at Zagazig University Hospitals and demonstrated that Colistin is the most effective used antibiotic, with sensitivity for Klebsiella spp., E. coli, Pseudomonas aeruginosa, and Acinetobacter spp. of 95, 89, 92, and 85%, respectively. As regards the sensitivity to Tigecycline, it was 87% for E. coli, 76% for Acinetobacter spp. and 75% for Klebsiella spp.. However, the sensitivity of Carbapenem for these organisms was remarkably low. Similarly, this study was concordant with the study of Negm et al.,[7] It has been used at Zagazig University Hospitals and proved that Colistin is the best antibiotic with sensitivity levels of 96.2% against Klebsiella spp., 94.7% against E. coli, and 89.9% against Acinetobacter spp., respectively, whereas carbapenem sensitivity was very low. It was also agreed in this study, Tahsin Salam, et al.,[9], that they were the most susceptible to Colistin. As well, this study was concordant with Gautam et al.,[10] which demonstrated that Klebsiella spp. was found to be the most susceptible to Colistin. According to Said et al.,[12] the results of the Saudi Arabian study corroborated those of the current investigation, showing that the isolates exhibited complete resistance to all antibiotics except amikacin (61.25%). However, it was determined that Colistin was once again completely susceptible to E. coli. This is why you should not use Colistin unless the antibiotic susceptibility patterns demand it. This study was not concordant with Manoj et al.,[11] results showed that ciprofloxacin (44% of patients), cefoperazone (48% of patients), piperacillin-tazobactam (62% of patients), and amikacin (65% of patients) were more susceptible. There are several reasons why studies conducted in Egypt, such as this one, have shown different results compared to their Western counterparts. These include environmental factors, overcrowding, patient health and socioeconomic status, health awareness campaigns, poverty, low levels of education, self-medication, antibiotic overprescribing, over-the-counter availability, insufficient dosage, outdated training, and antibiotic overuse. The study was also carried out at Al-Hussin University Hospital, which provides healthcare to nearby areas marked by informal settlements, various diseases, low levels of education, and a general lack of health awareness. As a result, the prevalence of antibiotic resistance among bacteria in these areas is higher than in other hospitals and environments. Not only that, but Al-Hussin University Hospital is both a university hospital and a central medical facility, meaning that it treats patients from all across Egypt. This range of patient demographics is unusual for hospitals and clinics.

4. Conclusion

According to the results of this study, the best empirical antibiotics are Colistin and Tigecycline. In order to manage antibiotic resistance, it is crucial to have evidence-based knowledge about the local bacterial species and their pattern of antibiotic resistance before deciding on empirical medication therapy. A hospital's antibiotic stewardship committee should meet together once a month for follow-up and once every three months to report on developments to the upper management.

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