Section: Microbiology

Original Research Article

EVALUATION OF ANTIMICROBIAL RESISTANCE AND ASSOCIATION OF BACTERIAL ORGANISMS ISOLATED FROM SURGICAL PROCEDURES OCCURRING UNDER TERTIARY CARE HOSPITAL IN MADHYA PRADESH

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ABSTRACT

Background: Today, antimicrobial resistance is regarded as a serious risk to world health. Although antibiotic resistance can develop naturally, there are a number of factors that can contribute to its emergence and acceleration, including over prescription and abuse of antibiotics. The present study was conducted to estimate the patterns of antimicrobial susceptibility of isolates at a rural hospital in the Madhya Pradesh. **Materials and Methods:** This is a hospital based cross-sectional study conducted in the Department of Microbiology and in collaboration with the Department of Surgery, Index Medical College, Hospital and Research Centre, Indore conducted between 2022 and 2024. All SSI patients with clinical evidence of infection were included in the study i.e 150 out of 15935. Identification of the bacteria in aerobic culture was done using phenotypic method. Antibiotic sensitivity test was performed by Kirby-Bauer disc diffusion method for all isolates according to the latest CLSI M100 guidelines. **Result:** Out of total 150 isolates, 31 (20.7%) were gram-positive isolates while 119 (79.3%) were gram- negative. Escherichia coli 59 (39.3%) was found to be most common isolate followed by Staphylococcus aureus 31(24.34%), Klebsiella pneumoniae 22 (14.7%), P. aeruginosa 17 (11.3%), A. baumannii 8 (5.3%), Enterobacter spp. 5 (3.3%), Citrobacter spp. 4 (2.7%) and Proteus spp. 4 (2.7%). **Conclusions**: Resistance to commonly used antibiotics and sensitivity to higher antibiotics by various cultured organism in present study signifies the prevalence of multidrug resistant organism in our hospital leaving clinicians with few choices of drugs like carbapenems and polymyxins, for the treatment of patients with SSIs.

INTRODUCTION

Today, antimicrobial resistance is regarded as a serious risk to world health. Although antibiotic resistance can develop naturally, there are a number of factors that can contribute to its emergence and acceleration, including over prescription and abuse of antibiotics. Due to the accompanying morbidity, mortality, and substantial cost ramifications, antibiotic resistance has made infections challenging to treat and may have an impact on the standard of care provided to a surgical patient.[1] Globally, SSI-associated bacterial resistance trends differ based on geographic location, local epidemiology data, and susceptibility testing procedures. High-income nations provided the majority of the medication resistance data.[2]

Because of their broad spectrum of activity, safety profile, and demonstrated therapeutic efficacy, beta-lactam antibiotics are the most often used antibiotics for SSI prophylaxis and therapy; however, between 30% and 90% of antibiotics are abused or misused. This unwarranted misuse raises the risk of SSI worldwide by raising selection pressure, favouring the formation of drug-resistant bacteria, complicating and increasing the cost of empirical therapy selection, and posing a major threat to public health.[3] Irrational antibiotic medications and outdated empirical therapy have made the situation worse. Therefore, to reduce the issue, strong epidemiological data from continuous nosocomial infection surveillance or data from clinical laboratories' antibiotic susceptibility testing are required. In developing countries such as India, there is a relative scarcity of data on the bacteria and their antimicrobial susceptibility patterns among surgical site infection cases.[3]

In India, between 60 and 70 percent of people reside in rural areas. Hospitals located in remote areas typically have subpar health care and poorly designed HAI surveillance systems. Microorganism groups with variable antimicrobial susceptibility patterns causing surgical site infections vary from hospital to hospital and time to time. Therefore continuous research is needed.

In order to highlight the issue and create regional and national plans to avoid and manage its burden, there is a dearth of current evidence data on the bacterial causes of SSIs and their patterns of antibiotic susceptibility in the Malwa region. In order to estimate the patterns of antimicrobial susceptibility of isolates at a rural hospital in the Malwa region, the current investigation was conducted. This research will assist in giving surgeons guidance for reasonable antibiotic selection in the treatment of surgical site infections.

MATERIALS AND METHODS

This hospital based cross-sectional study was conducted in the Department of Microbiology and in collaboration with the Department of Surgery, Index Medical College, Hospital and Research Centre, Indore. Study was planned for the period of two year from 2022 to 2024 and total of 150 patients' samples were taken from the Department of Surgery who underwent any emergency or elective surgeries & developed SSI out of 15935 patients. The study was carried out after approval from the Institutional Ethical Committee, written consent was obtained from all the patients.

All SSI patients with clinical evidence of infection were included during the study period. Patients of both sexes and all adults belonging to various surgical wards with superficial incision surgical site infections were included in the study. Exclusion criteria were paediatrics cases, cases taken for second surgery at the same site for any reason, patients on antibiotics already for any other infections. Patients' demographic details, clinical details and other relevant history were recorded in a proforma.

Specimen collection and transport

Clinical specimens were collected aseptically from the surgical site from suspected patients with SSI by adopting standard methods.[4] Two sterile disposable cotton swabs were collected and were transported to the microbiology laboratory for further study.

Clinical samples were processed and tested in the research department of Microbiology. Out of two collected swabs, one swab of each specimen was processed for Gram's staining. The second swab was used for enrichment in 5 ml sterile nutrient broth and incubated at 37°C for 24 hrs. Enriched broth was used for isolation of pathogens on Nutrient agar, 5% Sheep Blood agar, Mannitol salt agar and MacConkey agar by streaking method. The culture plates were incubated at 37°C for 24-48 hours. Plates were observed for growth. Well isolated colonies were picked up and identified on the basis of morphological, cultural and biochemical characteristics as per standard microbiological procedure.[4]

Antimicrobial sensitivity test

Antibiotic sensitivity test was performed by Kirby-Bauer disc diffusion method for all isolates according to the latest applicable CLSI M100 guidelines.[5] Following drug were tested: Piperacillin/tazobactam (PIT 100/10 µg), Cotrimoxazole (COT, 1.25/23.75 µg), Tetracycline (TE, 30µg), Ciprofloxacin (CIP, 5µg), Levofloxacin (LE, 5µg), Gentamicin (GEN, 10µg), Amikacin (AK, 30µg), Cefotaxime (CXM, 30µg), Cefotaxime + clavulanic acid (CXM-AX), Ceftazidime (CAZ, 30µg) , Ceftazidime + clavulanic acid (CAZ-AX), Cefepime (CPM, 30µg), Meropenem (MRP, 10 µg), Imipenem (IPM, 10µg), Colistin (CL), Tigecycline (TGC), Cefoperazone-Sulbactam (CPZ/S, 75/30µg), Tobramycin (TOB, 10 µg), Aztreonam (AT, 30µg), Cefoxitin (CX, 30µg), Clindamycin (CD, 2µg), Erythromycin (E, 15µg), Linezolid (LZ, 30µg), Vancomycin (VAN, 30µg). Statistical analysis was done using Microsoft Excel 2016 (Microsoft Corp., USA).

RESULTS

Bacterial profile

Out of total 150 isolates, 31 (20.7%) were gram-positive isolates while 119 (79.3%) were gram-negative. Escherichia coli 59 (39.3%) was found to be most common isolate followed by Staphylococcus aureus 31(24.34%), Klebsiella pneumoniae 22 (14.7%), P. aeruginosa 17 (11.3%), A. baumannii 8 (5.3%), Enterobacter spp. 5 (3.3%), Citrobacter spp. 4 (2.7%) and Proteus spp. 4 (2.7%). (Table 1)

Antimicrobial resistance

Escherichia coli isolates were highly susceptible to imipenem, meropenem, colistin and tigecycline. More than 50% isolates were resistant to piperacillin/tazobactam, tetracycline, ciprofloxacin, levofloxacin, gentamicin, cotrimoxazole, ceftazidime, cefepime, and cefotaxime.

Enterobacter spp. isolates were highly susceptible to imipenem, meropenem, cotrimoxazole, colistin and tigecycline. Only 25% isolates were susceptible to piperacillin/tazobactam, ceftazidime, cefepime, and ciprofloxacin. More than 80% isolates were resistant to cefoperazone sulbactam, amikacin, gentamicin, and cefotaxime.

Citrobacter spp. isolates were observed to be 100% susceptible to imipenem, meropenem, colistin and tigecycline. More than 75% isolates were resistant to piperacillin/tazobactam, tetracycline, cefepime, ciprofloxacin, levofloxacin, amikacin, gentamicin and cotrimoxazole.

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Klebsiella pneumoniae isolates were highly susceptible to imipenem, meropenem, colistin and tigecycline. More than 70% isolates were resistance to piperacillin/tazobactam, cotrimoxazole, tetracycline, ciprofloxacin, levofloxacin, amikacin, gentamicin, ceftazidime, cefotaxime and cefepime.

Proteus spp. isolates were found highly susceptible to imipenem, meropenem, piperacillin/tazobactam. More than 70% isolates were resistance to cotrimoxazole, tetracycline and amikacin. 50% isolates were resistance to ciprofloxacin, levofloxacin, gentamicin.

P. aeruginosa isolates were highly susceptible to imipenem, meropenem, gentamicin, ciprofloxacin, tobramycin, colistin and tigecycline. More than 70% isolates were resistant to piperacillin/tazobactam, amikacin, ceftazidime, cefoperazone sulbactam and aztreonam.

A. baumannii isolates were highly susceptible to tobramycin, colistin and tigecycline. Only 25% isolates were susceptible to piperacillin/tazobactam, ceftazidime, cefepime, imipenem, meropenem and ciprofloxacin. More than 80% isolates were resistant to cefoperazone sulbactam, amikacin, gentamicin, cotrimoxazole and cefotaxime.

S. aureus isolates, were found highly susceptible to gentamicin, linezolid, tetracycline and vancomycin. Around 55% were MRSA. Around 45% were susceptible to erythromycin, clindamycin, and cotrimoxazole. The antimicrobial susceptibility profile of all clinical isolates are shown in Table 2.

Table 1: Distribution of bacterial isolates in SSI

Organism	Number	Percentage
E. coli	59	39.3
S. aureus	31	20.7
Klebsiella pneumonia	22	14.7
P. aeruginosa	17	11.3
A. baumannii	8	5.3
Enterobacter Spp	5	3.3
Citrobacter spp	4	2.7
Proteus Spp	4	2.7
Total	**150**	**100**

Table 2: Antibiotic susceptibility pattern of Gram negative isolates in the study

	PIT	COT	TE	CIP	LE	GEN	AK	CXM	CXMAX	CAZ	CAZAX	CPM	IPM	MRP	TG
Enterobacterales															
E. coli (n=59)	45.8	20.3	37.3	25.4	25.4	44.1	69.5	11.9	40.7	33.9	61	30.5	81.3	78	100
Enterobacter spp. (n=5)	40	80	60	20	0	40	60	0	60	60	60	40	80	80	100
Citrobacter spp (n=4)	0	0	0	25	25	0	25	50	75	75	75	25	100	100	100
K pneumoniae (n=22)	9.1	22.7	36.4	22.7	22.7	9.1	22.7	9.1	31.8	31.8	36.4	9.1	54.5	54.5	81.8
Proteus spp. (n=4)	100	25	25	50	50	50	25	25	75	75	75	25	100	100	-
Non fermenters															
	PIT	COT	TE	CIP	LE	GEN	AK	AT	TOB	CAZ	CFS	CPM	IPM	MRP	TG
P. aeruginosa (n=17)	53	-	-	70.6	-	76.5	41.2	29.4	70.6	23.5	47	35.3	58.8	58.8	-
A. baumannii (n=8)	25	12.5	-	25	-	12.5	12.5	-	62.5	25	12.5	25	25	25	100
Gram positive															
	CX	COT	TE	CIP	LE	GEN	E	CD	LZ	VA	-	-	-	-	-
S. aureus (n=31)	54.8	42	87.1	25.8	-	67.8	48.4	45.2	93.5	100	-	-	-	-	-

DISCUSSION

The microorganisms causing healthcare facility infections have found a changed pattern in medical practices over the years.[6] The gram-positive organisms were found initially predominantly involved in surgical site infections but after a decade gram-negative organisms are being isolated at an increasing rate.[7] This pattern shift was noted in the present study, which found a high percentage of gram-negative bacteria as 119 (79.3%) than Gram-positive isolates 31 (20.7%) of the total isolates. Similar findings were also observed in the study of Abiodun et al,[1] Gemedo Misha et al,[2] Bhalodia et al.[8] Dahal et al[9] Abayneh M et al[10]

The commonest pathogen isolated from SSI was *E. coli* (39.3%). This was followed by *S. aureus* and *Klebsiella sp. E. coli* has also been reported as the commonest isolate from SSI in previous studies.[11-15] This was in contrast with some of the previous studies which reported S. aureus as the most common SSI bacterial pathogen.[16-18/20] The most frequent gram-

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negative bacterium linked to surgical infection in other trials was *E. coli* where S. aureus was the most prevalent gram positive isolate.[16,19-20] *E. coli* infections may have been the most common isolates from the study because they were primarily endogenous, meaning they are a typical component of intestinal flora. In the present study, most of the patients have undergone abdominal surgery, which supports E. coli being the most predominant organism.

Proper antibiotics played an important role in reducing the burden of surgical site infection in clinical practice globally. The major factor that promote resistance is inappropriate and irrational use of antibiotics. Numerous other aspects of the patient's surgical experience have been found to increase the likelihood of SSIs in a research by Abaynah et al.[10] ASA class ≥III, contaminated wound procedures, post-operative hospital stays exceeding 14 days, and co-morbid conditions such diabetes mellitus and anemia were all associated to a greater risk of SSIs. 50 (19.92%) of the participants in a research by Gemedo Misha et al[2]. (7) had one or more co-morbidities. The most prevalent ones were diabetes mellitus 6 (2.39%), respiratory disorders 7 (2.79%), psychiatric issues 7 (2.79%), and heart disorders 20 (7.97%). 24.3% of patients stayed in the hospital for >7 days prior to surgery.

In the present study, we reported a high rate of multi-drug resistance bacteria isolates. Considering the commonest isolates in this study, the resistance was very high to most of the antibiotics except imipenem, meropenem and amikacin. This was also similar to previous studies.[20,21] Quinolones are commonly prescribed antibiotics but the resistance to these drugs was very high in present study.

Previous studies also have shown high resistance to Quinolones.[22,23] This study's isolated E. coli showed a high susceptibility to amikacin, imipenem, and meropenem in comparison of earlier research.[13,24] In the current investigation, S. aureus was the second most prevalent isolate and the most prevalent gram-positive bacteria. According to the study, S. aureus is less sensitive to the majority of antibiotics. The findings in the present study were consistent with other researches' rising patterns of antibiotic resistance.[25-27] Abuse in the form of excessive use may be the origin of the high resistance pattern, which creates an environment conducive to resistance. Although the decreased antibiotic susceptibility of bacteria found in this study was not a surprising finding in surgical practice, surgeons should be concerned, especially in low- and middle-income nations where access to healthcare is a major problem.[1]

CONCLUSION

Resistance to commonly used antibiotics and sensitivity to higher antibiotics by various cultured organism in present study signifies the prevalence of multidrug resistant organisms in our hospital leaving clinicians with few choices of drugs like carbapenems and polymyxins, for the treatment of patients with SSIs. Surgeons should be concerned about the growing rate of antibiotic resistance after SSI. The need for antibiotics can be decreased by using them sparingly and sensibly and by strictly adhering to aseptic procedures during surgery. Therefore, the present study recommends effective antimicrobial stewardship and antibiotic treatment depending on the organisms' AST in order to stop the emergence and spread of MDR SSI. This includes the concerned authorities closely monitoring the antibiotics used as empirical therapy and prophylactics.

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