Pharmacology, Pharmaceutics and Toxicology Journal

https://www.harrisonacademicpress.com/index.php/PPTJ

Vol 1, Issue 1, 2026

The medication resistance profile of gastrointestinal and postbiliary surgical site infections in a tertiary care hospital

1. **V. LEELA LAKSHMI***, Asso. Professor, DEPT OF Pharmaceutics

2. **DR.M.Krishnaveni**, Professor ,dept of Pharmaceutics

3. **P.Padmavathi Devi**, Asst. Professor, dept of Pharmaceutics

4. **Mr. G. Dileep Kumar**, Asso. Professor, Pharmaceutical Analysis

5.**Dr.M. SREENIVASULU**, PRINCIPAL, NARAYANA PHARMACY COLLEGE

[1,2,3,4,5] NARAYANA PHARMACY COLLEGE, CHINTHA REDDY PALEM, NELLORE

Abstract:

In less developed areas, germs linked to surgical site infections (SSIs) are exhibiting symptoms of growing drug resistance, which is causing more serious problems and higher healthcare costs. Our goal in this research was to determine the pattern of drug resistance in our isolates connected to SSI. Over the course of two years, 191 clinically confirmed SSIs (postbiliary tract and postgastrointestinal surgery) were treated with wound swabs using conventional aerobic and anaerobic culture. The antibiotic's minimum inhibitory concentration (MIC) was found using the Epsilometer. Multidrug resistance phenotypes were found based on the criteria. Klebsiella, Staphylococcus, and Pseudomonas were the main causes of the 5.3% SSIs; no anaerobes were detected. A third of the Staphylococcus aureus bacteria had an increased macrolide minimum inhibitory concentration (MIC), and 19% of the bacteria were resistant to methicillin. It was discovered that around 58.2% of the Enterobacteriaceae isolates produced extended-spectrum beta-lactamases. We discovered isolates with a higher MIC for meropenem. MICs that are quickly approaching resistance in susceptible isolates are present in conjunction with the alarmingly rising percentage of antibiotic resistance in SSI patients. The legislation requires immediate corrective action.

Search Terms:

Methicillin-resistant Staphylococcus aureus, extended-spectrum beta-lactamase, surgical site infections, health care-associated infections, and minimum inhibitory concentration Surgical-site infections (SSIs) are related with increased rates of patient morbidity, mortality, and healthcare-associated expenses, even though they are preventable in more than half of cases.Surgical site infections (SSIs) are the most common kind of healthcare-associated disease (HAI), affecting up to 30% of patients who have surgery in low- and middle-income countries.[2] Up to 20% of all healthcare-associated infections (HAIs) in affluent countries are SSIs, making them the second most prevalent kind of HAI.[5]

Introduction

A thorough multicentric study that included data from six Indian cities found that the average SSI rate in this area was 4.2%.Medication resistance is common in hospital settings, where bacterial isolates linked to SSIs are often discovered. Extended surgical

prophylaxis and emergency procedures are two surgery-related characteristics that may be linked to drug resistance.As germs grow resistant, SSIs become more expensive and time-consuming for both patients and enterprises.The majority of SSI isolates in the Western world are Gram-positive, and many of them are drug-resistant.[5] Comparable statistics from low- and medium-income countries are scarce.From three to five The Attribution-NonCommercial-ShareAlike Creative Commons As long as appropriate attribution is given and the new works are licensed under the same conditions, the 4.0 License allows others to alter, adapt, and build upon the work in non-commercial ways. The dissemination of papers in this open access publication is governed by this license. less widely reported. We looked at the pathogen profile and treatment resistance trend of surgical site infections (SSIs) after gastrointestinal (GI) and biliary operations, which are the two most common procedures in the general surgery department of our tertiary care hospital.

Methods

Selection of patients

The general surgery department, which was spread throughout the main hospital complex and one annexe hospital within the city, six kilometres away, was the source of ongoing subject recruitment. According to CDC criteria, individuals who satisfied the inclusion requirements had to have recently had upper gastrointestinal or biliary surgery (such as cholecystectomy, appendicectomy, gastrojejunostomy, repair of duodenal ulcers, repair of duodenal and intestinal perforations, choledochoduodenostomy, removal of choledochal cysts, Whipple's operation, or partial gastrectomy) and exhibit symptoms of surgical site infection (SSI).[1] After informed permission was given, medical, laboratory, and epidemiological data were recorded. After being soaked in Amies transport medium, two swabs were removed from the area that seemed to be contaminated, if any. Then, as quickly as possible, they were sent in to the department's bacteriology lab. Swabs were inoculated in two sets of standard culture media (blood agar and MacConkey agar) in accordance with normal procedure. They were then incubated for 48 hours, or until detectable growth was seen, under both aerobic and anaerobic conditions (GasPak technique).[9] When growth was found, antibiotic susceptibility testing was carried out in accordance with the standards established by the Clinical and Laboratory Standards Institute [CLSI], USA.Additionally, drug-resistant phenotypes and minimum inhibitory concentration (MIC) were confirmed using the Epsilometer test method (bioMérieux, USA, Durham).Methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant Enterococci (VRE), carbapenemase producers, and ESBL producers were among the resistance phenotypes that were investigated in accordance with the recommendations.The modified Hodge test (MHT) was used to determine if Enterobacteriaceae isolates produced carbapenemase.[10] The Institutional Ethics Committee gave its approval to the procedure in letter number MC/119/2007/1128.

Quantity of samples

The cross-sectional study formula, n = Z (1−α)/2 2P (1 − P)/d2, was used to calculate the sample size. The conventional normal variate in this case is Z (1−α)/2, which is 1.96 at 5%. Type I error or. We estimated that 50% of participants had drug-resistant isolates since our population lacked a published research or pilot study, and d = 7% is the allowable precision/absolute error.The eleventh

According to the formula (1.96)2 × 0.5 (1−0.5)/(0.07), the computed value of n is 196.2. The follow-up's durationThe study was conducted throughout the two and a half years from June 2014 to November 2015.

Objective

The experiment's primary objective was achieved by identifying the pathogen profiles and drug-resistant patterns of the subjects as indicated by key phenotypes.
A spreadsheet including patient-specific epidemiological and clinical data was examined for trends using the Statistical Package for the Social Sciences (SPSS) version 23 (IBM, Armonk, NY, USA). Chi-square and Fisher's exact tests were then used to display the analysis's findings. A number of groups associated with SSI and the corresponding category values were the focus of the investigation.

Final Product

In accordance with the inclusion criteria used [Table 1 baseline data], about 191 (5.3%) of the 3616 surgical patients (postsurgery) were recruited as study subjects. 69.3% of the 133 SSI patients were successful in isolating organisms.
The bacterial agents that were detected from the participants in our study are also included in Table 2.Table 3 displays the main findings of the phenotypic drug resistance test. Table 3 indicates that 94 isolates, or 69.11% of the total, had phenotypic drug resistance.

Subject under consideration

Our high culture positive rate of 69.6% was similar to previous studies due to the high prevalence of bacterial separation when there is persistent antibiotic resistance [13,14]. The observed heterogeneity in culture positive among studies and locations may be explained by differences in infection control strategies, as well as the characteristics of the study population (e.g., age, sex, and the incidence of concomitant diseases). Negative isolation may be caused by particularly specific bacteria or nonbacterial substances (30.4%).
Consistent with previous studies, a much higher proportion of men (76.5%) than women (61.8%) displayed signs of isolation.12 and 15 A decrease in following the recommended course of treatment, an increase in patients needing emergency surgery as a result of accidents, and an increase in smoking, a significant risk factor for surgical site infections, are some common causes.[16]

Table 1 shows that more patients requiring emergency operations needed pathogen isolation than those having elective treatments (P = 0.00588). This is understandable.

Table1:Baselinedataofthestudysubjects

	n	Isolation(%)	*P* (significance=0.05)
Gender			
Female	89	55 (61.8)	0.007152
Male	102	78 (76.5)	
Age(years)			
<30	47	34 (73.3)	0.761994
30–50	116	81 (69.8)	
>50	28	18 (64.3)	
Residence			
Rural	106	73 (68.9)	0.797218
Urban	85	60 (70.6)	
Religion			
Hindu	96	60 (62.5)	0.181565
Muslim	91	62 (68.1)	
Other	4	1(25.0)	
Comorbidity*			
Present	58	48 (82.6)	0.009188
Absent	133	85 (63.9)	
Admission			
ICU/semi-ICU	7	2(28.6)	0.005218
Indoor	153	114(74.5)	
Outdoor	31	17 (54.8)	
Woundclass#			
Clean	126	76 (60.3)	0.001524
Cleancontaminated	53	47 (88.7)	
Contaminated	7	6(85.7)	
Dirty	5	4(80.0)	
Surgery			
Biliarysurgery	82	43 (52.4)	0.0001
Cholecystectomy	51		
Choledocholithotomy	11		
Choledochalcystexcision	6		
Liverresection,orotherbileducts/GB-relate doperation	14		
GIsurgery	109	90 (82.6)	
Appendicectomy	68		
Hepaticojejunostomy	12		
Gastrectomy	11		
Gastrojejunostomy	9		
Truncalvagotomy	9		
Typeofurgency			

Emergency	52	44 (84.6)	0.005886
Elective	139	89 (64.0)	
Laboratoryresults			
Totalcasestested		191	
Totalcaseswithpositiveisolation		133(69.6)	
Singleisolate	130		
Doubleisolate	3		
Totalnumberofisolates,*n*(%)		136	
Gramnegative	82 (60.3)		
Grampositive	54 (39.7)		

*Cardiovasculardisease16(10.9%),hypertension42(28.6%),diabetesmellitus39(26.5%),HIV/AIDS4(2.7%),otherinfections14(9.5%),bronchialasthma

16(10.9%),multiplecomorbidities7(4.8%),andothers9(6.1%).#Themajorityoftheproceduresh adnoncleanwounds,mainlycontaminated(34%)andclean-contaminated (30%). GI=Gastrointestinal, ICU=Intensive care unit

Compromise in the degree of aseptic methods and lengthy hospital stays, such as in severe emergency situations, are predicted in life-saving operations and emergency treatments.17 and 18 Going back to a couple earlier pieces, the We observed a substantially greater isolation rate (P = 0.005218) in filthy and contaminated wounds compared to clean wounds in our research [Table 1]. This finding is likely due to the increased bacterial burden in infected wounds.[17]

Table2:Isolatedmicrobesfromsurgical-siteinfection lesions

Nameofthemicrobe	Frequency(%)
S. aureus	44 (33.1)
K. pneumonia	37 (27.9)
P. aeruginosa	24 (18)
Citrobacter sp.	5(3.8)
E. coli	5(3.8)
*Staphylococcus*sp.(otherthan *S. aureus*)	4(3.0)
Enterococci	3(2.3)
Acinetobacter sp.	3(2.3)
Enterobacter sp.	3(2.3)
Proteus sp.	2(1.5)
Mixedinfection(type1)	2(1.5)
Mixedinfection(type2)	1(0.8)
Anaerobes	0

Type1=*S.aureus*and*E.coli*; Type2=*S.aureus*and *Klebsiella.*
S.aureus=Staphylococcusaureus,K.pneumonia=Klebsiellapneumonia,
P.aeruginosa=Pseudomonasaeruginosa,E.coli=Escherichiacoli

In line with previous studies, 136 isolates were discovered, 130 of which were single isolates and three of which had two.[14] It is customary to associate polymicrobial isolates with dirty or unclean wounds and monomicrobial isolates with sterile surgical operations.[17] Sixty-three percent of our isolates were Gram-negative, which is consistent with prior studies.The year 19 Gram-negative bacteria are common in hospitals because of their propensity to colonise inanimate surfaces and environments, their resistance to antibiotics, and how easily they may get contaminated from the digestive tract after surgery. Klebsiella species came in second overall (27.9% vs. 33.1% in Table 2), behind S. aureus, which is in line with a number of previous investigations.(6, 17) Perhaps the reason Klebsiella is so common in operating rooms and hospitals is because it is a common fomite and airborne contaminant there.According to several studies, Pseudomonas seems to be the most prevalent kind of bacterium. This variation in prevailing species may be due to a variety of factors, including geographic location, season, differences in aseptic methods, resistance trends, and surgical procedures.If the internal organs, especially the lower gastrointestinal tract (gut), are inspected, gram-negative gut flora may indicate SSI. In sterile treatments, foreign microorganisms or skin colonisers are often the most prevalent.[17]

During antibiotic susceptibility testing, ten isolates of methicillin-resistant Staphylococcus were discovered, making up 19.6% of the total. **Table 3**. This number was previously found to be 30.3% in an Indian study and 44% in a Mumbai-based study.cited in [18, 19] About 31.9% of S. aureus strains had macrolide resistance (MIC 8 g/mL or more), while Table 3 shows that 3 isolates (6.4% of the total) had very high levels of resistance (MIC 64 g/mL). Likewise, 21.3% of S. aureus isolates had a resistant strain. Out of the range of 8 g/mL, one isolate had a MIC of 32 g/mL, indicating a very high degree of ciprofloxacin resistance. It was shown that linezolid and vancomycin were not resistant. However, Table 3 indicates that the resistance mechanism may have developed since three of the isolates exhibited linezolid MIC values of 4 g/mL, the greatest limit of sensitivity. All three enterococci isolates (n = 3) were confirmed to be VRE-free, with a vancomycin MIC below 1 g/mL and an upper limit of sensitivity of 4 g/mL. Of the 55 Enterobacteriaceae isolates, 32 (58.2%) tested positive for the production of pure ESBL in phenotypic confirmatory testing. All of these strains were inhibited by ceftazidime/cefotaxime and clavulanate combination discs, with a zone diameter difference of more than 5 mm (compared to ceftazidime/cefotaxime without clavulanate).[9] One kind of multidrug resistance linked to the development of ESBL is resistance to beta-lactams, which includes third-generation cephalosporin and a number of other medications.It was discovered that around 10 isolates of Enterobacteriaceae (18.2%) produced both lactamases and metalloenzymes. This enhanced resistance in SSI-associated Klebsiella and Escherichia bacteria has also been shown in previous studies.Three of the isolates (one each for Klebsiella, E. coli, and Citrobacter sp.) tested positive for carbapenemase in MHT, as shown in Table 3 [17]. The MIC value of meropenem was also

quite high for these identical isolates. A research conducted in Saudi Arabia revealed that 5.5% of Klebsiella isolates were carbapenem-resistant, while another study reported that 67% of Klebsiella linked to SSIs were resistant to this medication.[18,20] Both Approximately 56.4% of Enterobacteriaceae isolates were resistant to ciprofloxacin, whereas 27.1% were resistant to amikacin. Similar findings have also been seen in earlier studies, especially for Klebsiella.[17] Of the twenty-four isolates of Pseudomonas aeruginosa, eight (33.3%) had a minimum inhibitory concentration (MIC) of 4 g/mL for ciprofloxacin, three (12.5%) had a MIC of 8 g/mL, which is twice the resistance breakpoint, and twelve (50%) had a MIC of 32 to 64 g/mL for ceftazidime, with a resistant breakpoint of 32 g/mL.The minimum inhibitory concentrations (MICs) of three distinct isolates of Acinetobacter sp. ranged from 8 AAFs g/mL to 64–128 AAFs g/mL, indicating resistance to ciprofloxacin, amikacin, ceftazidime, and cefotaxime, respectively. In the SSI patients examined by El-Kholy et al., multidrug-resistant Acinetobacter sp. (70%) and pseudomonas aeruginosa (67%) were also found frequently.[20]

In summary

The emergence of carbapenem resistance in SSI patients is alarming; the minimum inhibitory concentration (MIC) for resistant levels is three times higher than the CLSI threshold. The high frequency of resistant Pseudomonas and ESBL in our hospital's SSI patients need urgent attention. When compared to Western study, the MRSA level was not particularly high, even though 19.1% (9/47) of MRSA may be going towards an increasing level.

Table3:Salientpointsinantimicrobialsensitivitytestingresults

Agent/group	Phenotype/species	Resistancein	*n*(%)	Comment
Enterobacteriaceae (*n*=55)	ESBLproducer (pure)		32 (58.2)	MIC(Epsilometertest)confirmedtheresult
		*Klebsiella*sp.	24	
		E. coli	3	
		Citrobacter	2	
		Enterobacter	2	
		Proteus	1	
	Mixedbeta-lactamase		8(14.6)	
		*Klebsiella*sp.	6	
		E. coli	1	
		Enterobacter sp.	1	
	Carbapenemase positive(MHTest)		3(5.5)	
		*Klebsiella*sp.	1	MeropenemMICis16µg/uL(3-foldhigher than the resistant level, i.e., 4 µg/mL)

		E. coli	1	Meropenem MIC is 8 µg/uL (i.e., 2-fold higherthantheresistantlevel,i.e.,4µg/mL)
		Citrobacter sp.	1	Meropenem MIC is 8 µg/uL (i.e., 2-fold higherthantheresistantlevel,i.e.,4µg/mL)
Non-*Enterobacteriaceae* Gram negatives	*Pseudomonas*sp. (*n*=24)	Quinolone-resistantpseudomonas	11 (45.8)	Ciprofloxacin MIC >8 µg/mL in 3 isolates (doubletheresistancelimit,i.e., 4µg/mL)
		3rd-generationcephalosporin-resistantpseudomonas	12 (50.0)	CeftazidimeMIC=32–64µg/mL
		Meropenem-resistant pseudomonas	2(8.3)	MeropenemMIC8µg/mLinone isolate (equal to resistance limit)
	*Acinetobacter*sp. (*n*=3)	Resistanttoamikacin, beta-lactams,andquinolones	3(100)	
Gram-positivecocci	*S.aureus*(*n*=47)	*S.aureus*resistant topenicillin	47 (100)	10UpenicillinGdiscused
		MRSA	9(19.1)	Confirmedinoxacillinagarmedia
		Macrolide-resistant*S.aureus* (MIC >8 µg/mL)	15 (31.9)	Inthreeisolates,MICforerythromycin was 64 µg/mL
		Quinolone-resistantS. aureus (>4 µg/mL)	11 (23.4)	Inoneisolate, MICwas32µg/mL
		Vancomycin-resistant/intermediate *S. aureus*(VRSA/VISA)	0	MICvalueofallstrainswasbelow2 µg/mL
		Linezolid-resistant*S.aureus*	0	ThreeisolateshadMIC=4µg/mL(upper limit for sensitive strain), while all other isolates had MIC below 0.5 µg/mL
		*Staphylococcus*sp.otherthan*S. aureus*showingMRS(30 µgdisc screening followed by oxacillin	1	

agar testing)

Enterococci sp. (*n*=3)	Vancomycin-resistant *enterococci*	0

When we refer to "Escherichia coli" or "Staphylococcus aureus," we mean just that. The following acronyms are utilised: For "Modified Hodge test," MHT stands. VRSA stands for "Vancomycin-resistant Staphylococcus aureus," VISA stands for "Vancomycin intermediate Staphylococcus aureus," MRSA to stand for "Methicillin-resistant Staphylococcus aureus," ESBL to stand for "Extended-spectrum beta-lactamase producer," and MRS, which stands for "Methicillin-resistant Staphylococcus."Our study's findings demonstrate how urgently action must be taken to stop antibiotic resistance. Antibiotic stewardship, adequate surgical prophylaxis, prudent antibiotic usage, and the implementation of an effective infection control program—especially for surgical patients—are all part of this.

References

1.This sentence is a citation for a study by Allegranzi et al. (2002). Systematic study and meta-analysis of the burden of endemic healthcare-associated infections in developing nations. Published in the Lancet in 2011, volume 377, pages 228–41.

2.Casey AL, Petrosillo N, Hudson PM, Mitchell SA, and Crosby C. 3. Badia JM. A comprehensive analysis spanning six European nations examining the effects of surgical site infections on healthcare expenditures and patient outcomes. Public Health Viruses 2017;96:1–15.

3.Umscheid CA, Mitchell MD, Doshi JA, Agarwal R, Williams K, Brennan PJ. Trying to predict the amount of avoidable healthcare-associated infections, together with the accompanying expenditures and fatality rates. Epidemic Prevention Journal of Hospital Epidemiology 2011; 32: 101–14%.

4. Health-Related Infections and Antimicrobial Utilization in European Acute Care Hospitals: A Point Prevalence Survey (ECDC) Version 3.1.2 of the ECDC PPS Validation Protocol was used in 2021. Downloadable at: https:// www.ecdc.europa.eu/en/publications-data/point-prevalence-survey-healthcare-associated-infections-and-antimicrobial-use-4.pdf. Access was last made on July 10, 2021..

5.Myatra SN, Dwivedy A, Bagasrawala I, Rosenthal VD, Chakravarthy M, Singh S, et al. The International Nosocomial Infection Control Consortium assessed the prevalence of surgical site infections in six Indian cities (INICC). International Journal of Health 2015;7:354–9.

6. The authors: Allegranzi B, Zayed B, Bischoff P, Kubilay NZ, de Jonge S, de Vries F, and others. A worldwide evidence-based viewpoint on the new World Health Organization guidelines for preventing surgical site infections during and after surgery. The article was published in 2016 in the Lancet Infect Dis journal and covered pages 288 to 303.

7. Yu H., Gaffney M., Emons MF, Mardekian J., Girgenti D., and Campbell RS. Problems with clinical outcomes and the use of resources linked to Staphylococcus aureus infections, whether methicillin-resistant or methicillin-sensitive, after elective surgery. Surgery: Infectious Diseases (Larchmt) 2015;16:543-52.

8. Institute for Clinical and Laboratory Standards. Anaerobic Specimen Detection Principles and Procedures; Implemented Guidelines. File M56-A of the CLSI. Clinical and Laboratory Standard Institute; 2014. 10. Wayne, PA-based organization.Standards for Clinical and Laboratory Medicine (CLI)