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ORTHOPEDIC SURGICAL ANTIBIOTIC PROPHYLAXIS IN LAHORE, PAKISTAN: GUIDELINE COMPLIANCE, UTILIZATION PATTERNS, AND ANTIMICROBIAL RESISTANCE IN A CROSS-SECTIONAL STUDY



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Abstract

Background: Surgical Site Infections (SSIs) are significant complications of orthopedic surgeries and lead to a longer stay in the hospital, high healthcare expenses, and antimicrobial resistance. Postoperative infections can be successfully prevented by appropriate use of surgical antibiotic prophylaxis (SAP); nevertheless, irrational use of antibiotics is still widespread in clinical practice.

Objectives: To assess the trend of antibiotic use, compliance with hospital antibiotic policies and antimicrobial resistance trends in orthopedic surgery patients in the tertiary care hospitals in Lahore, Pakistan.

Methods: A prospective cross-sectional observational study was conducted among 188 orthopedic surgical patients in five tertiary care hospitals. A structured form was used to collect data through patient records, the operative notes, medication charts and laboratory reports. The use of antibiotics was evaluated in terms of selection, number, dose, route, frequency, and duration. Hospital antibiotic policies and microbiological data were also reviewed. The statistical analysis was done using SPSS version 26 with $p < 0.05$ regarded as significant.

Results: Cefoperazone + Sulbactam were the most commonly used antibiotics. Combination therapy was most common, with 59.6% of the patients receiving three antibiotics, while only 5.3% received single antibiotic therapy. Intravenous administration and twice daily dosing were the most frequently observed practices. There was high compliance with the policy, although only 1.6% of samples were subjected to culture testing. Only one patient (0.5%) developed an infection with antibiotic resistance. Statistically significant associations were found between patient age, type of surgical procedure and number of prescribed antibiotics ($p = 0.027$).

Conclusion: Routine use of multiple broad-spectrum antibiotics without adequate culture and sensitivity testing should be avoided.

Keywords: Antibiotic prophylaxis, Antibiotic stewardship, Antimicrobial resistance, Empirical therapy, Orthopedic surgery, Surgical site infection

INTRODUCTION

Most dreadful but avoidable complications of orthopedic surgery is surgical site infection (SSI). It has a great impact on the recovery of patients as it increases morbidity, hospital stay, cost of treatment, and in severe instances, causes implant failure or permanent disability. Orthopedic surgeries are highly susceptible to infection because of high exposure of tissues and the large number of implants used which serve as a source of bacterial binding and biofilm formation. Thus, SSI prevention can be discussed as of high priority in orthopedic surgery care (1, 2).

Surgical Antibiotic Prophylaxis (SAP) use is the most effective measure of the prevention of SSI occurrence. When all these factors are right and the antibiotics are used in the right dosage, route and time, the chance of postoperative infections is reduced substantially by SAP. It has been demonstrated that antibiotics used at the suggested pre-incision period can be effective in terms of decreasing microbial contamination of the surgical site. The success of SAP, however, is highly reliant on the observance of the set guidelines (3, 4).



The appropriate use of antibiotics in orthopedic surgery is very difficult despite the evident guidelines. The compliance with hospital antibiotic policies is not always easy in clinical practice because of the ignorance, the absence of local recommendations, and the fear of postoperative infections. This has led to irrational prescription of antibiotics, such as unnecessary administration of broad-spectrum agents, inappropriate time, and length of use, inappropriate combination (5, 6).

One of the critical factors of the increased issue of antimicrobial resistance being a public health problem worldwide is irrational antibiotic use. *Pseudomonas aeruginosa*, Methicillin-resistant *Staphylococcus aureus* (MRSA) and resistant *Escherichia coli* are some of the resistant organisms frequently isolated in orthopedic settings as the cause of SSI. These drug-resistant microbes make treatment more challenging, extend the healing period and raise medical expenses (7, 8).

Orthopedic implant infections are difficult to treat because biofilm formation reduce antibiotic effectiveness and protects bacteria from host defenses. The infections may necessitate the use of long courses of antibiotics, revision surgery or removal of the implants. It has been demonstrated that improper choice of first line antibiotics and overexposure to antibiotics are closely linked with development of multidrug-resistant organisms in orthopedic ward (7, 9).

Most surgical procedures require the use of narrow-spectrum antibiotics as surgical prophylaxis, drug intake 30-60 minutes prior to incision, and discontinuation 24 hours' post-surgery which is advised by international guidelines. Nevertheless, there is a deficiency of compliance to these guidelines especially in developing nations. Surgical unit audits have shown that there has been a high dissimilarity to suggested practices, with necessary improvements in the implementation strategies (3, 10).

The problem of irrational antibiotic usage is growing in Pakistan, which is burdensome by SSIs and antimicrobial resistance. The percentage of hospital spending on drugs is largely on antibiotics with surgical prophylaxis taking a significant share of the total antibiotics. Earlier research done in Pakistan had shown improper choice of antibiotics and lack of compliance with prophylaxis practice, yet that research was only done in certain areas and in certain hospitals (11).

The second largest city in Pakistan Lahore is where some of the most advanced tertiary care hospitals in the country are situated. Although it is clinically noteworthy, no published information assessing the behavior of antibiotic use, adherence to hospital policy, and resistance patterns in orthopedic surgery is available in Lahore. The majority of existing literature is based on less-known hospitals or any other city, which makes it hard to generalize it to large healthcare facilities(12). No previous study from Lahore has evaluated antibiotic prophylaxis practices and resistance patterns in orthopedic surgery patients. The analysis of the patterns of antibiotic use and microbiological resistance data is necessary to detect inappropriate prescribing patterns and new trends of resistance. These measurements give useful information to direct rational antibiotic utilization and assist in creating targeted antimicrobial stewardship programs (13).

It has been demonstrated that the role of the antimicrobial stewardship programs and the clinical pharmacists can assist in improving antibiotic prescribing, improving adherence to guidelines and decreasing unwarranted exposure to antibiotics in the surgical environment. Surveillance of antibiotic use by standardized indicators can play a major role in enhancing patient outcomes and decreasing resistance (14, 15).

Hence, the objective of the study was to evaluate the patterns of antibiotic use in patients of orthopedic surgery in the tertiary care hospitals of Lahore, to check the adherence to the antibiotic policy in the hospital, and to measure the patterns of bacterial resistance. The results of this research will be used to implement necessary changes to reduce SSIs and address the problem of antimicrobial resistance by improving the areas where changes are necessary, encouraging reasonable use of antibiotics, and allowing the hospital to amend the antibiotic policies.

The primary outcomes of this study were to analyze the pattern of antibiotic utilization in orthopedic surgeries. Secondary outcomes included assessment of compliance with hospital antibiotic policy, surgical site infection, and antibiotic resistance patterns.

MATERIALS AND METHODS

STUDY DESIGN AND SETTING

This was a prospective observational cross-sectional study that was conducted to determine antibiotics use patterns, adherence to hospital antibiotic policies, and the trend of bacterial resistance in preventing surgical site infections (SSIs) in patients with orthopedic surgeries. This kind of study design was chosen because it is necessary to assess the actual practice of prescribing without intervention and also to find out the gaps in the adherence to the standard prophylactic guidelines in the hospital environment. The researchers did not interfere with doctors prescribing practices during the study. This study conducted for two months (December 2025 – January 2026) in the orthopedic wards of the chosen tertiary care government hospitals (Mayo hospital, Jinnah hospital, General hospital, Children hospital, and Gulab Devi Hospital) in Lahore, Pakistan. These are the hospitals that offer specialized orthopedic surgical services such as elective and emergent surgical services.

POPULATION AND SAMPLING TECHNIQUE

The population in the study included the patients of all aged group and were undergoing orthopedic surgical procedures and were put on antibiotic prophylaxis to prevent SSI in the process of their time in the hospital. The non-probability convenience sampling method was used in which all the eligible patients within the study period got recruited. This method is widely used in clinical pharmacy and drug usage studies based in a hospital because of feasibility limitations. The data of 188 patients of orthopedic surgeries was collected and the sample size was determined by using formula:

$$n = \frac{Z^2 p (1-p)}{d^2}$$

Where Z represents the value for the desired level of confidence, p represents the expected prevalence or proportion and d represents the margin of error or position. In the recent study about the SSI prevalence in orthopedic surgeries is 14.1% (16). By putting it in the formula we get the sample size of 188 on 95% level of confidence. We included every eligible patient during the study period.

INCLUSION AND EXCLUSION CRITERIA

Patients undergoing orthopedic surgery who receive surgical antibiotic prophylaxis during hospitalization and have accessible, complete medical, prescription, and operative records during the study period were included. Exclusion criteria consist of patients with missing or incomplete clinical or antibiotic prescription data; those who received antibiotics for more than 48 hours before surgery or were on pre-existing therapeutic antibiotic treatment prior to surgery; patients experiencing minor procedures where prophylactic antibiotics were not indicated; and patients referred from other hospitals or wards without complete documentation.

DATA COLLECTION PROCEDURE

The data was collected using pre-tested structured data collection form (1, 6) by the final year Pharm-D students in a prospective manner. Demographic information, surgical procedures, prophylactic antibiotic regimen, treatment characteristics (dose, route, frequency, duration) were obtained from patient's medical records, medication charts, operative notes and/or laboratory reports. Antibiotic usage and compliance with approved guidelines for antibiotic prophylaxis in hospitals were evaluated by antibiotic selection, timing, dose, route and duration of treatment. Prescriptions were classified as compliant or non-compliant, with reasons for non-compliance being noted. Microbial data such as culture results, isolated pathogens, antimicrobial susceptibility patterns and multidrug resistance (MDR) were obtained from reports of patients with suspected or confirmed surgical site infection (SSI). Patient names were not recorded, only hospital registration numbers were recorded, to maintain confidentiality.

DATA ANALYSIS

Data were entered, coded and analyzed by the Statistical Package for Social Sciences (SPSS) version 26. Descriptive statistics were applied to describe the data on patient demographics, clinical variables,



antibiotic use patterns, adherence to hospital antibiotic policy and the state of antibiotic resistance. Descriptive statistics for categorical variables (gender, age, types of surgical procedures performed, antibiotic therapy, culture results and resistance patterns) were expressed as frequencies and percentages. Quantitative variables (such as age and mean number of antibiotics prescribed per patient) were presented as mean \pm standard deviation (SD). Antibiotic use patterns were assessed in terms of frequency of antibiotic use, number of antibiotics prescribed per patient, route of administration, dosage form, frequency and duration of therapy. Adherence to the hospital antibiotic policy was measured by comparing the antibiotic regimens prescribed to the hospital antibiotic policy guidelines for the selection, dose, route, frequency, and duration of the antibiotic. Appropriate inferential statistical tests were used. Chi-square test was applied for the categorical variables to assess association between study parameters. One-way Analysis of Variance (ANOVA) was applied to compare the mean number of antibiotics prescribed per patient in various age groups and surgical types. A p-value of less than 0.05 was considered statistically significant. Missing data were excluded on a case wise basis during analysis.

ETHICAL CONSIDERATIONS

Patient confidentiality was ensured through anonymization of all the data gathered and no personal identifiers were taken. The participating hospitals had their own ethics committee, which is Institutional Review Board/Ethics Committee that gave ethical approvals. Data was kept confidential and use only for research.

RESULTS

The study involved 188 patients to assess the use pattern and adherence to hospital policy in orthopedic surgical patients with respect to the use of antibiotics.

DEMOGRAPHIC CHARACTERISTICS

The patients included in the study were 188. The study population was mainly composed of young adults, with 21-30 years of age group having the highest percentage. The majority of the subjects were male, married, and were in the middle socioeconomic status. The occupation-wise distribution of population showed that the largest population group was job holders followed by housewives and students (Table I).

Table I: Demographic characteristics of the patients

	Category	Frequency (n)	Percentage (%)
Total patients		188	100
Age	Less than 20	36	19.1
	21-30	54	28.7
	31-40	28	14.9
	41-50	28	14.9
	51-60	22	11.7
	More than 60	10	5.32
Sex	Male	138	73.4
	Female	50	26.6
Marital status	Married	118	62.8
	Unmarried	70	37.2
Occupation	Worker	27	14.4
	Job holder	52	27.7
	Business Man	20	10.6
	House Wife	33	17.6
	Student	30	16
	Nil	26	13.8
Socioeconomic status	Lower class	37	19.7
	Middle class	147	78.2
	High Class	4	2.1

BODY MEASUREMENTS

Most of the patients were between 1.68-1.80 meters (49.5%), 1.52-1.65 meters (36.2%). In terms of the weight distribution, the majority of the patients had 61- 70 kg (39.9%), then 71-80 kg (21.8%), and 51-60 kg (17%). Most patients had normal Body Mass Index (BMI). The weight distribution of patients has shown BMI analysis normal in 69.1% and overweight (19.7%), and underweight (11.2%) (Table II).

Table II: Body measurements of the patients

	Category	Frequency (n)	Percentage (%)
Height (meters)	1.83-1.98	2	1.1
	1.68-1.80	93	49.5
	1.52-1.65	68	36.2
	1.37-1.50	11	5.9
	1.22-1.35	3	1.6
	0.91-1.19	7	3.7
Weight (kg)	1-20	10	5.3
	21-40	9	4.8
	41-50	15	8
	51-60	32	17
	61-70	75	39.9
	71-80	41	21.8
	81-90	6	3.2
	More than 90	0	0
BMI (Body Mass Index)	Normal (18.5-24.9)	130	69.1
	Under weight (<18.5)	21	11.2
	Over weight (>24.9)	37	19.7

MEDICAL CHARACTERISTICS

Most patients (91) did not have any history of hospitalization and 9% had prior hospitalization at the Jinnah Hospital, General Hospital, Gulab Devi Hospital, Lahore and Children Hospital, Lahore. Only 21.3 percent patients were smokers with 78.7 percent of the non-smokers, good for surgical outcomes. The drug allergy was identified in 2.1% of the patients and the rest 97.9% were without any allergies. No patients were reported to consume alcohol. With regard to the co-morbid conditions, 10.1% of the patients were both hypertension and diabetes, 9.6% were hypertension and 6.9% diabetes mellitus. Kidney related issues and anemia were noticed in 0.5% of the patients each, and the rest (72.3) of the patients had no co-morbidity. Diabetes and Hypertension were the most common co-morbidities (Table III).

Table III: Medical condition of the patients

	Category	Frequency (n)	Percentage (%)
Hospital	Mayo Hospital	115	61.2
	Jinnah Hospital	37	19.7
	General Hospital	20	10.6
	Children Hospital	7	3.7
	Gulab Devi Hospital	9	4.8
Previous Hospitalization	Yes	17	9
	No	171	91
Patients smoking	Yes	40	21.3
	No	148	78.7
Drug allergy	Yes	4	2.1
	No	184	97.9
Alcohol Intake	Yes	0	0
	No	188	100
Co-morbidities	Diabetes	13	6.9
	Hypertension	18	9.6
	Asthma	0	0
	Kidney problem	1	0.5
	Anemia	1	0.5
	Osteoarthritis	0	0

Brain disease	0	0
Diabetes + Hypertension	19	10.1
Nil	136	72.3

ANTIBIOTIC RESISTANCE, CULTURE REPORTS

Microbiological culture testing was done in limited number of patients 1.6% and majority of the patients did not undergo microbial culture and sensitivity analysis. There was one patient with an identified bacterial isolate whose antibiotic resistance was confirmed. With very low culture rates, a detailed analysis of the resistance patterns of the studied population was not possible. Therefore, the true incidence of SSI and antibiotic resistance could be higher than reported due to under-reporting and poor microbiological surveillance (Table IV).

Table IV. Patients with culture reports and antibiotic resistance

	Category	Frequency(n)	Percentage (%)
Total Patients		188	100
Culture Reports	Occur	3	1.6
	Not occur	185	98.4
Organism Present	Yes	1	0.5
	No	187	99.5
Antibiotic Resistance patients	Yes	1	0.5
	No	187	99.5

ADHERENCE TO HOSPITAL ANTIBIOTIC POLICY

There was a very high compliance with the policy of the hospital antibiotic use in all the hospitals that participated. The Mayo Hospital showed the highest compliance of 99.1% with non-compliance of 0.9% only. The Jinnah Hospital, General Hospital, Children Hospital, and Gulab Devi Hospital had a 100% compliance with hospital antibiotic policy. High policy compliance does not mean correct antibiotic choice and policy itself may be outdated, it needs review (Table V).

Table V. Compliance with hospital policy

Name of hospitals	Category	Frequency (n)	Percentage (%)
Mayo Hospital	Yes	114	99.1
	No	1	0.9
Jinnah Hospital	Yes	37	100
	No	0	0
General Hospital	Yes	20	100
	No	0	0
Children Hospital	Yes	7	100
	No	0	0
Gulab Devi Hospital	Yes	9	100
	No	0	0

SURGICAL SITE INFECTION

There is no any significant number of surgical site infections was observed during the study. Out of the 188 patients only three culture reports done and from these three only one patient has SSI.

PATTERN OF ANTIBIOTIC PRESCRIBE IN EACH SURGERY

The review of the pattern of antibiotic prescription in various surgical operations showed that the most common antibiotics that were used across the various categories were Cefoperazone (CPZ) and Sulbactam (SUL). Their utilization was always high (between 71.4% to 100%) and this means that they were predominantly used in the prophylaxis of surgery. The second most used antibiotic was co-amoxicillin (amoxicillin + clavulanic acid) shown to be used between 42.9% and 70.6% especially between ligament related and joint replacement surgeries. Other antibiotics like amikacin (5.9%-25%), ciprofloxacin (up to 5.3%), ceftriaxone (up to 14.3%), and moxifloxacin (up to 6.3% were less common; they were only observed in isolated instances). The statistical analysis revealed that there was no significant correlation between the

nature of the surgical procedure and the choice of antibiotics ($p > 0.05$), indicating that doctors give same antibiotics for all surgical procedures (Table VI, Fig. 1).

Table VI. Frequency (n) and percentages (%) of various antibiotics prescribed in selected surgical procedures

Antibiotics	Fracture fixation procedures (Plates, Screws, Nails, ORIF/CRIF)	Joint replacement / arthroplasty	Ligament, tendon & arthroscopic procedures	External fixation & deformity correction	Implant removal / revision / secondary procedures	Other procedures (Biopsy, Tumor Removal, Wound Care, Amputation, Spine)	P-value
CPZ	82(87.2%)	15(93.8%)	17(100%)	17(89.5%)	10(71.4%)	22(78.6%)	0.163
SUL	82(87.2%)	15(93.8%)	17(100%)	17(89.5%)	10(71.4%)	22(78.6%)	0.163
LIN	6(6.4%)	0	0	1(5.3%)	0	2(7.1%)	0.663
MOX	2(2.1%)	1(6.3%)	0	0	0	0	0.602
CIP	4(4.3%)	0	0	1(5.3%)	0	0	0.628
CO-AMOX	43(45.7%)	11(68.8%)	12(70.6%)	13(68.4)	6(42.9%)	13(46.4%)	0.131
CEF	4(4.3%)	0	0	0	2(14.3%)	2(7.1%)	0.274
VAN	0	1(6.3%)	0	0	0	0	0.055
MET	1(1.1%)	0	0	0	0	0	0.962
AMI	13(13.8%)	4(25%)	1(5.9%)	1(5.3%)	3(21.4%)	6(21.4%)	0.384
Total surgeries	94(50%)	16(8.5%)	17(9%)	19(10.1)	14(7.4%)	28(14.9%)	-
Implant Use	Yes	Yes	Yes	Yes	Yes	No	-

*CPZ=Cefoperazone, SUL=Sulbactam, CO-AMOX=Amoxicillin + Clavulanic acid, AMI=Amikacin, LIN=Linezolid, CIP=Ciprofloxacin, MOX=Moxifloxacin, VAN=Vancomycin, MET=Metronidazole, CEF=Ceftriaxone

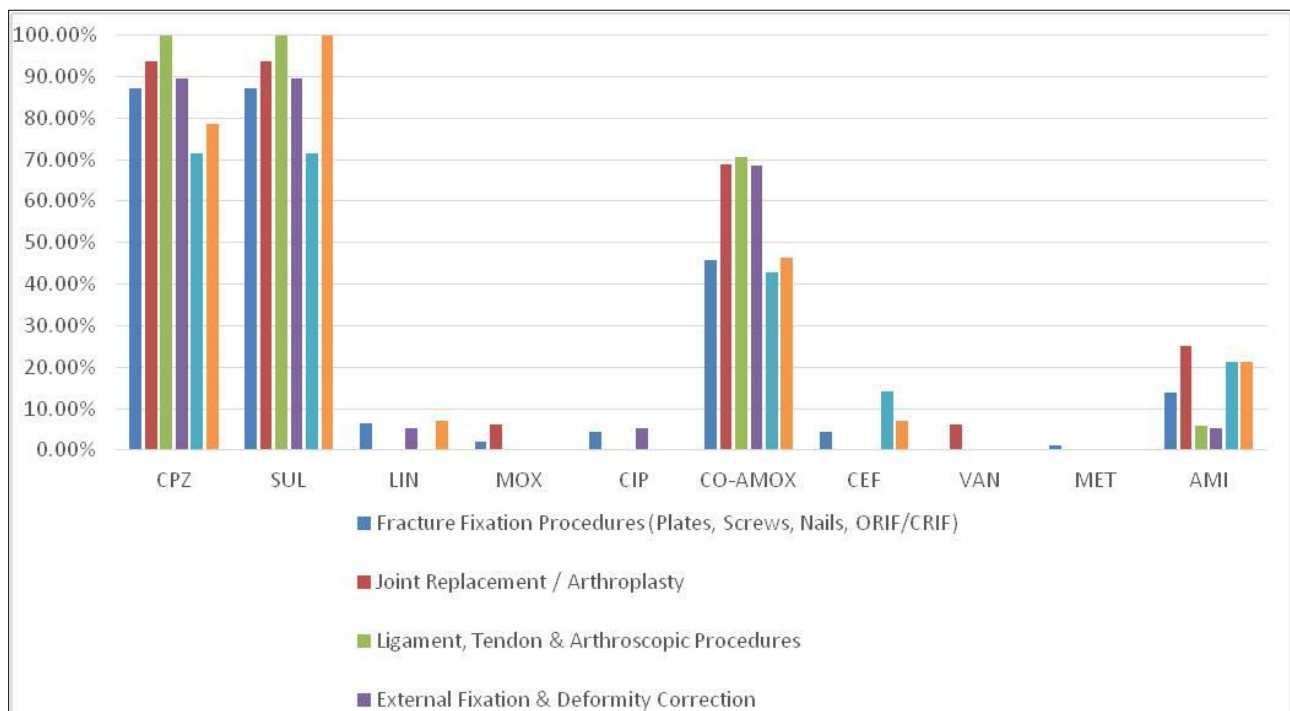


Fig. 1. Pattern of antibiotic use across orthopedic surgeries

PATTERN OF ANTIBIOTIC USE

Antibiotics analysis showed that combination therapy was the preferred option among the orthopedic surgical patients. Antibiotic therapy consisted of single- or multiple-drug combinations, only 5.3% patients received single antibiotic with the majority of patients receiving two or three courses, indicating that multidrug prophylaxis was widely used. Four antibiotics were infrequently prescribed. Typical treatment combinations were used and these consisted of cefoperazone + sulbactam plus co-amoxicillin or amikacin. No oral step-down therapy was seen and all antibiotics were given twice a day (BD) intravenously (IV). The most frequent among surgical procedures was fracture fixation, followed by biopsy,

tumor removal, and wound care. The use of combination antibiotics was seen in all procedures, regardless of surgical complexity (Table VII, Fig. 2).

Table VII. Utilization pattern of antibiotics in selected surgical procedure (n=188)

Procedure Type	1 Antibiotic	2 Antibiotic	3 Antibiotic	4 Antibiotic	Most common antibiotic with dose	Route	Frequency	Dosage form	Total n (%)
Fracture fixation procedures (Plates, Screws, Nails, ORIF/CRIF)	4(4.3%)	38(40.4%)	51(54.3%)	1(1.1%)	CPZ(1g) SUL(1g) CO-AMOX (1g) AMI (500mg)	I/V I/V I/V I/V	BD BD BD BD	Inj. Inj. Inj. Inj.	94(100%)
Joint Replacement / Arthroplasty	0(0.0%)	1(6.3%)	15(93.8%)	0(0.0%)	CPZ(1g) SUL(1g)	I/V I/V	BD BD	Inj. Inj.	16(100%)
Ligament, tendon & arthroscopic procedures	0(0.0%)	4(23.5%)	13(76.5%)	0(0.0%)	CPZ(1g) SUL(1g)	I/V I/V	BD BD	Inj. Inj.	17(100%)
External fixation & deformity correction	1(5.3%)	5(26.3%)	13(68.4%)	0(0.0%)	CPZ(1g) SUL(1g)	I/V I/V	BD BD	Inj. Inj.	19(100%)
Implant removal / revision / secondary procedure	2(14.3%)	7(50%)	5(35.7%)	0(0.0%)	CPZ(1g) SUL(1g)	I/V I/V	BD BD	Inj. Inj.	14(100%)
Other procedures (Biopsy, Tumor Removal, Wound Care, Amputation, Spine)	3(10.7%)	10(35.7%)	15(53.6%)	0(0.0%)	CPZ(1g) SUL(1g) CO-AMOX (1g)	I/V I/V I/V	BD BD BD	Inj. Inj. Inj.	28(100%)
Total	10(5.3%)	65(34.6%)	112 (59.6%)	1(0.5%)					188(100%)

*CPZ=Cefoperazone, SUL=Sulbactam, CO-AMOX=Amoxicillin + Clavulanic acid, AMI=Amikacin BD=Twice a day, IV=Intravenous, Inj=Injection, 1g=1gram, 500mg=500 milligram

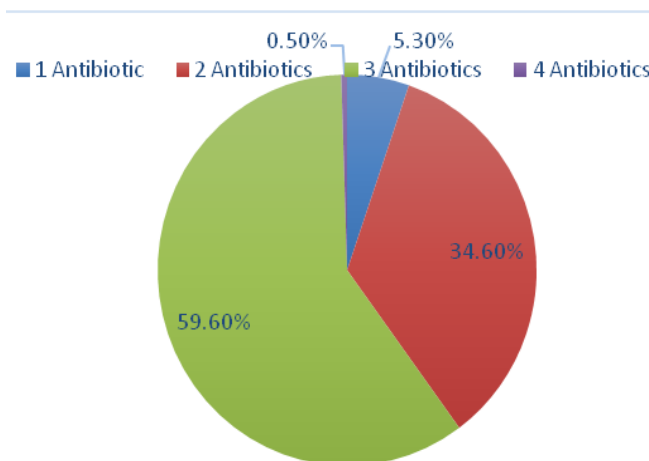


Fig. 2. Distribution of number of antibiotic per patient



ANTIBIOTIC USE ACCORDING TO PATIENT AGE AND TYPE OF SURGERY

Average number of antibiotics used for patients for various age groups and surgical procedures showed variations depending on the age group and surgery type. The mean number of antibiotics used varied from 2.55 ± 0.61 to 2.73 ± 0.46 in different surgical procedures, with comparatively more antibiotics used in fracture fixation and implant removal/revision surgeries. This means that the doctors are more likely to prescribe more than one antibiotic during more complicated or secondary surgeries. Older patients (51-60 years) received the most antibiotics (mean 2.73 ± 0.46) while younger patients (<20 years) had the lowest mean antibiotic use (2.25 ± 0.73). This result indicates that antibiotic prescription is likely to rise as the age increases, which probably reflects an enhanced risk of postoperative complications and infections in older patients. The one-way ANOVA analysis showed that there was a statistically significant relationship between the number of antibiotics prescribed and the patient's age ($p = 0.027$), type of surgery ($p = 0.006$), and patient's age group ($p = 0.001$). The result is statistically significant ($p \text{ value} < 0.05$); results showed that age and type of surgery had a significant impact on the number of antibiotics administered. These results indicate differences in clinical practice and indicate that clinicians might tailor their antibiotic treatment based on patient-related risk factors and the surgical complexity (Table VIII, Fig. 3).

Table VIII. Calculation of average number of antibiotics use and p-value

Surgery Type	<20y(N) Mean + SD	21y-30y(N) Mean+ SD	31y-40y(N) Mean + SD	41y-50y(N) Mean + SD	51y-60y(N) Mean + SD	>60y(N) Mean + SD	Total Mean + SD	Overall p- value
Fracture fixation procedures (Plates, Screws, Nails, ORIF/CRIF)	(6) 2.10 ± 0.70	(20) 2.65 ± 0.50	(15) 2.55 ± 0.60	(12) 2.60 ± 0.65	(10) 2.70 ± 0.45	(5) 2.50 ± 0.60	2.55 ± 0.73	0.027
Joint replacement/arthroplasty	–	(6) 2.80 ± 0.42	–	(3) 2.60 ± 0.50	–	(2) 2.50 ± 0.58	2.65 ± 0.52	0.027
Ligament, tendon & arthroscopic procedures	–	(3) 2.60 ± 0.55	(7) 2.50 ± 0.50	–	–	(6) 2.50 ± 0.60	2.57 ± 0.57	0.027
External fixation & deformity correction	(2) 2.20 ± 0.45	(5) 2.65 ± 0.50	(6) 2.55 ± 0.60	(5) 2.60 ± 0.65	(6) 2.75 ± 0.40	–	2.61 ± 0.63	0.027
Implant removal / revision / secondary procedure	(1) 2.25 ± 0.50	(4) 2.65 ± 0.50	–	(6) 2.60 ± 0.60	(5) 2.75 ± 0.45	–	2.73 ± 0.46	0.027
Other procedures (Biopsy, Tumor Removal, Wound Care, Amputation, Spine)	(3) 2.30 ± 0.60	(6) 2.70 ± 0.55	(4) 2.60 ± 0.60	(7) 2.65 ± 0.60	–	(8) 2.55 ± 0.60	2.55 ± 0.60	0.027
Total Mean + SD	(12) 2.25 ± 0.73	(44) 2.65 ± 0.52	(32) 2.57 ± 0.57	(33) 2.61 ± 0.63	(21) 2.73 ± 0.46	(21) 2.55 ± 0.60	2.55 ± 0.61	0.027

*N = number of patients in that age-surgery combination, Mean = average number of antibiotics. SD = standard deviation. "–" = no patients in that group



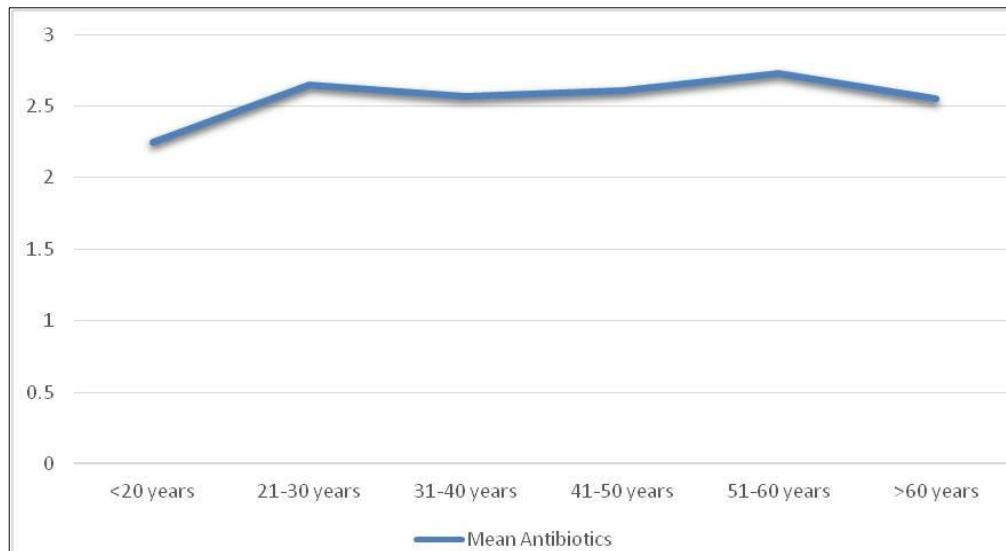


Fig. 3. Mean number of antibiotics prescribed across age groups

DISCUSSION

This study raises several significant issues related to the antibiotic use after surgery in orthopedic surgery, including widespread empirical use of broad spectrum antibiotics and limited microbiological testing. Prescribing patterns from other studies conducted in Pakistan and South Asia are similar, with antibiotics being routinely prescribed to prevent surgical site infections (SSIs), poor antibiotic stewardship and limited facilities for culture (1, 11). International and Western guidelines, however, recommend the use of procedure-specific prophylaxis, preference for narrow-spectrum antibiotics, and a switch-off of antibiotics after 24 hours of an uncomplicated surgical procedure (3, 17). The results indicate that there is a gap between practices of recommended surgical antibiotic prophylaxis and routine clinical use of antibiotics in tertiary care centers.

The demographic pattern observed in this study is similar to other orthopedic epidemiological studies, where young adult males constituted the bulk of the surgical admissions for trauma-related surgery (18, 19). The reasons for this may be due to increased exposures of young males to occupational injuries, road traffic accidents and/or physical labor in the community (19). Similar demographic findings were observed in other studies in tertiary care settings in developing countries, which also showed a predominance of males in orthopedic surgical admissions for trauma-related surgery (11, 12).

The most prevalent co-morbidities of the study population were diabetes and hypertension. Given this, previous studies have indicated that these factors contribute to higher rates of postoperative infection and delayed wound healing, and clinicians may be more inclined to pursue wider, or multiple antibiotic coverage of these patients due to the perceived increased risk of infection. This could account for the higher exposure to antibiotics seen in older patients and in patients with large surgical procedures (20, 21). This might be partly accounted for, by the higher number of antibiotic courses prescribed to older people that were identified in the present study.

The use of culture and sensitivity was one of the most important observations that was made in this study, as it was very limited. The low reported resistance rate in this study should therefore be interpreted with caution, as a lack of routine microbiological evidence may underestimate the true burden of resistant organisms, because of the low microbiological facilities, delayed reporting of results and resource constraints in low and middle-income countries that are common with empirical prescribing (22-24). Culture and sensitivity was rarely performed, with the result that in-depth analysis of the resistance pattern of the microorganisms was not possible, which indicates the continued use of empirical antibiotic usage in the participating hospitals. Better use of microbiological testing will help inform evidence based antibiotic use and antimicrobial stewardship.

The study showed very high conformance with hospital antibiotic policies in all the hospitals included. Previous studies have found that high policy compliance rates do not necessarily correspond to

rational antibiotic prescribing when the institutional policies are out of date, and do not reflect current evidence-based recommendations (6, 17, 25). Even though there was almost total adherence to the policies, only very small amounts of culture tests and the routine use of multidrug broad-spectrum prophylaxis suggest that institutional policies need to be re-reviewed as per the international guidelines based on evidence.

Cefoperazone + Sulbactam usage was so general that it was used in almost all orthopedic procedures, implying that there was a general preference for broad-spectrum coverage regardless of the orthopedic procedure being performed. The common utilization of same antibiotics in all surgery groups also indicates a lack of individualized or procedure specific antibiotic selection for surgical prophylaxis as per western and international guidelines, which advocate the use of first generation cephalosporin's (e.g., cefazolin) for most orthopedic procedures (1, 3, 11).

The routine use of two or three antibiotics for prophylaxis in uncomplicated orthopedic procedures can lead to higher treatment costs, drug adverse reactions, and antimicrobial resistance with little to no additional clinical benefit. This is probably related to institutional prescribing practices and to fears of postoperative infections (26-28).

Maintaining adequate tissue concentrations was consistently seen in the case of twice-daily dosing and intravenous administration, which are preferable during the perioperative period. But extended IV antibiotic use beyond the recommended duration of antibiotic prophylaxis is not beneficial and may result in greater complications associated with antibiotics (29).

The patient's age and antibiotic use were associated with the complexity of surgery, as found in prior studies. Unfortunately, older patients are often more susceptible to complications after surgery due to their weaker immune systems, having more other health conditions and slower recovery times, and as a precaution, multiple antibiotics may be prescribed. The number of antibiotics used was highest in patients aged 51-60 years in the present study, which is consistent with the clinical trend (30, 31).

This study revealed that there is a gap between the evidence-based surgical prophylaxis recommendations and current prescribing practices in the hospitals participating in the study. Adopting antimicrobial stewardship programs, revising antibiotic policies based on the international guidelines to rationalize antibiotics use, performing routine culture and sensitivity before using antibiotics in orthopedic patients are the key measures to reduce unnecessary use of antibiotics and decrease the risk of future resistance (3, 17)

CONCLUSION

This study proved that antibiotic prophylaxis was mostly empirical, with multiple broad-spectrum antibiotics being used in many orthopedic surgery patients, especially Cefoperazone + Sulbactam, regardless of surgery type. The majority of patients were given two or three antibiotics with microbiology culture and sensitivity rarely performed. The compliance with hospital antibiotic policies was high but this may be due to a lack of alignment between hospital guidelines and current international guidelines. A greater mean number of antibiotics were used during procedures for older patients and more complicated procedures. The results underscore the importance of routine updating of hospital antibiotic policy, the establishment of antimicrobial stewardship programs, the promotion of procedure specific prophylaxis and the greater use of culture and sensitivity testing to facilitate rational antibiotic prescribing and to minimize the problem of antimicrobial resistance.

Study limitations:

There are some limitations of this study. The first is that culture and sensitivity was carried out in a small percentage of patients, which restricts the ability to fully assess the resistance pattern of the microbes. Second, surgical procedures were not distinguished between elective and emergency surgeries due to inconsistent and insufficient data on the classification of surgical procedures in participating hospitals. Third, the study period was limited to two months, and so may not showing seasonality or long-term

prescribing behavior. Last, post-discharge follow-up was not performed, which may have resulted to underreporting of surgical site infections after hospital discharge.

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Conflict of interest:

Authors declared no conflict of interest.

Authors' contribution:

MAS Conceptualization, data curation, formal analysis, software, validation, writing original draft, writing review and editing; AA Supervision, review and validation; AT Conceptualization, data curation, validation, editing, writing original draft and investigation; SAR Investigation and writing original draft; HS Investigation and visualization; WA Methodology, supervision and project administration.

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