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Original Research Article

A cross-sectional study on antibiotic utilization patterns for surgical procedures in a tertiary care hospital

Wasim Ali[1]*, Hanamantaray Padashetty[1], Jain Mariya Jestin[1], Mohamed Danish Kotta[1], E. Satheesh Kumar[1], Sri Vidya[2], Padma[2]

[1]Dept. of Pharmacy Practice, Rajiv Gandhi University of Health Sciences. Jayanagar, Bengaluru, Karnataka, India.
[2]Dept. of Pharmacology, Sapthagiri Institute of Medical Sciences and Research Centre, Bengaluru, Karnataka, India.

Abstract

Background: Evaluation of antibiotic use as a preventive measure, ensuring adequate use, and identification of potential areas for surgical care practice improvement are its goals.

Materials and Methods: Patients over 18 who were hospitalised to the surgical department and got antibiotics both before and after surgery were the focus of a cross-sectional study that involved 326 inpatients at a tertiary care hospital in Bangalore. Based on patient case histories and prescription records, data were gathered using a specially designed form. Next, Excel and SPSS, a statistical analysis program, were used to process the data.

Results: 22.78% of the 326 surgical patients in this study were between the ages of 48 and 57, and 62.27% of the patients were men. The majority of antibiotic prescriptions (59.82%), specifically ceftriaxone (69.13%), were cephalosporins, and co-morbidities were present in 68.40% of patients. In oncology surgeries, the rate of surgical site infections (SSIs) was 50%; gastroenterology surgeries were the most prevalent, with a rate of 21.6%. The lowest infection rates were linked to the administration of antibiotics one hour prior to surgery. The rates of SSIs were significantly greater for lengthy procedures (62.71%) than for short surgeries (0.78%).

Conclusion: It is clear that the use of antibiotics was deemed suitable. Broad-spectrum antibiotic prescription rates have clearly increased, which could lead to the emergence of bacterial resistance. On the other hand, unfavourable antibiotic use and medical expenses can be reduced by developing guidelines for antibiotic prescription and using the right medications for the conditions at hand.

Keywords: Surgical site infection, Antibiotic prophylaxis, Antimicrobial Stewardship, Sterilization.

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1. Introduction

Surgical antibiotic prophylaxis refers to the prevention of infectious complications by administering an effective antimicrobial agent prior to exposure to contamination during surgery.[1] Surgical site infections (SSIs) are infections on the incision, organ, or space that occur after surgery. It is one of the most common hospitals acquired infections. The World Health Organization (WHO), the American Society of Health System Pharmacists (ASHP), the Scottish Intercollegiate Guideline Network (SIGN), the Centers for Disease Control and Prevention (CDC), and the National Institute for Health and Care Excellence (NICE) have all issued guidelines regarding surgical antimicrobial prophylaxis.[2]

1.1. Antibiotics

A class of medications known as antibiotics is used to treat infections brought on by bacteria and some parasites. A parasite is a particular kind of germ that must reside on or within a host. Antibiotics are ineffective against viral illnesses, such as the flu or the common cold. Since many bacterial infections resolve on their own, antibiotics are typically only recommended for more severe cases. To help lower antibiotic resistance, antibiotics must be used properly. Antibiotics lose their effectiveness over time as germs develop resistance to them. The World Health Organization (WHO) says "the world urgently needs to change the way it prescribes and uses antibiotics" as antibiotic resistance is a major global threat.[3]

*Corresponding author: Wasim Ali
Email: narendravarma8951@gmail.com

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1.2. Antimicrobial stewardship

Antibiotics have become an essential component of global health since the discovery of penicillin, including cancer chemotherapy and advanced surgical procedures. Antimicrobial agents are not like other medications. They are unique in that the consequences of each prescription affect both the individual patient and society as a whole.

The careful and responsible handling of something entrusted to one's care is referred to as stewardship. The phrase "antimicrobial stewardship" was first used in 1996 by John McGowan and Dale Gerding, who asserted a causal relationship between the use of antimicrobial agents and resistance. Large-scale controlled trials of antimicrobial-use regulation that employ advanced epidemiological techniques, molecular typing, and accurate resistance mechanism studies are also crucial, they underlined. The term Antimicrobial Stewardship (AMS) describes the greatest possible clinical outcome with the fewest adverse effects for patients and the least influence on future resistance through the selection, dosage, and duration of antimicrobial treatment.[4]

1.3. Surgical antibiotic prophylaxis

While SSI rates can be significantly decreased by antimicrobial prophylaxis, other factors may also have a significant impact, including adherence to basic infection-control strategies, the surgeon's skill and technique, the length of the procedure, hospital and operating room environments, instrument sterilization issues, preoperative preparation (e.g., surgical scrub, skin antisepsis, appropriate hair removal), perioperative management (temperature and glycaemic control), and the patient's underlying medical condition. Extremes of age, nutritional status, obesity, diabetes mellitus, tobacco use, coexisting remote body-site infections, altered immune response, corticosteroid therapy, recent surgery, length of hospital stay prior to surgery, and microbial colonization are patient-related factors linked to an increased risk of SSI.[5]

1.1 Literature review

A cross-sectional study on the assessment of surgical antibiotic prophylaxis in a tertiary care hospital in Jakarta, Indonesia, was carried out by Maksum Radji *et al*. All patients who had surgery between January and December 2012 had their medical records reviewed in order to get the data. The National Guidelines on Antibiotic Usage in Indonesia and the Scottish Intercollegiate Guidelines served as the basis for the evaluation of the suitability of antibiotic prophylaxis. The study comprised 161 patients in total, 40 of whom were male (24.85%) and 121 of whom were female (75.15%). The patients' ages were as follows: 3.62% were under 20, 27.88% were between 20 and 39, 44.72% were between 40 and 59, and 13.66% were over 60. The most common surgical procedures were exploratory laparotomy (25.46%), ovarian cystectomy (21.74%), myomectomy (20.49%), and cholecystectomy (24.22%). Prior to surgery, all patients (100%) were given preventative antibiotics. A combination of ampicillin and gentamicin (31.5%), ceftriaxone (26.08%), cefotaxime (21.11%), ceftriaxone + gentamicin (10:55%), meropenem (5%) and ciprofloxacin (0.62%) were the preventive antibiotics administered. 34 patients (21.11%) out of 161 had surgery site infections. There was still a very low level of compliance with surgical antibiotic prophylactic recommendations.[6]

A comparative prospective study of preoperative antibiotic prophylaxis in the prevention of surgical site infections was carried out by Suresh Karlatti and Havannavar. 300 clean and clean contaminated elective surgical cases were admitted to the District hospital at Belgaum Institute of Medical Sciences for this study. A single prophylactic intravenous dosage of 1 gm ceftriaxone was administered to 150 individuals in Group A 30 minutes prior to surgery, while 150 cases in Group B did not receive any antibiotic of such type. 118 patients out of the 300 cases enrolled in the study were found to have risk factors for the development of surgical site infections. In the current study, all patients in group A received a single dose of IV ceftriaxone (1 gm) containing a third-generation cephalosporin 30 minutes prior to the incision as a precaution. In contrast to group B, which did not receive this antibiotic, the infection rate in group A was 3.80% (4 patients) in clean cases and 37.78% (17 patients) in clean contaminated cases. According to the current study, the development of surgical site infections is significantly influenced by the existence of several risk factors, and patients who are not administered a prophylactic antibiotic dose are definitely at risk of acquiring surgical site infections. We may infer from this study that prophylactic antibiotics are not necessary in clean surgery cases since there is no statistical significance, but they are advised in clean contaminated instances because they statistically significantly lower SSI.[7]

The study "Cephalosporin Use and Resistance Trends in Sudanese Hospital Surgical Wards" was carried out by Salah I. Kheder. They found that this research offers valuable information about cephalosporin usage and resistance patterns in a surgical context. The purpose of the study was to assess how cephalosporins, a class of antibiotic, were used in surgical wards at a hospital in Sudan. It also investigated the process by which bacteria became resistant to cephalosporins. The hospital's surgical wards provided the researchers with data. They looked into cephalosporin prescription trends, doses, and usage durations. According to the study, there were roughly 2.68 defined daily doses (DDD) of cephalosporins used for every 100 bed-days. Regretfully, just 49.6% of patients fulfilled the necessary prescription requirements. Bacterial resistance may be a result of the growing use of cephalosporins. When administering antibiotics, medical professionals should follow evidence-based standards to prevent resistance. Preventing resistance requires careful consideration of antibiotic use, dosage, and duration.[12]

2. Materials and Methods

1.2 Sources of Data and Materials

1. Patient case sheet.
2. Patient medication chart.

1.3 Method of data collection

All the inpatients undergoing surgery were reviewed before and after surgery. Patient data such as patient demographics, chief complaints, past histories like medical, medication, family, social history, laboratory and non-laboratory investigations, proposed drug therapies and patient progress were collected. All the above data were collected from patient case sheets, doctor's notes, medication charts etc. The collected data was recorded in a self-designed patient profile form.

1.3.1 Statistical analysis

1. In order to evaluate and present the report as counts and percentages in the form of tables, charts, and graphs, the data was gathered, inputted, and interpreted using descriptive statistics in Microsoft Excel program 2024.
2. The Statistical analysis of collected data was performed using IBM SPSS version 26 statistical software.

3. Ethical Consideration

1. The study was conducted with confidentiality.
2. Every participant provided written informed permission.
3. Because there were no interventions, none of the individuals suffered any bodily injury.

3.1.0 Ethical clearance

Ethical approval for the study was judiciously secured from the esteemed ethics committee of the study site. The research was carried out by utilizing officially sanctioned surveillance data for the purpose of analysis.

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4. Results

4.1 Patient age distribution

The **Figure 1** presents the age distribution of 326 patients. The majority, 22.7%, were aged 48-57, followed by 21.78% in the 58-67 age range. Patients aged 38-47 and 18-27 make up 16.56% and 15.03%, respectively. Smaller groups include 28-37-year-olds at 12.89%, 68-77 at 8.89%, and the oldest group, 78-87, at 2.15%.

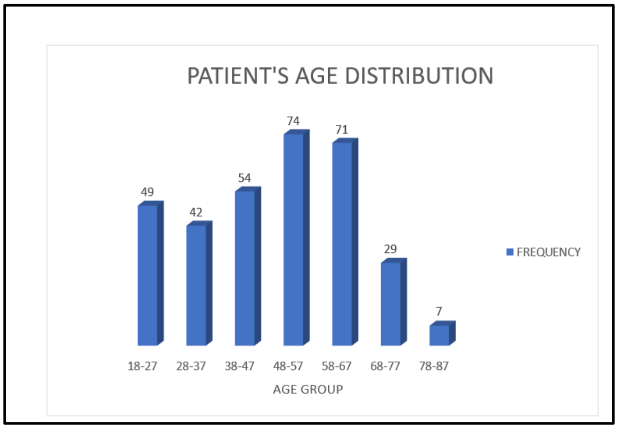

Figure 1: Patient age distribution

4.2 Gender distribution

The **Figure 2** illustrates the gender distribution of patients. Out of a total of 326 patients, 203 were male, making up 62.27% of the total, while 123 were female, representing 37.73%. This indicates a higher proportion of male patients compared to female patients.

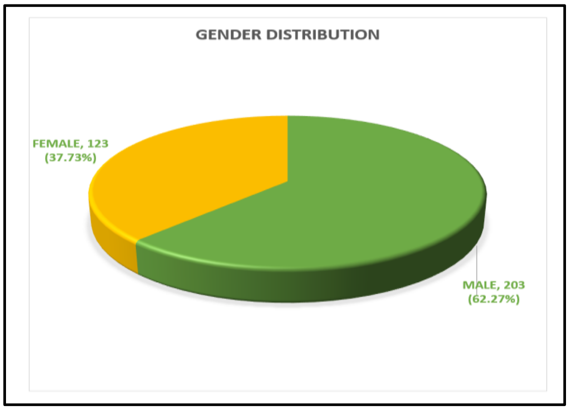

Figure 2: Gender distribution

4.3 Prescribing pattern of Antibiotics

The **Figure 3** presents the distribution of various classes of antibiotics, highlighting their respective quantities and percentages. Cephalosporins dominate the list with nearly 59.82%, followed by combination antibiotics at 17.89%. Other classes, such as nitroimidazoles and fluoroquinolones, make up smaller proportions, with several categories, like lincosamides and oxazolidinone's, showing minimal representation. Overall, a total of 570 antibiotics were accounted for.

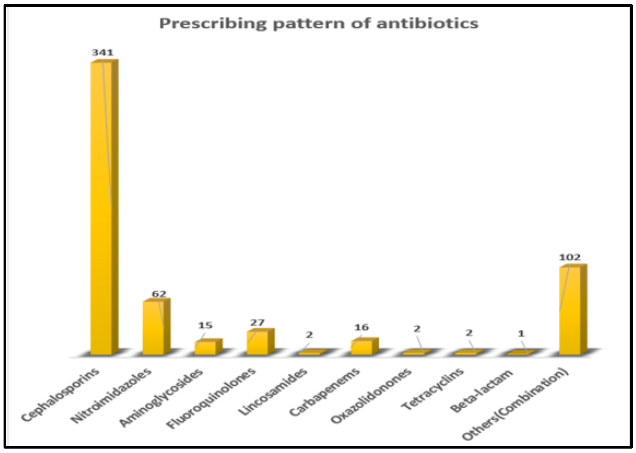

Figure 3: Prescribing pattern of Antibiotics

4.4. SSIS Associated with Comorbidities

Figure 4 Fig. 4, Among 326 patients, the number of patients containing co-morbidities were 223 patients (68.40%) and the patient with no co-morbidities are 103 patients (31.59%). The table highlights the varying SSI percentages across different comorbidities, with some conditions like systemic hypertension, TVD, and osteoarthritis showing a 100% infection rate, albeit with only one surgery performed in each case. (**Figure 4**)

Figure 4: SSIS Associated with comorbidities

Table 1, Among all antibiotics ceftriaxone (69.13%) acquired top pre operatively prescribed antibiotics and next was Metronidazole (8.74%), Amoxicillin+clavulanate (4.64%), Piperacillin+tazobactam (2.46%) etc. The top post operative antibiotic prescribed were Ceftriaxone (46.55%), Metronidazole (13.79%), Cefoperazone+sulbactam (8.62%) followed by and so on.

4.6. Class of Surgeries and Surgical Site Infection Rates

Figure 4: SSIS Associated with comorbidities

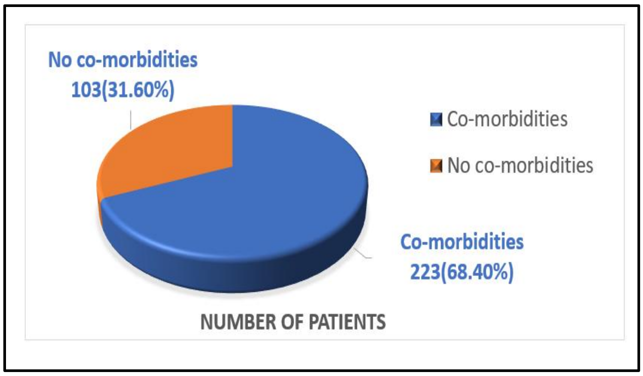

Figure 4: SSIS Associated with comorbidities

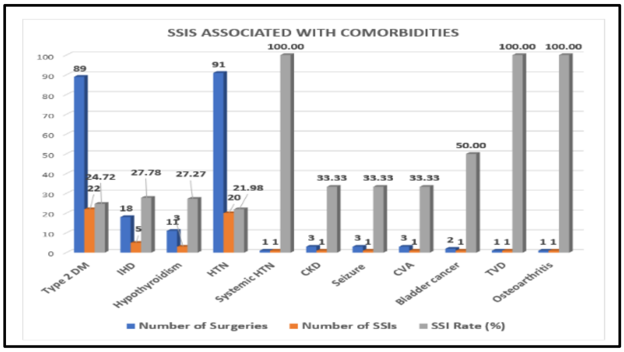

Figure 4: SSIS Associated with comorbidities

4.5 Prescribing Pattern of Pre and Post Operative Antibiot

The **table 2** outlines the classification of surgeries and associated surgical site infection (SSI) rates. It categorizes surgeries into four types: clean, clean contaminated, contaminated, and dirty/infected. The data show that dirty/infected surgeries had the highest SSI rate at 57.14%, while clean surgeries had the lowest at 6.90%. Overall, as the level of contamination increases, the SSI rate also rises.

Table 1: Prescribing pattern of pre and post operative antibiotics

Antibiotics	Pre-op	Percentage (%)	Post-op	Percentage(%)
Ceftriaxone	253	69.13	189	46.55
Metronidazole	32	8.74	56	13.79
Amikacin	7	1.91	13	3.20
Cefuroxime + sulbactam	4	1.09	9	2.22
Amoxicillin + clavulanate	17	4.64	20	4.93
Cefoperazone	2	0.55	3	0.74
Ciprofloxacin	9	2.46	9	2.22
Piperacillin + tazobactam	9	2.46	16	3.94
Cefuroxime	4	1.09	7	1.72
Faropenem	1	0.27	1	0.25

Cefotaxime	2	0.55	5	1.23
Ceftriaxone + sulbactam	3	0.82	3	0.44
Clindamycin	-	0.00	2	0.49
Ciprofloxacin + tinidazole	1	0.27	1	0.25
Cefoperazone + sulbactam	8	2.19	35	8.62
Cefuroxime + clavulanate	-	0.00	4	0.99
Cefixime	1	0.27	7	1.72
Meropenem	9	2.46	13	3.20
Ofloxacin	-	0.00	3	0.74
Ornidazole	-	0.00	2	0.49
Linezolid	1	0.27	2	0.49
Doxycycline	-	0.00	2	0.49
Cefoperazone + tazobactam	1	0.27	2	0.49
Ofloxacin + ornidazole	2	0.55	1	0.25
Cephalexin + clavulanate	-	0.00	1	0.25

Table 2: Class of surgeries and surgical site infection rates

Surgical class	Patints		SSIS		SSI Rate (%)
	No.	%	No.	%	
Clean surgeries(1)	58	17.79	4	5.13	6.90
Clean contaminated surgeries (2)	129	39.57	14	17.95	10.85
Contaminated surgeries (3)	90	27.67	32	41.03	35.56
Dirty/ infected surgeries (4)	49	15.03	28	35.90	57.14

Table 3: Type of surgery associated with SSIS

Type of Surgery	Total Surgeries Performed	SSI Cases	SSI Rate (%)
Gastroenterology	125	27	21.6
Urology	116	30	25.9
Orthopaedics	35	9	25.7
Cardiology	27	5	18.5
ENT	8	1	12.5
Oncology	6	3	50.0
Ophthalmology	3	1	33.3
Neurology	3	1	33.3
Plastic surgery	3	1	33.3

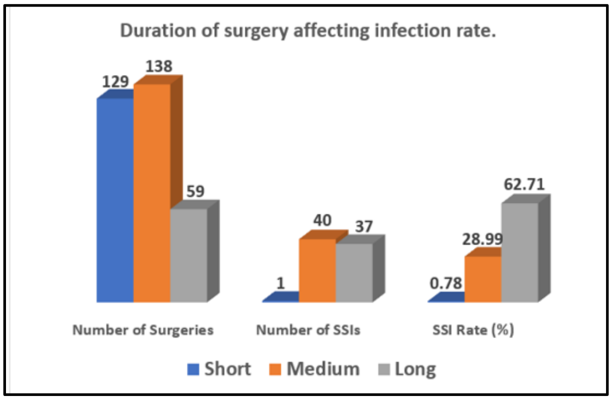

Figure 5: Duration of surgery affecting infection rate

4.7 Duration of surgery affecting infection rate

The **Figure 5** details the relationship between surgery duration and surgical site infection (SSI) rates. It shows that short surgeries (under 1 hour) had a very low SSI rate of 0.78%, while medium surgeries (1-2 hours) had a significantly higher rate of 28.99%. Long surgeries (over 2 hours) had the highest SSI rate at 62.71%, indicating a clear trend where longer procedures correlate with increased infection risk.

4.8 Type of surgery associated with SSIS

The

Table 3 summarizes the incidence of surgical site infections (SSIs) across different types of surgeries. Gastroenterology procedures had the highest number of surgeries but a 21.6% SSI rate, while oncology surgeries had the highest SSI rate at 50% despite fewer total surgeries. Other specialties, such as urology and orthopaedics, also showed notable SSI rates, indicating varying risks associated with different surgical fields.

.9 Effectiveness of antibiotic prophylaxis in association with SSIS.

The **Figure 6** presents the impact of antibiotic timing on surgical site infection (SSI) rates. Group A, with antibiotics administered within 1 hour before surgery, had a low SSI rate of 5.15%. In contrast, Group B, receiving antibiotics 1-2 hours prior, had a higher rate of 17.56%. Notably, Group C, where antibiotics were given after the surgery started, faced a significantly elevated SSI rate of 81.36%, highlighting the importance of timely antibiotic administration.

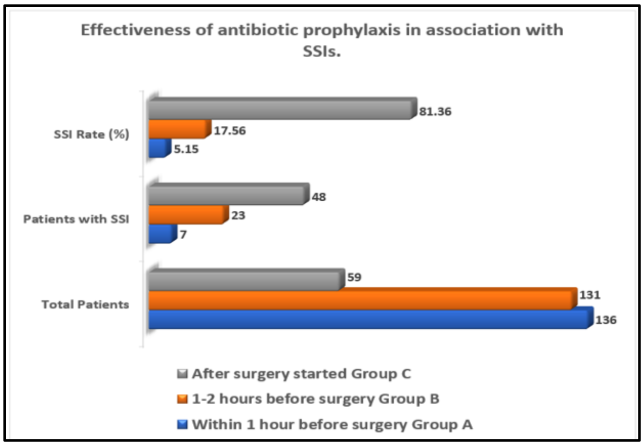

Figure 6: Effectiveness of antibiotic prophylaxis in association with SSIS.

5. Discussion

The goal of this prospective study was to evaluate the overall trend of antibiotic use in surgical wards. It lasted 6 months and included 326 patients who met the study's inclusion criteria. Reduce the incidence of SSI, use antibiotics in a way that is supported by evidence of efficacy, minimize the impact of antibiotics on the patient's normal bacterial flora, minimize side effects, and cause minimal alteration to the patient's host defences, according to SIGN guidelines for prophylactic antibiotic administration.[9]

Out of the total number of patients in our study, the highest number of patients who underwent various procedures was 74, or 22.70% of the patients were between the ages of 48 and 57, and the lowest number of patients admitted was 7, or 2.15% of the patients were between the ages of 78 and 87.

Out of the 326 patients in our study, 203 (62.27%) were men and 123 (30.73%) were women. (Class of surgeries and surgical site infection rates **Table 2**). The use of antibiotics in surgical inpatients at a teaching hospital at Poona College of Pharmacy, Bharati Vidyapeeth Deemed University, Pune, Maharashtra, India, was the subject of a similar study in 2017. The study's gender distribution was comparable, with more male patients than female patients.[8]

In this study, 570 antibiotics were used in a total of 326 patients, with third-generation cephalosporins accounting for 59.82% and combination antibiotics accounting for 17.89% and 10.87% of metronidazole, respectively, and 4.73% fluroquinolones. As a result, carbapenems were prescribed 2.80%, aminoglycosides 2.63%, lincosamides 0.35%, oxazolidonones 0.35%, tetracyclines 0.35%, and beta lactams 0.17% on the surgery ward.

The most commonly administered antibiotic (30.19%), cefixime (18.87%), and amoxicillin (16.98%) were ceftriaxone, according to a 2009 study that looked at treatment data for 150 patients at a primary health center in Bangladesh. Because the inpatient and outpatient departments have different antibiotic regimens, this deviates from the research. Injectable antibiotics were more frequently utilized in hospitals due to the severity of the patients' diseases.[10]

Similar trends were observed in a 2014 study on the prescription of antibiotics to post-operative patients at a teaching hospital in Hyderabad, where metronidazole accounted for 30.7% of prescriptions and third-generation cephalosporins for 44%. The most often recommended antibiotics were cephalosporins (35.60%) and penicillins (21.30%), according to a different study done in a tertiary care hospital in Pondicherry, South India.[11]

As antimicrobials for the treatment of both acute and chronic bacterial infections, cephalosporins are a significant class of medications that are frequently administered. They have proven to be quite successful in both treating and managing infections. However, resistance is being reported more frequently as these drugs are used more frequently. Resistance rates are significantly influenced by cephalosporin usage patterns, leading to problematic nosocomial infections that are resistant to many drugs.[12]

Our study included 223 patients with co-morbidities; HTN (n=91), diabetes mellitus (n=89), IHD (n=18), hypothyroidism (n=11), CKD (n=3), seizure. The study shows the varying SSI percentages across different comorbidities, with some conds, such as systemic hypertension, TVD, and osteoarthritis, showing a 100%

infection rate, despite only having one surgery in each case, followed by bladder cancer, CVA, seizure, CKD, and so on.

Ceftriaxone and metronidazole were the most prescribed antibiotics prior to surgery, with 69.13% and 8.74%, respectively. Post-operatively, 46.55% ceftriaxone and 13.79% metronidazole were prescribed.

One helpful metric for prescription auditing is the average number of medications per prescription. The average number of medications per prescription should be kept as low as feasible. This will help avoid bacterial resistance, drug-drug interactions, and higher hospital expenses. According to this survey, patients in the surgical department were administered an average of 1.5 antimicrobials. In his study of indoor patients at SRTR Government Medical College in Maharashtra, Deshmukh reported a prescribing pattern of 3.02 antimicrobial agents, which is in line with this.[13] Antimicrobial medicine use in post-operative patients was 2.5±3.02 in a 2012 study conducted at Dr. B.R. Ambedkar Medical College in Bengaluru, which is comparable to our results.[14] A 2013 study on rational prescription and use by the Department of Community Health Sciences and Women and Child Health Division, Aga Khan University, Stadium Road, Karachi, Pakistan, revealed that the average number of medications prescribed was three or more, which is 1.5 in our study.[Error! Reference source not found.]

The risk of wound infections after surgery can be decreased with appropriate antibiotic prophylaxis; however, the use of antibiotics raises the selective pressure that favors the development of antibiotic resistance. The classification of procedures and the incidence of related surgical site infections (SSIs) are described in the study. It separates procedures into four groups: contaminated, dirty/infected, clean, and clean contaminated. The data show that dirty/infected surgeries had the highest SSI rate (57.14%), while clean surgeries had the lowest (6.90%). Overall, the SSI rate rises in proportion to the level of contamination. This parameter was found out to be similar to the study conducted by Evaluation of surgical antibiotic prophylaxis in tertiary care hospital in Jakarta, Indonesia. The data show that dirty/infected surgeries had the highest SSI rate (53.33%), while clean surgeries had the lowest (2.56%).[6]

The study investigates the relationship between surgery duration and surgical site infection (SSI) rates. It shows that short surgeries (under 1 hour) had an extremely low SSI rate of 0.78%, while medium surgeries (1-2 hours) had a significantly higher rate of 28.99%. Long surgeries (more than 2 hours) had the highest SSI rate (62.71%), indicating a clear trend in which longer procedures are associated with an increased infection risk. This parameter was found out to be similar to the study conducted by Belgaum Institute of Medical Sciences, Belgaum, Karnataka, India. Six patients who got infected the duration was 1 hour and 55 minutes and the other 12 patients who got infected the duration was more than two hours. No patients whose surgery was done below one hour got infected in both the groups.[7]

Our study examines the prevalence of surgical site infections (SSIs) in several types of surgeries. Gastroenterology procedures had the most surgeries but a 21.6% SSI rate, while oncology surgeries had the highest SSI rate at 50% despite having fewer total surgeries. Other specialties, such as urology and orthopaedics, had higher SSI rates, indicating that the risks associated with different surgical fields vary.

The impact of antibiotic prophylaxis on surgical site infection (SSI) rates is examined in this study. Group A, which received antibiotics within 1 hour of surgery, had a low SSI rate of 5.15%. In contrast, Group B, which received antibiotics 1-2 hours before, had a higher rate of 17.56%. Notably, Group C, which received antibiotics after the surgery began, had a significantly higher SSI rate of 81.36%, emphasizing the importance of effectiveness of antibiotic prophylaxis.

6. Conclusion

It is evident that the use of antibiotics was found to be appropriate in a number of circumstances. It was found that when prescribing antibiotics, the hospital's antibiotic policy and other standard treatment recommendations were being followed. A third-generation cephalosporin was the most often prescribed or advised drug for prophylaxis, followed by nitroimidazole. In the surgery department, each patient was prescribed 1.5 antimicrobials on average. Amoxicillin and Clavulanate, Cefoperazone and Sulbactam were the fixed medication combinations that were prescribed to the maximum extent.

7. Limitations

One of the study's weaknesses is its singular-center emphasis, which limits how broadly the results may be applied to other hospitals with distinct patient populations and clinical workflows. Antibiotic consumption is only captured at a single point in time by the cross-sectional design, making it difficult to evaluate long-term trends. Reliance on medical records may also introduce data bias and result in inconsistent or missing material. The study did not take into consideration extraneous variables that could affect surgical site infection (SSI) rates, such as differences in surgical technique or patient reaction. Lastly, SSIs and antibiotic efficacy during hospital stays may be underestimated in the absence of post-discharge follow-up.

7.1. Future directions

Multi-center studies to confirm results in various healthcare contexts should be part of this study's future directions on the patterns of antibiotic use in surgical procedures. Monitoring changes in antibiotic use and resistance patterns over time requires longitudinal investigations. Furthermore, further in-depth understanding can be gained by looking at how patient demographics and comorbidities affect antibiotic efficacy and SSI rates. Antimicrobial stewardship initiatives will be strengthened by including routine resistance pattern monitoring and assessing compliance with approved protocols. In conclusion, investigating substitute preventive measures may aid in reducing resistance while maintaining patient security.

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8. Source of Funding

None.

9. Conflict of Interest

None.

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