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A Study on Surgical Antibiotic Prophylaxis Practices and Surgical Site Infection in a Tertiary Care Centre in South India

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ABSTRACT

Background: Surgical site infections (SSIs) represent a significant burden in healthcare settings, with antibiotic prophylaxis serving as a critical prevention strategy. However, inappropriate prophylaxis practices may contribute to antimicrobial resistance.

Objective: To evaluate surgical antimicrobial prophylaxis practices and to assess the frequency of SSI occurrence in a tertiary care medical college hospital in South India.

Methods: This retrospective observational study analyzed data from a random sample of 208 patients who underwent surgical procedures from October 2022 to December 2023. Also the data on all patients who developed SSI were collected from medical records and electronic medical records using a structured data collection tool. Statistical analysis was performed using SPSS version 24.

Results: The study population had a mean age of 48.4 years with male predominance (59.1%). Prophylaxis administration rate was 98.6%, with cefazolin being the most commonly used antibiotic (65.4%). Overall SSI was reported in 48 patients in the study duration of 15 months. Factors significantly associated with SSI included surgical duration >3 hours, emergency procedures, and inappropriate timing of antibiotic administration.

Conclusion: While prophylaxis administration rates were excellent, there is a scope for improvement in quality of care by reducing the SSI occurrence to further lower levels which could be achieved by optimization of timing, duration, and selection of prophylactic antibiotics. Implementation of standardized protocols and continuous surveillance are recommended.

Keywords*: Surgical site infection, antibiotic prophylaxis, tertiary care, antimicrobial stewardship, surgical outcomes.*

INTRODUCTION

Surgical site infections (SSIs) represent one of the most significant complications in surgical practice, accounting for 14% to 18% of all healthcare-associated infections and ranking as the third most frequently reported nosocomial infection.[1] The economic burden of SSIs extends beyond immediate treatment costs to include prolonged hospital stays, increased morbidity, and potential mortality. Prophylactic use of antibiotics has emerged as a cornerstone strategy for reducing SSI incidence, with effectiveness dependent on appropriate antibiotic selection, optimal timing of administration, and appropriate dosage regimens. [2]

The risk of developing SSI is multi-factorial, encompassing both procedure-related factors such as duration of surgery, invasiveness, tissue damage, and penetration of hollow viscera, as well as patient-related factors including pre-existing medical conditions, wound classification, and immune status. The judicious use of antimicrobial prophylaxis requires careful consideration of these risk factors alongside the specific surgical procedure being performed. [3]

However, the indiscriminate use of broad-spectrum antibiotics, particularly prevalent in low and middle-income countries like India, has raised concerns about the emergence of resistant microorganisms.[4, 5] Studies have documented high rates of antimicrobial use among surgical inpatients, with frequent observations of over-coverage (using antibiotics with broader coverage than necessary) and redundant coverage (using multiple antibiotics with overlapping spectra).[5, 6] These practices highlight the urgent need for standardized antibiotic policies and rational prescribing practices.

Ideally, prophylactic antibiotics should be administered within 30 minutes before surgical incision to ensure peak drug concentrations coincide with the time of clot formation at the surgical site. The duration of prophylaxis should generally not exceed 24 hours for most surgical procedures, as prolonged administration has been shown to be unnecessary and may contribute to the development of antimicrobial resistance without providing additional clinical benefits. [7, 8]

The selection of prophylactic antibiotics is typically based on the anatomic region of the surgical procedure, with pharmacokinetic profile, bactericidal activity, safety profile, and institutional resistance patterns serving as primary determinants. [9] First-generation cephalosporins, particularly cefazolin, are preferred agents for many procedures in patients without β-lactam allergies or known methicillin-resistant Staphylococcus aureus (MRSA) colonization. Alternative agents such as clindamycin or vancomycin are reserved for patients with significant allergies or suspected MRSA infections. [10]

Given the potential for antimicrobial usage patterns to alter both hospital and patient bacterial flora, leading to colonization and resistance development, periodic surveillance of antibiotic usage patterns for surgical prophylaxis is essential. Such surveillance enables understanding of local sensitivity patterns and promotes safe and rational antibiotic use while preventing antimicrobial resistance development.

The current study was designed to evaluate surgical antimicrobial prophylaxis practices in a tertiary care medical college hospital in South India and to assess the frequency of SSI occurrence in the studied population, with the ultimate goal of identifying areas for improvement in current practices.

MATERIALS AND METHODS

This was a hospital-based retrospective observational study conducted in the Department of Pharmacology at a tertiary care medical college hospital in South India after the approval of Institutional human ethics committee (Approval number: 23/479). The study was conducted over a period of 15 months, from October 2022 to December 2023. The study included a sample of 208 patients who underwent surgical procedures performed by the Surgery department for common surgical conditions during the study period. Patients were selected through systematic random sampling method from surgical records. Adult patients aged 17-80 years who underwent elective or emergency surgical procedures with documented antibiotic prophylaxis were included in the study. The patients who were excluded from the study were the paediatric patients (age <18 years), pregnant and lactating mothers, elderly patients (age >80 years), trauma patients, patients with history of road traffic accidents, medico-legal cases, patients with contaminated and infected wounds, patients with chronic wounds, patients on long-term antibiotic prophylaxis or antimicrobial therapy (including HIV treatment, anti-tuberculosis therapy), and patients with pre-existing organ dysfunction including renal failure, liver failure, and organ transplant recipients. Data collection was performed using both physical medical records and electronic medical records (EMR) systems. A structured data collection tool was developed to ensure standardized data capture.

The parameters which were recorded for each patient included demographic data like age, gender, geographic location (urban/rural/semi-urban), and relevant medical history including comorbidities. Also the primary diagnosis, the surgical procedure, surgical approach (open, laparoscopic, combined), duration of surgical procedure, wound classification (clean, clean-contaminated, contaminated, and dirty), type of anaesthesia administered, and urgency of procedure (elective vs. emergency) were noted. In addition, prophylactic antimicrobial agent prescribed, route of administration, timing of administration relative to surgical incision, intraoperative re-dosing requirements, duration of prophylactic antibiotic administration, and any post-operative continuation of antibiotics.

Data on all patients who developed surgical site infections during the study period, the available microbiological culture and sensitivity results, and post-operative antimicrobial treatment administered were collected in addition other baseline demographics, surgery related details and preoperative prophylaxis data. Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software version 24. Qualitative data was analyzed using frequency distributions and presented as percentages. The study was conducted in accordance with ethical guidelines for retrospective studies. Patient confidentiality was maintained throughout the study period, and all data were anonymized before analysis.

RESULTS

The study included 208 patients with a mean age of 48.4 years (median 50 years, range 17-79 years). The largest age group comprised patients aged 40-59 years (88 patients, 42.3%), followed by patients aged 20-39 years (60 patients, 28.8%) and 60-80 years (58 patients, 27.9%). Only 2 patients (1.0%) were under 20 years of age. Male patients predominated with 59.1% compared to female patients (40.9%). The study population was predominantly urban, with 197 patients (94.7%) residing in urban areas, while 7 patients (3.4%) were from rural areas and 4 patients (1.9%) from semi-urban locations. [Table 1]

Comorbidities were present in 97 patients (46.6%), while 111 patients (53.4%) had no documented comorbidities. The most common comorbid conditions were diabetes mellitus (37 patients, 17.7%) systemic hypertension (30 patients, 14.4%), and hypothyroidism (10 patients, 4.8%). Combined diabetes and hypertension was present in 12 patients (5.8%), while bronchial asthma was documented in 6 patients (2.9%). [Fig 1] Major surgical procedures predominated, accounting for 192 cases (92.3%), while minor surgical procedures comprised 16 cases (7.7%). The vast majority of procedures were elective (202 patients, 97.1%), with only 6 emergency procedures (2.9%). [Table 1]

Regarding surgical approach, open surgery including laparotomy was performed in 109 patients (52.4%), laparoscopic procedures in 92 patients (44.2%), and combined approaches in 7 patients (3.4%). Post-operative wound classification revealed clean wounds in 160 patients (76.9 %), clean-contaminated wounds in 31 patients (14.9%), contaminated wounds in 16 patients (7.7%), and dirty wounds in 1 patient (0.5%). The most common diagnoses were hernia (101 patients, 48.6%), cholecystitis with cholelithiasis 32 (15.4%), varicose veins (11 patients, 5.3%). General anaesthesia was administered in 134 patients (64.4%), spinal anaesthesia in 59 patients (28.4%), combined spinal-epidural anaesthesia (CSEA) in 12 patients (5.8%), and peripheral nerve blocks in 2 patients (1.0%) and regional anaesthesia in 1 patient. [Table 1]

Surgical duration varied considerably across procedures. Procedures lasting less than 3 hours comprised 144 cases (69.2%), procedures lasting 3-5 hours included 54 cases (26.0%), procedures lasting 5-6 hours included 5 cases (2.4%), and procedures exceeding 6 hours comprised 5 cases (2.4%). Prophylactic antibiotics were administered to 207 patients (99.6%), demonstrating excellent compliance with prophylaxis protocols. The most commonly used prophylactic antibiotic was Cefazolin, administered to 136 patients (65.4%), followed by Ceftriaxone in 37 patients (17.8%), Metronidazole in 9 patients (7.7%), and Cefoperazone plus Sulbactam in 11 patients (5.3%). Meropenem was used in 2 patients (1.4%) for prophylaxis. [Table 1]

Single antibiotic prophylaxis was employed in 195 patients (93.7%), while dual antibiotic prophylaxis was used in 13 patients (6.3%). Single-dose prophylaxis was administered to 189 patients (90.8%) while multiple-dose prophylaxis was given to 6 patients (2.9%). The timing of prophylactic antibiotic administration varied among patients. Administration within 30 minutes before surgery, considered optimal timing, occurred in 135 patients (64.9%). Administration more than 30 minutes before surgery occurred in 15 patients (7.2%), within 30 minutes after surgery began in 38 patients (18.3%), and more than 30 minutes after surgery began (intraoperatively) in 20 patients (9.6%). [Table 1]

Post-operative antibiotic continuation was documented in 92 patients (44.2%), while 116 patients (55.8%) did not receive post-operative antibiotics. Among those receiving post-operative antibiotics, the duration varied: 51 patients (24.5%) received antibiotics for 1-4 days, 41 patients (19.7%) for 5-9 days. The most commonly used post-operative antibiotics were Ceftriaxone. Surgical site infections were documented in 48 patients over study duration of 15 months which reflected that the surgical prophylactic antibiotic practices were effectively followed. Among patients with SSIs, microbiological culture revealed single organisms in 29 patients (60.4%) and multiple organisms in 17 patients (35.4%), while 2 patients had no documented culture results. [Fig 2]

The most frequently isolated organisms were Escherichia coli (23 isolates, 47.9%), Klebsiella species (14 isolates, 29.2%), Pseudomonas species (9 isolates, 18.8%), Enterococcus species (8 isolates, 16.7%), Candida species (4 isolates, 8.3%), and Proteus mirabilis (3 isolates, 6.3%). Analysis of risk factors associated with SSI development revealed several significant associations. Age distribution among SSI patients showed 7 patients (14.6%) were less than 40 years, 25 patients (52.1%) were 40-60 years, and 16 patients (33.3%) were more than 60 years old. Gender distribution among SSI patients was equal, with 24 male patients (50.0%) and 24 female patients (50.0%).

All SSI cases occurred in patients undergoing major surgical procedures, with no infections documented in minor procedures. Elective procedures out-numbered the emergency procedures in the SSI patients group also. Surgical approach analysis revealed SSIs in 37 out of 48 (77.1%) undergoing open/laparotomy procedures, 10 (20.8%) laproscopic procedures and 1 (2.1%) combined approach procedures. Wound classification analysis showed SSIs in 25 (52.1%) clean and 23 (47.9%) clean-contaminated wounds (74.2%).

Surgical duration emerged as a significant risk factor, with SSI of 4.6% (7/151) for procedures lasting less than 3 hours, 34.1% (28/82) for procedures lasting 3-5 hours, and 72.2% (13/18) for procedures lasting 5-6 hours. Timing of prophylactic antibiotic administration significantly impacted SSI rates. Patients receiving antibiotics more than 30 minutes before surgery had the highest SSI risk at 48.2% (14/29 patients), while those receiving antibiotics within 30 minutes before surgery had an SSI risk of 20.1% (34/169 patients). Among patients with diabetes mellitus, 15 out of 48

(31.2%) developed SSIs, suggesting diabetes as a significant risk factor for post-operative surgical site sepsis. All infections were superficial SSI only.

DISCUSSION

This retrospective study of 208 surgical patients in a South Indian tertiary care centre revealed important insights into current surgical antibiotic prophylaxis practices and their associated outcomes. The study demonstrated excellent compliance with prophylaxis administration (98.6%), the overall SSI incidence being low indicated that best practices and monitoring were being effectively followed. The demographic profile of our study population, with a mean age of 48.4 years and male predominance (59.1%), is consistent with typical surgical populations in tertiary care settings. The high prevalence of comorbidities (46.6%), particularly diabetes mellitus and hypertension, reflects the changing epidemiological landscape in India and underscores the importance of considering these risk factors in prophylaxis strategies.

Our finding that cefazolin was the most commonly used prophylactic antibiotic (65.4%) aligns with international guidelines recommending first-generation cephalosporins for most surgical procedures. This practice is appropriate given cefazolin's excellent tissue penetration, favorable pharmacokinetic profile, and narrow spectrum of activity that covers the most common surgical site pathogens including Staphylococcus aureus and streptococci. However, the significant use of ceftriaxone (17.8%) for prophylaxis may represent suboptimal practice, as broader-spectrum agents should generally be reserved for specific indications rather than routine prophylaxis.

The timing of antibiotic administration emerged as a critical factor influencing SSI outcomes in our study. Patients receiving antibiotics earlier than 30 minutes before surgery had higher SSI rate compared to those receiving it in appropriate timing ideally within 30 minutes before surgery. This finding strongly supports established guidelines emphasizing the importance of achieving peak antibiotic concentrations at the time of tissue incision and bacterial contamination.[11]Recent evidence from large-scale studies confirms that optimal timing of prophylactic antibiotics within 60 minutes before incision significantly reduces SSI risk, with median administration times of 28 minutes showing optimal outcomes.[12]

Surgical duration demonstrated a clear relationship with SSI risk, with infection rates increasing dramatically from procedures less than 3 hours to procedures lasting 5-6 hours. This finding highlights the importance of intraoperative re-dosing protocols for prolonged procedures, which may not have been consistently implemented in our study population. Current guidelines recommend re-dosing of antibiotics every 1-2 half-lives of the drug during prolonged procedures to maintain adequate tissue concentrations.

The significantly higher proportion of patients undergoing emergency procedures (10.4%) compared to those without SSI (2.9%) reflects the inherent risks associated with urgent surgical interventions, including potential delays in antibiotic administration, altered patient physiology, and often more complex surgical presentations. This finding emphasizes the need for specialized protocols for emergency surgical cases.

Wound classification analysis revealed concerning findings, with clean-contaminated wounds showing a disproportionately high SSI rate of 74.2%. This suggests that current prophylaxis strategies may be inadequate for these higher-risk procedures, potentially requiring broader-spectrum coverage or extended duration of prophylaxis. The relatively high SSI rate in clean wounds (15.5%) also indicates room for improvement in prophylaxis practices for routine procedures.

The microbiological profile of SSIs in our study, dominated by Gram-negative organisms including E. coli (47.9%) and Klebsiella species (29.2%), suggests that current prophylaxis regimens may not adequately cover these pathogens. This finding is particularly relevant for intra-abdominal procedures where Gram-negative coverage is essential. The presence of Candida in 8.3% of infections raises concerns about the appropriateness of antifungal prophylaxis in select high-risk patients. Post-operative antibiotic continuation in 44.2% of patients may represent unnecessary prolongation of prophylaxis, as most guidelines recommend discontinuation within 24 hours of surgery completion. This practice contributes to antimicrobial resistance development and increases healthcare costs without proven clinical benefit for most procedures.[13] Recent guidelines from major professional societies have emphasized shortened postoperative antimicrobial courses, advocating for single-dose or less than 24-hour continuation to minimize resistance development while maintaining efficacy.[14]

SSI rate in our study was within the international benchmarks (typically 2-5% for clean procedures). Presence of SSI suggests systemic issues in perioperative care that extend beyond antibiotic prophylaxis alone. Factors such as surgical technique, infection control practices, operating room environment, and post-operative care likely contribute significantly to these outcomes. While compliance with prophylaxis protocols was excellent, the study identified key areas for improvement including standardization of antibiotic timing protocols to ensure administration within 30 minutes before incision, implementation of intraoperative re-dosing guidelines for prolonged procedures, optimization of antibiotic selection based on procedure type and local resistance patterns, and reduction of unnecessary post-operative antibiotic continuation. Special attention should be paid to high-risk procedures, including emergency surgeries and clean-contaminated wounds, which may require enhanced prophylaxis strategies. The establishment of a multidisciplinary antimicrobial stewardship program, incorporating surgical, pharmacy, and infectious disease expertise, would be beneficial for developing institution-specific guidelines and ensuring consistent implementation of best practices.[15] Studies from Indian tertiary care hospitals have demonstrated that implementing antimicrobial stewardship interventions can significantly reduce prophylaxis costs while maintaining or improving SSI outcomes, with feasibility demonstrated across different hospital settings.[16] However, challenges in implementing antimicrobial stewardship programs in low- and middle-income countries include resource limitations, lack of trained personnel, and need for context-specific adaptations of international guidelines.[17] Regular surveillance of SSI rates and antimicrobial resistance patterns should guide ongoing refinement of prophylaxis protocols. Also, future research should focus on prospective studies evaluating the impact of standardized prophylaxis protocols on SSI outcomes, investigation of local antimicrobial resistance patterns to guide empirical therapy selection, and assessment of the cost-effectiveness of enhanced prophylaxis strategies in high-risk patient populations.

Limitations

Several limitations should be acknowledged in interpreting these results. The study was conducted at a single center, which may limit generalizability to other institutions with different patient populations and practices. Additionally, the relatively small sample size for some subgroup analyses may have limited statistical power to detect significant associations. The exclusion of high-risk patient populations, while methodologically sound, may have resulted in an underestimation of the challenges faced in real-world clinical practice. Furthermore, the study did not assess long-term outcomes beyond the immediate perioperative period, which may have missed delayed SSIs or other complications.

CONCLUSION

This study reveals a good correlation between high rates of prophylaxis administration and SSI outcomes in a South Indian tertiary care setting. The findings of this study emphasize the critical importance of evidence-based antibiotic prophylaxis practices in surgical settings and highlight the need for continuous quality improvement efforts to optimize patient outcomes while promoting antimicrobial stewardship principles.

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Illustrations

Table 1.

Parameter	**Category**	**Surgical antibiotic prophylaxis group patients n=208**	**Patients with Surgical Site Infections n=48**
Age	Less than 40 years (n=69)	62 (29.8%)	7 (14.6%)
	40 to 59 years (n=113)	88 (42.3%)	25 (52.1%)
	60 years and above(n=74)	58 (27.9%)	16 (33.3%)
Sex	Male (n=147)	123 (59.1%)	24 (50%)
	Female (n=109)	85 (40.9%)	24 (50%)
Surgery details	Major (n=240)	192 (92.3%)	48 (100%)
	Minor (n=16)	16 (7.7%)	-
	Elective (n=245)	202 (97.1%)	43 (89.5%)
	Emergency (n=11)	6 (2.9%)	5 (10.4%)
	Open /Laprotomy (n=139)	109 (52.4%)	37 (77.1%)
	Laparoscopy (n=109)	92 (44.2%)	10 (20.8%)
	Combined (n=8)	7 (3.4%)	1 (2.1%)
Anaesthesia	General (n=182)	134 (64.4%)	48 (100%)
	Spinal (n=59)	59 (28.4%)	-
	Regional (n=1)	1 (0.5%)	-
	CSEA (n=12)	12 (5.8%)	-
	PNB (n=2)	2 (1.0%)	-
Diagnosis	Hernia (n=115)	101 (48.6%)	14 (29.2%)
	Cholecystitis and cholelithiasis (n=36)	32 (15.4%)	4 (8.3%)
	Cholelithiasis and hernia (n=6)	3 (2.9 %)	-
	Varicose veins (n=11)	11 (5.3%)	-
	Others(n=88)	58 (27.8%)	30 (62.5%)
Wound classification	Clean (n=185)	160(76.9%)	25 (52.1%)
	Clean contaminated (n=54)	31 (14.9%)	23 (47.9%)
	Contaminated (n=16)	16 (7.7%)	-
	Dirty (n=1)	1 (0.5%)	-
Duration of surgery in hours	< 3 hrs (n=151)	144 (69.2%)	7 (14.6%)
	3-5 hrs (n=82)	54 (26.0%)	28 (58.3%)
	>5-6 (n=18)	5 (2.4%)	13 (27.1%)
	>6 (n=5)	5 (2.4%)	-
Time of prophylactic antibiotic	More than 30 minutes before surgery (n=29)	15 (7.2%)	14 (29.2%)
	Within 30 minutes before surgery (n=169)	135 (64.9%)	34 (70.8%)
	Within 30 minutes after surgery begins (n=38)	38 (18.3%)	-
	Intraoperative -more than 30 minutes after surgery begins (n=20)	20 (9.6%)	-
Pre-op antibiotic	Cefazolin (n=158)	136 (65.4%)	22 (45.8%)
	Ceftriaxone (n=49)	37 (17.8%)	12 (25%)
	Metronidazole (n= 12)	9 (7.7%)	3 (8.3%)
	Cefoperazone + Sulbactam (n=18)	11(5.3%)	7 (14.6%)
	Meropenam(n=4)	2 (1.4%)	2 (6.3%)
Number of pre-	Single Antibiotic(n=235)	195 (93.7%)	40 (83.3%)

operative antibiotics	Single dose(n=215)	189 (90.8%)	26 (54.2%)
	Multiple dose (n=20)	6 (2.9%)	14 (29.2%)
	Dual Antibiotic (n=19)	13 (6.3%)	6 (12.5%)
	No(n=2)	-	2 (4.2%)
Post op antibiotic	No (n=118)	116 (55.8%)	2 (4.2%)
	Taken (n=138)	92 (44.2%)	46 (95.8%)
Duration of post op antibiotic	1 to 4 days (n=68)	51 (24.5%)	17 (35.4%)
	5 to 9 days (n=59)	41(19.7%)	18 (37.5%)
	>9 Days (n=11)	-	11 (22.9%)

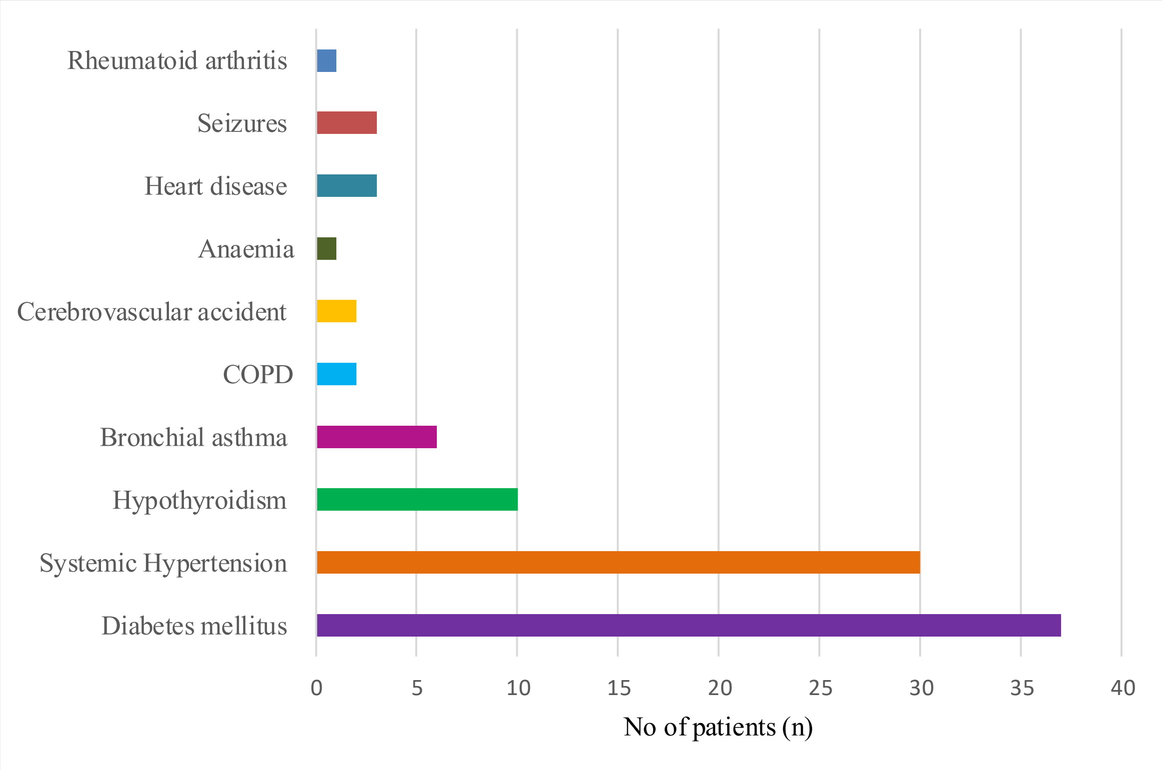

Figure1. Chart representing the co-morbidities in surgical antibiotic prophylaxis group

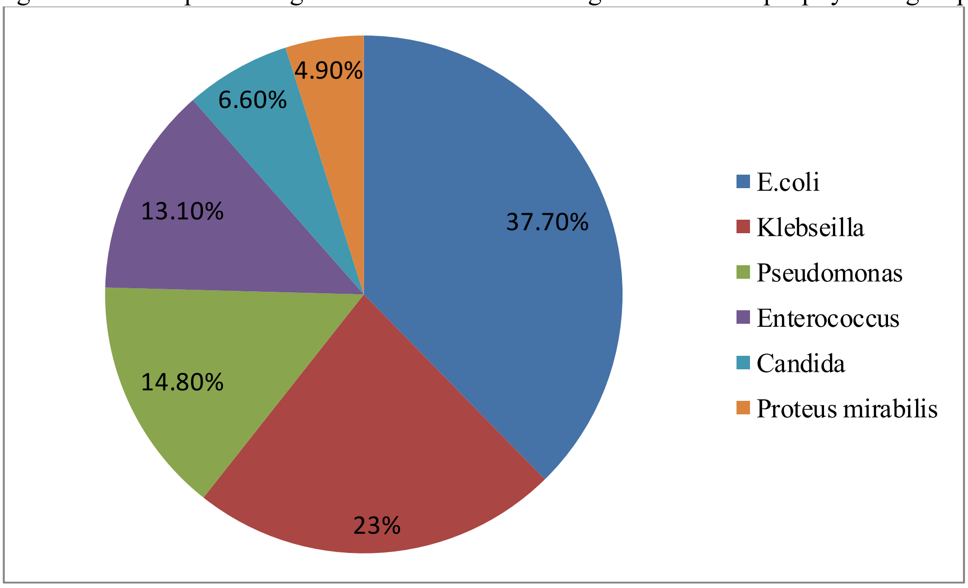

Figure 2. Pie chart representing the organisms in wound culture of SSI patients