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Original Research Article

A Descriptive Clinical Study of Surgical Site Infections Following Elective and Emergency Surgeries

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Abstract

Background: Surgical site infections (SSIs) remain a significant cause of postoperative morbidity and healthcare burden despite advancements in surgical techniques and infection control measures. Understanding the incidence, risk factors, and clinical profile of SSIs is crucial for developing targeted strategies to reduce their occurrence, particularly in both elective and emergency surgical settings.

Objectives: This study aims to describe the incidence, risk factors, microbiological profile, and outcomes of SSIs among patients undergoing elective and emergency surgeries in a Government Hospital, Kamareddy.

Methods: A prospective observational study was conducted over a specified period, including patients who underwent elective and emergency surgical procedures. Data collected included patient demographics, type of surgery, wound classification, and duration of surgery, comorbidities, perioperative factors, and postoperative wound evaluation. SSIs were diagnosed based on CDC criteria. Microbial cultures were obtained from infected sites to determine the causative organisms and antibiotic sensitivity patterns.

Results: Among the patients studied, the overall incidence of SSIs was higher in emergency surgeries compared to elective procedures. Common risk factors identified included diabetes mellitus, prolonged operative time, higher wound contamination class, and inadequate antibiotic prophylaxis. The most frequently isolated pathogens were Escherichia coli, pseudomonas aeruginosa and klebsiella species followed by Escherichia coli and Pseudomonas aeruginosa. Most SSIs were superficial, but deep and organ/space infections were also observed, particularly in emergency cases.

Conclusion: Surgical site infections are more prevalent in emergency surgeries due to urgent, often suboptimal operative conditions. Identification of modifiable risk factors and adherence to strict aseptic and antibiotic protocols can significantly reduce the incidence of SSIs. Further surveillance and individualized infection prevention strategies are recommended to improve surgical outcomes.

Keywords: Surgical site infection (SSI), Elective surgery, Risk factors, Microbiology, Infection control.

Introduction

Infections that occur in the wound created by an invasive surgical procedure are generally referred to as surgical site infections (SSIs)

SSIs are one of the most important causes of healthcare-associated infections. Surgical site infections are among the most common complications of inpatient admissions and have serious consequences for outcomes and costs. Different risk factors may be involved, including age, sex, nutrition and immunity, prophylactic antibiotics, operation type and duration, type of shaving, and secondary infections [1].Despite the advances in surgical sciences post-operative wound infection remains one of the common complication which surgeons encounter. This problem if not evaluated and treated in a timely manner can lead to significant sequel Infection is a common challenge faced by all surgeons due to the inherent nature of surgical procedures, which compromise the body's primary defense mechanisms. Breaching the cutaneous or mucosal barriers provides an entry point for microorganisms, thereby creating the conditions necessary for infection to occur. [2]

During the years there has been considerable progress in both the prevention and treatment of infection. Since Pasteur, Cohn, Lister, Koch and

Klebs, man has constantly strove to combat infection. The discovery and confirmation of the link between microbes and diseases led ultimately to the use of arsenic, mercury and of sulphonamides and following the discovery of penicillin to the steady development of antibiotics. SSIs are associated with considerable morbidity and it has been reported that over one-third of postoperative deaths are related, at least in part, to SSI. [3] However, it is important to recognise that SSIs can range from a relatively trivial wound discharge with no other complications to a life-threatening condition. Other clinical outcomes of SSIs include poor scars that are cosmetically unacceptable.

SSI can double the length of time a patient stays in hospital and thereby increase the costs of health care. The main additional costs are related to re-operation, extra nursing care and interventions, and drug treatment costs. The indirect costs, due to loss of productivity, patient dissatisfaction and litigation, and reduced quality of life, have been studied less extensively.

Aims of the Study: To study the risk factors affecting surgical site infections and their incidence at Government Hospital Kamareddy.

Objectives:

1. To study the incidence of surgical site infections.
2. Risk factors associated with the surgical site infections.
3. Most common organism encountered and its antibiotic sensitivity and resistance in surgical site infection.

Materials and Methods

A total of 50 patients were admitted to the Department of General Surgery at Government Hospital, Kamareddy, from June 2023 to May 2025 and underwent surgery. Surgical sites were considered infected based on the definition provided by the National Nosocomial Infections Surveillance (NNIS) system. The wounds were classified according to the wound contamination classification system proposed by the U.S. National Research Council.

Inclusion Criteria

- Patients undergoing elective or emergency surgical procedures (both open and laparoscopic approaches).
- Age ≥ 18 years(adults).
- Patients who consentto participate in the study and agree to follow-up for postoperative evaluation.
- Surgeries performed under sterile conditionsin the operating theatre of the participating hospital.
- Patients available for at least 30 days postoperative follow-up(or up to 90 days for surgeries involving implants, as per CDC guidelines).
- Patients with clean, clean-contaminated, contaminated, or dirty wounds(all wound classes included for broader analysis).

Exclusion Criteria:

1. Patients below 18 years of age.
2. Patients who refuse to give informed consent or are lost to follow-up.
3. Patients undergoing minor surgical procedures not involving deep tissue dissection (e.g., superficial skin excisions, dressing changes).
4. Patients with pre-existing infections at or near the surgical site at the time of surgery.
5. Patients undergoing surgeries outside the institution (to maintain consistency in surgical environment and protocols).
6. Immunocompromised patients (e.g., those on chemotherapy, long-term corticosteroids, or with advanced HIV) if not a part of the primary study focus.
7. Patients with incomplete medical records or inadequate documentation of perioperative details.

Procedure in laboratory: In the microbiology department, the swabs were inoculated onto blood agar plate, McConkey's agar plates and nutrient broth. Inoculated media were incubated aerobically at 37°C for 24-48 hrs. Nutrient broth was sub cultured if the original plates did not yield organisms.

The bacteria isolated were identified by their morphological and cultural characteristics.

The samples collected were processed as follows:

b) Direct microscopic examination of gram-stained smear.
c) Inoculation of the samples onto different culture media for aerobic and anaerobic organisms.
d) Preliminary identification
e) Bio-chemical tests
f) Antibiotic sensitivity

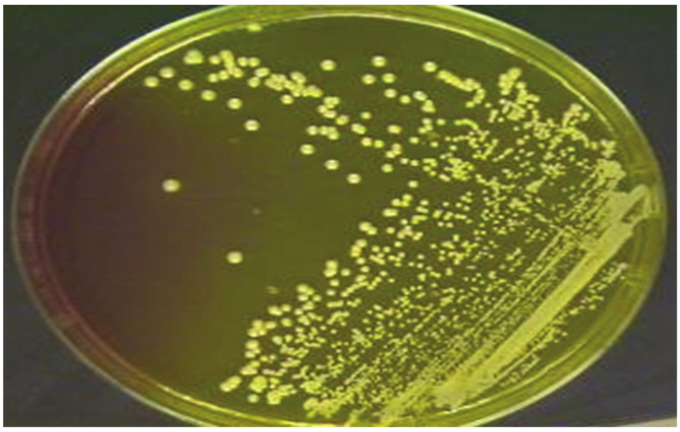


Figure 1: Disc Showing Growth of Staph Aureus

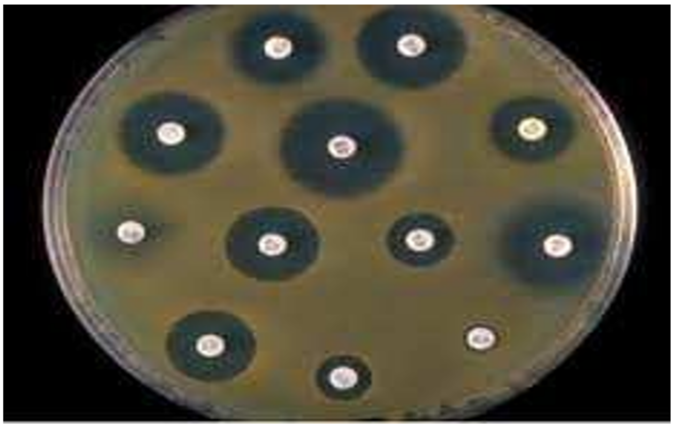


Figure 2: Disc Showing Antibiotic Sensitivity

Figure 3: Showing Superficial SSI of Appendicectomy Wound

Figure 4: Showing Deep SSI Following Appendicectomy (For Gangrenous Appendicitis)

Figure 5: Showing Infected Laparotomy Wound with Pus Discharge

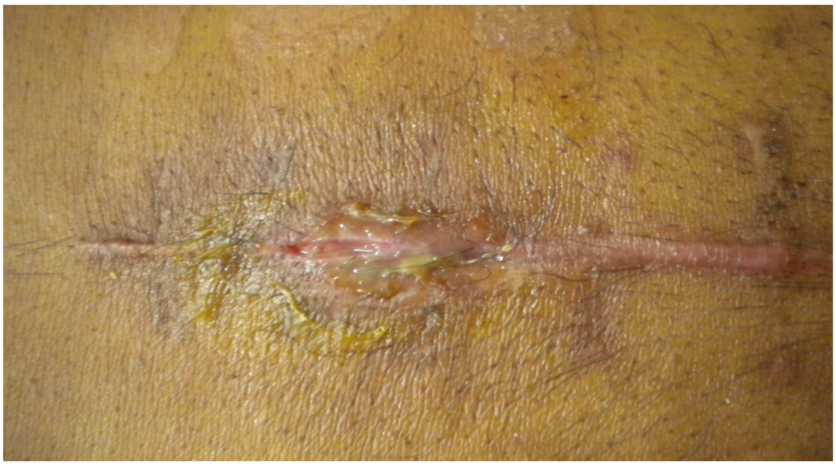


Figure 6: Showing Wound in Healing Phase Following SSI

Results

Table 1: Incidence in relation to Age Group

AGE (in years)	No. of Cases	Infected	Percentage
12 to 20	1	0	0
21 to 30	13	1	7.7
31 to 40	8	1	12.5
41 to 50	15	3	20
51 to 60	8	3	37.5
61 to 70	3	1	33.3

Table 2: Incidence in relation to type of operation

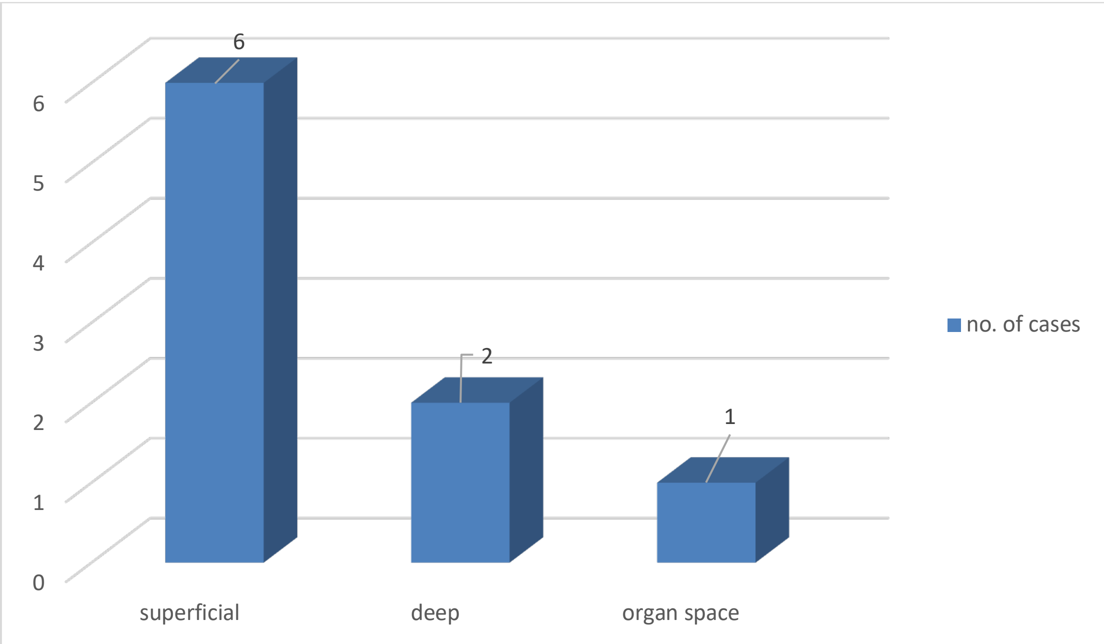
Type	No. of Cases	Infected	Percentage
Elective	25	3	12
Emergency	25	6	24
Total	**50**	**9**	

Table 3: Incidence In Relation To Anemia, Hypoproteinemia, Diabetes

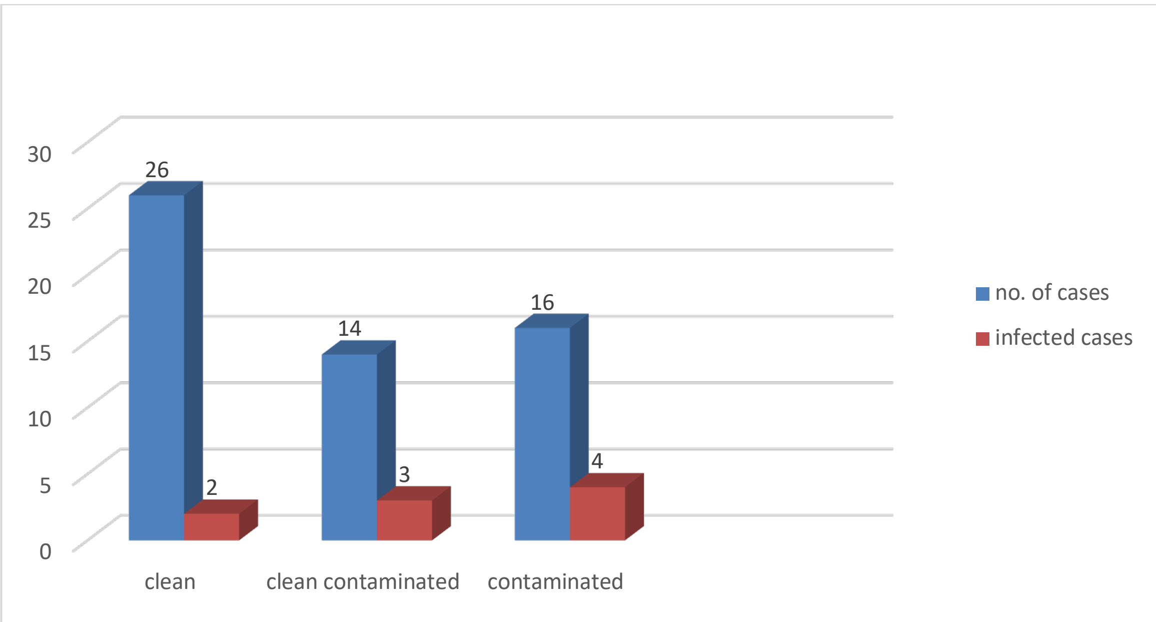
Risk Factors	NO. of Cases	Infected	Percentage
Anemia	11	5	45.4
Hypoproteinemia	15	4	26.6
Diabetes Mellitus	8	4	50
Total	**34**	**9**	

Table 4: Incidence in Relation to Diagnosis

Diagnosis	No. of cases	Incidence	Percentage
Duodenal perforation	8	2	25
Ileal perforation	3	1	33.3
Intestinal obstruction	5	1	20
Acute/ recurrent appendicitis	7	2	28.5
Cholelithiasis	5	1	20
Malignancy	1	0	0
Inguinal hernias	6	0	0
Thyroid	2	0	0
Ventral hernias	7	2	28.5
Varicose vein	4	0	0
Others	2	0	0
Total	**50**	**9**	



Graph 1: Incidence in relation to type of SSI



Graph 2: Incidence in relation to Wound Class

Table 5: Incidence in Relation to Duration of Surgery

Duration (IN HRS)	No. of cases	Incidence	Percentage
<1	27	3	11.1
1 to 2	19	4	21.05
> 2	4	2	50
Total	**50**	**9**	

Table 6: Incidence of Infection noted on Post-Operative Day

Day	No. of Infected Cases	Percentage
Second	1	11.1
Third	3	33.3
Fourth	1	11.1
Fifth	2	22.2
Sixth	1	11.1
More Than six	1	11.1
Total	**9**	

Table 7: Incidence of Organism Isolated

Organism	No. of cases	Percentage
Pseudomonas	2	22.2
Staphylococci	0	0
Mrsa	1	11.1
Ecoli	4	44.4
Klebsiella	2	22.2
Citrobacter	0	0
Others	0	0
TOTAL	**9**	

Table 8: Antibiotic Resistance Spectrum

Parameters	Ak	pit	Cip	cpm	Cxm	cap	cf	azm	I	l	v	d
										z	a	o
Ecoli	0	2	3	4	2	0	0	0	0	0	0	0
Staph	0	0	0	0	0	0	0	0	0	0	0	0
Pseud	0	1	0	2	1	0	0	0	0	0	0	0
MRSA	0	0	0	0	0	0	1	1	0	0	0	0
Klebs	1	0	0	2	2	0	0	0	0	0	0	0
Citro	0	0	0	0	0	0	0	0	0	0	0	0
Total	**1**	**3**	**2**	**8**	**6**	**0**	**1**	**1**	**0**	**0**	**0**	**0**

Discussion

This is a prospective study of 50 cases who underwent surgery and were followed up from the day of operation to 30 days after discharge to look for the development of SSI. Prophylactic antibiotic was given to all cases.The overall infection rate in a sample of 50 cases was 18%. Studies across India report SSI rates ranging from 6.09% to 38.7%, significantly higher than in countries like the USA (2.8%) and Europe (2–5%).

This may be due to inadequate hospital infrastructure and poor adherence to infection control practices. The table below compares infection rates from various studies.

Author	Year	Country	No. of Operations	Infection
Cruse and Foord et al [4]	1980	Canada	62939	4.7%
Edwards et al [5]	1984	U.S	20,193	2.8%
Anvikar et al [6]	1999	India	3280	6.09%
Umesh s et al [7]	2008	India	114	30.7%
Mahesh c b et al [8]	2010	India	418	20.9%
Present study	2023	India	50	18%

The rates of SSIs in male patients were 15.8% and in female patients, they were 25%.The significance of this observation is not well understood. The present study observed the highest incidence of surgical site infections (SSI) in the 51–60 age group, followed by the 41–50 group, which may be attributed to a higher volume of surgeries performed in these age ranges. Younger patients demonstrated fewer infections, supporting the well-established trend of increased SSI risk with advancing age. Interestingly, the 61–70 age group showed a lower SSI rate, likely due to a smaller number of surgeries conducted in this cohort. Similarly, Cruse and Foord reported that older patients are more susceptible to infections, particularly in clean wounds.

The high incidence of 37.5% in patients aged 51-60 years in our study is perhaps due to decreased immune competence and increased chances of co-morbid factors like Diabetes Mellitus, Hypertension, Chronic ailments like Asthma, conditions requiring Steroid therapy and personal habits like Smoking and Alcoholism. Age, obviously is an immutable patient characteristic and even, if it is a risk factor for wound infection, it appears to be at most a modest one.

The SSI rate was 12% in elective surgeries, rising to 24% in emergency cases. This aligns with findings by Mahesh CB et al. (2010), who reported rates of 7.61% and 21.05% respectively. Higher infection rates in emergency surgeries are likely due to inadequate pre-op preparation, existing health issues, and a greater incidence of contaminated wounds.

Smith RL et al [9]. Reported that among key pre-operative risk factors for surgical site infection (SSI), the incidence in their cohort was approximately 45.4% in patients with anemia, 26.6% with hypoproteinemia, and 50.0% in individuals with diabetes mellitus. They noted that these findings were consistent with results from other studies reporting similar associations between malnutrition, low serum protein levels, diabetic status, and increased SSI risk.

Cause being the reduced immunocompetence, wound healing factors, hyperglycemia, and pre-existing infection.

In this study incidence in relation to the type of surgery, clean cases had infection rate of 10%, clean contaminated had incidence of 23% and contaminated cases had 23.5%.

In the prospective surveillance conducted at the University Clinical Centre of Kosovo (2005–2006), Lul Raka et al10. Reported wound-class–specific surgical site infection (SSI) rates in abdominal procedures: 3.1% in clean wounds (n = 64), 9.8% in clean contaminated wounds (n = 143), 46.1% in contaminated wounds (n = 13), and 100% in dirty/infected wounds (n = 5). They also calculated that the relative risk of developing SSI in contaminated wounds was roughly 5.4 times higher compared to clean wounds. These results closely align with elevated SSI risk trends observed in similar surveillance systems.

In their prospective analysis at Imam Khomeini Hospital (Tehran), Seyd Mansour Razavi et al [11]. (2005) at an found clean wounds in 109 cases (13.6%); clean-contaminated wounds in 214 cases (26.7%); contaminated wounds in 307 cases (45.8%); and dirty infected wounds in 112 cases (14%).

Mahesh C B et al in 2010 at Bagalkot had SSI rate of 11.53% in clean surgeries, 23.33% in clean contaminated ones, 38.10% in contaminated ones and 57.14% in dirty surgeries.

Our study correlates with most series, incidence among contaminated cases are more due to the fact most of the cases were bowel perforation cases.

The difference in the rates of SSIs between the clean and the clean contaminated wounds showed the effect of endogenous contamination and the difference in the rates of SSIs between the clean contaminated and the contaminated wounds showed the effect of exogenous contamination. The endogenous or the exogenous contamination of the wounds by the organisms had a profound influence on the SSIs.

In the present study, 27 cases underwent surgery lasting less than 1 hour, with a surgical site infection (SSI) incidence of 11.1%. Among the 19 cases with a surgical duration of 1 to 2 hours, the incidence rose to 21.05%, while in the 4 cases where surgery lasted more than 2 hours, the infection rate reached 50%. These findings clearly demonstrate that the incidence of SSI increases with the duration of surgery.

Similar trends were observed in several previous studies. Seyd Mansour Razavi et al. (2005), in a study at an Iranian teaching hospital, identified prolonged surgery as a significant risk factor for SSI. Likewise, LulRaka et al. (2006) at Kosovo Teaching Hospital reported higher infection rates in longer procedures, particularly in contaminated and dirty wounds. Additionally, Mahesh C. B. et al. (2010) found a direct correlation between longer operative times and increased SSI incidence, reinforcing the role of surgery duration as a major contributing factor.

Abdominal surgical site infection was noted most commonly on 3rd post op day in our study. Similar results were obtained in other studies at Irani Hospital 2005.

In our study, the most commonly isolated organism from surgical site infections (SSI) was Escherichia coli (44.4%), followed by Pseudomonas aeruginosa (22.2%) and Klebsiella species (22.2%). These findings are consistent with those reported by

Umesh S. Kamat et al (2008), who observed that 79.3% of isolates from SSIs were gram-negative bacteria, with Pseudomonas being the predominant pathogen. Similarly, Mofikoya et al [12]. (2009) in Nigeria identified Pseudomonas as the most frequent aerobic isolate in postoperative wound infections. The predominance of gram-negative bacilli in our study corroborates the established understanding that endogenous flora, particularly coliforms from the gastrointestinal tract, are the primary sources of infection in abdominal surgeries. These organisms tend to be hospital-endemic, often exhibiting resistance to commonly used antiseptics and antibiotics, thereby posing significant challenges for infection control and contributing to the burden of hospital-acquired infections.

E. coli showed the highest sensitivity to amikacin, followed by piperacillin-tazobactam. Pseudomonas was most sensitive to piperacillin and amikacin. MRSA showed the greatest sensitivity to vancomycin and linezolid. Klebsiella was most sensitive to piperacillin, followed by amikacin.

Overall, E. coli showed the highest sensitivity to piperacillin and amikacin but was most resistant to cefixime, cefepime, and cefotaxime. Pseudomonas exhibited the greatest resistance to cefixime and cefepime, followed by other antibiotics. MRSA was resistant to most commonly used antibiotics, especially azithromycin, cefazolin, and cefoperazone. Klebsiella showed the highest resistance to cefixime, ceftriaxone, and linezolid, followed by other antibiotics. Overall, amikacin, cefixime, and cefepime were the antibiotics with the highest resistance rates.Mofikoya Bo et al had Pseudomonas species 37.5% sensitive for Ceftaxidine followed by 12.5% Ceftriaxone, and it was most resistant for Cefotaxime.

Umesh S. Kamat (2008) reported that Pseudomonas species showed 21.4% sensitivity to the cefoperazone-sulbactam combination. The proportion of bacteria resistant to all tested antibiotics was as high as 63.93% (39/61). Most studies have shown that nearly all pathogens were resistant to commonly prescribed antibiotics such as ampicillin and doxycycline. The cultured aerobes also demonstrated less than 50% sensitivity to the cephalosporins tested (ceftazidime, cefuroxime, and ceftriaxone) in over 80% of infected patients. These findings highlight the high prevalence of multidrug-resistant nosocomial pathogens in our environment, likely reflecting widespread antibiotic misuse in the general population.

The relative frequency of different isolates varies between studies, indicating that the organisms causing SSIs change over time and across locations. Antibiotic sensitivity testing revealed multidrug resistance in most isolates. Literature review shows a gradual increase in drug resistance among pathogens isolated from surgical patients. Our study confirms that, despite extensive research, SSIs remain a major cause of morbidity and mortality in surgical patients. Current measures to reduce SSIs are still insufficient. Strengthening infection control practices and implementing a robust antibiotic policy are essential to decrease SSIs in the future.

Conclusion

- The incidence of surgical site infection (SSI) in this study was 18%.
- The majority of infected cases were in the 51–60 years age group, with an incidence of 37.5%.
- SSI incidence was 12% in elective surgeries and 24% in emergency cases.
- Most SSIs were detected on the 3rd postoperative day.
- Anemia and diabetes were the main risk factors associated with higher SSI rates.
- Longer duration of surgery correlated with increased SSI rates.
- Infection rates increased progressively from clean to contaminated wounds.
- E. coli was the most common organism isolated.
- Most organisms were isolated from clean-contaminated and contaminated wounds.
- Overall, amikacin and piperacillin were the most effective antibiotics.

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