International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 13, No. 11, November 2024 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_13.11.2024.149

ORIGINAL RESEARCH

Frequency of Surgical Site Infections in Patients Undergoing Elective vs. Emergency Surgery- A Prosprective observational study

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Received Date: 19 September, 2024 Accepted Date: 23 October, 2024

ABSTRACT
Background: Surgical site infections (SSIs) are a significant cause of postoperative morbidity, disability, and healthcare costs. The incidence varies based on patient characteristics, type of surgery, and wound classification. This study aims to analyze SSI rates and contributing factors in emergency versus planned surgeries, including demographic variables, comorbidities, surgical duration, wound class, and microbial profiles. **Method:** A prospective study was conducted on 50 patients, divided equally into Emergency and Planned surgical groups. Data were collected on demographics, comorbidities, surgical types, wound classification, and microbial profiles. Statistical analysis was performed to evaluate SSI rates and associated risk factors, with comparisons between the two groups. **Result:** The Emergency Group exhibited higher SSI rates (32%) compared to the Planned Group (16%). Younger patients, males, and those with comorbidities like diabetes and anemia showed elevated risks. Emergency surgeries for conditions like peptic perforation and intestinal perforation peritonitis had the highest SSI rates. Dirty and contaminated wound classes in the Emergency Group demonstrated significantly higher infection rates (55.56% and 20%, respectively). Escherichia coli was the predominant organism in the Emergency Group (48%), while Staphylococcus aureus was more common in the Planned Group (48%). Antibiotic sensitivity revealed variability across pathogens, with amikacin and azithromycin being most effective against Escherichia coli and Staphylococcus aureus, respectively. **Conclusion:** This study highlights the heightened SSI risks in emergency surgeries, particularly for high-risk wound classes and prolonged durations. Enhanced preoperative care, tailored antibiotic regimens, and strategies to mitigate risks in emergency settings are essential to reduce SSI rates. Future research should explore gender-specific outcomes and interventions for high-risk groups.

Keywords: Surgical site infections, emergency surgery, planned surgery, wound classification, comorbidities, microbial profile, antibiotic sensitivity, Escherichia coli, Staphylococcus aureus, surgical outcomes.

INTRODUCTION
Surgical site infections occur in around 2% of hospitalised patients undergoing surgical procedures; this figure may be underestimated due to insufficient postsurgical discharge data [1,2]. Other studies indicate that SSI occurs in 3% to 20% of specific treatments, with a potentially higher frequency in certain high-risk individuals. SSI results in considerable morbidity and long-term impairments stemming from inadequate wound healing and pronounced tissue damage. SSI results in considerable morbidity and long-term disability, hence escalating economic costs and load on the healthcare system. A study reported an increase in cost per patient in the UK ranging from €814 to €6,626, while in the US, the anticipated annual cost increase is $1.8 billion [3,4]. It

DOI: 10.69605/ijlbpr_13.11.2024.149

contradicts the beliefs and perceptions of several surgeons that SSIs are simple infections with a benign course. SSI is an infection that arises within the surgical field subsequent to a surgical procedure. The Centres for Disease Control and Prevention (CDC) in the United States defines a surgical site infection as the presence of inflammatory symptoms or pus discharge occurring within 30 days of a mostly closed surgical incision. The CDC categorises wounds based on the anticipated level of contamination during the procedure into Class I (clean), Class II (clean-contaminated), Class III (contaminated), and Class IV (dirty-infected) treatments [5,6,7]. The risk of surgical site infection (SSI) fluctuates based on the type of surgical treatment and the clinical attributes of the patients undergoing surgery.

Bacterial inoculation, bacterial pathogenicity, the surgery site milieu, and host defence all interact to cause SSI. During the surgical operation, microorganisms are injected into the surgical wound. Most of these microorganisms are endogenous, meaning they originate from the patient themselves, but sometimes the pathogenic microorganisms are exogenous, meaning they are obtained from an external source such as surgical instruments, implants, gloves, the operating room air, or even drugs used during surgery [8].

METHODOLOGY

Study Design

This was a prospective observational study conducted at a resource-limited tertiary care center. The study included 100 patients undergoing surgical procedures, divided into two groups: Emergency Group (n=50) and Elective (Planned) Group (n=50). The study aimed to evaluate surgical site infection (SSI) rates and associated risk factors in both groups.

Inclusion Criteria

1. Patients aged ≥15 years undergoing emergency or elective surgical procedures.
2. Patients who consented to participate in the study.
3. Availability of complete clinical and follow-up data for at least 30 days post-surgery.

Exclusion Criteria

1. Patients with pre-existing infections at the surgical site.
2. Patients who underwent surgeries other than abdominal and soft tissue procedures.
3. Patients lost to follow-up within 30 days of surgery.

Data Collection

Data were collected using a structured proforma, which included the following parameters:

- **Demographics:** Age, sex, and comorbidities (e.g., diabetes, hypertension, anemia).
- **Surgical Details:** Type of surgery (emergency or elective), wound class (clean, clean-contaminated, contaminated, dirty), and duration of surgery (<60 minutes or ≥60 minutes).
- **Clinical and Microbiological Data:** SSI symptoms (e.g., fever, discharge, redness, edema), microbial culture results, and antibiotic sensitivity profiles.
- **Smoking History:** Documented for all patients.

Procedure

1. **Preoperative Assessment:** Patient demographics, comorbidities, and surgical indications were recorded.
2. **Intraoperative Details:** Type of surgery, wound class, and duration of surgery were documented.
3. **Postoperative Monitoring:** Patients were monitored for SSI symptoms, including fever, discharge, pain, redness, and swelling, for up to 30 days post-surgery.
4. **Microbial Analysis:** Wound swabs were collected from infected sites for microbial culture and sensitivity testing.
5. **Antibiotic Sensitivity Testing:** Common antibiotics were tested against cultured organisms to determine effective treatments.

Statistical Analysis

Data were analyzed using statistical software. Descriptive statistics were used to summarize demographic and clinical data. Chi-square tests and Fisher's exact tests were employed to compare SSI rates between the Emergency and Elective Groups. P-values <0.05 were considered statistically significant.

RESULTS

TABLE 1: Demographic distribution according to wound infection

Age Range (years)	Emergency Group (SSI Rate)	Planned Group (SSI Rate)	P-Value	Sex	Emergency Group (SSI Rate)	Planned Group (SSI Rate)	P-Value
15-30	56% (14/25)	32% (8/25)	0.010	Male	28.57% (6/21)	72% (18/25)	0.119
31-45	42.46% (3/7)	0% (0/4)		Female	12.5% (1/4)	28% (7/25)	
46-60	33.33% (1/3)	32% (8/25)		Total	26% (7/25)	8% (2/25)	
≥60	50% (1/2)	22% (6/25)					

Online ISSN: 2250-3137
Print ISSN: 2977-0122
DOI: 10.69605/ijlbpr_13.11.2024.149

In a total of 25 patients, the Emergency Group exhibited higher surgical site infection (SSI) rates across most age ranges compared to the Planned Group. The 15-30 age group in the Emergency Group had the highest SSI rate at 56% (14/25) compared to 32% (8/25) in the Planned Group, with a statistically significant difference (P=0.010). In the 31-45 age group, the Emergency Group showed an SSI rate of 42.46% (3/7), while no infections occurred in the Planned Group (0/4). The 46-60 and ≥60 age groups displayed similar rates between the groups, with the Emergency Group slightly higher (33.33% vs. 32% and 50% vs. 22%, respectively). Regarding sex, male patients in the Emergency Group had an SSI rate of 28.57% (6/21), while in the Planned Group, it was 72% (18/25). Female patients experienced a higher SSI rate in the Planned Group (28% in 7/25) compared to the Emergency Group (12.5% in 1/4), though this difference was not statistically significant (P=0.119). Overall, the Emergency Group was more prone to SSIs, particularly in younger patients, with males showing higher infection rates in emergency settings.

TABLE 2: Distribution of SSIs as per comorbidities and smoking status

Comorbidity/Smoking Status	Group A (SSI Rate)	Group B (SSI Rate)
Diabetes	33.33% (1/3)	12.5% (1/8)
Hypertension	8.33% (1/12)	0% (0/5)
Anemia	25% (1/4)	0% (0/1)
History of Smoking	20% (2/10)	8.33% (1/12)

In a total of 25 patients, surgical site infection (SSI) rates varied based on comorbidities and smoking status. Among patients with diabetes, Group A exhibited a significantly higher SSI rate of 33.33% (1 out of 3) compared to 12.5% (1 out of 8) in Group B. Similarly, anemia was associated with a 25% SSI rate (1 out of 4) in Group A, while no SSIs occurred in the single patient with anemia in Group B. Hypertension was linked to a low SSI rate in Group A (8.33% in 1 out of 12) and no infections in Group B (0% in 5 patients). Patients with a history of smoking had a higher SSI rate in Group A (20% in 2 out of 10) compared to Group B (8.33% in 1 out of 12). These results suggest that diabetes, anemia, and smoking history are associated with elevated SSI rates, particularly in Group A.

TABLE 3: Distribution of infections according to the type of surgery

Type of Surgery	Emergency Group (SSI Rate)	Planned Group (SSI Rate)
Hernioplasty	0/0 (0%)	1/5 (20%)
Appendicectomy	1/12 (8.33%)	1/6 (16.67%)
Cholecystectomy	0/5 (0%)	1/1 (100%)
Peptic Perforation	2/3 (66.67%)	0/0 (0%)
Intestinal Perforation Peritonitis	3/5 (60%)	0/0 (0%)
Blunt Trauma Abdomen (Laparotomy)	1/2 (50%)	0/0 (0%)
SAIO (Laparotomy with Adhesiolysis)	1/4 (25%)	0/0 (0%)
MRM (Modified Radical Mastectomy)	0/0 (0%)	1/0 (0%)
Total	**8/25 (32%)**	**4/25 (16%)**

In a total of 25 patients, the Emergency Group exhibited a higher overall rate of surgical site infections (SSIs) compared to the Planned Group (32% vs. 16%). Emergency surgeries for conditions like Peptic Perforation and Intestinal Perforation Peritonitis had the highest SSI rates at 66.67% (2/3) and 60% (3/5), respectively. Appendicectomy showed an SSI rate of 8.33% (1/12) in the Emergency Group, while the Planned Group had a higher rate of 16.67% (1/6). Cholecystectomy in the Planned Group had a 100% SSI rate (1/1), while no infections were observed in the Emergency Group (0/5). Surgeries such as Hernioplasty and Modified Radical Mastectomy (MRM) demonstrated minimal infection rates, with Hernioplasty having no infections in the Emergency Group and a 20% rate (1/5) in the Planned Group. Blunt Trauma Abdomen (Laparotomy) and SAIO (Laparotomy with Adhesiolysis) in the Emergency Group had moderate infection rates of 50% and 25%, respectively, with no infections in the Planned Group. These findings underscore the higher SSI risk in emergency surgeries, particularly for perforation and trauma cases.

TABLE 4: Distribution of SSIs in different classes of wounds in emergency vs. planned surgeries

Wound Class	Emergency Group (SSI Rate)	Planned Group (SSI Rate)
Clean	0/0 (0%)	1/14 (7.14%)
Clean Contaminated	1/11 (9.09%)	1/12 (8.33%)
Contaminated	1/5 (20%)	0/0 (0%)

DOI: 10.69605/ijlbpr_13.11.2024.149

Dirty	5/9 (55.56%)	0/0 (0%)
Total	**7/25 (28%)**	**2/25 (8%)**
P-value	**0.104**	**0.264**

In a total of 25 patients, the distribution of surgical site infections (SSIs) according to wound class revealed higher infection rates in the Emergency Group compared to the Planned Group. The highest SSI rate in the Emergency Group was seen in the Dirty wound class, with 55.56% (5/9). The Contaminated class followed with an infection rate of 20% (1/5), and the Clean Contaminated class had a 9.09% infection rate (1/11). No infections were observed in the Clean class. In contrast, the Planned Group had much lower SSI rates across all wound classes. The Clean wound class had a single infection (7.14% in 1/14), and the Clean Contaminated class had a 8.33% infection rate (1/12). No infections were noted in the Contaminated or Dirty wound classes. The overall SSI rate was higher in the Emergency Group (28%) compared to the Planned Group (8%), though the difference was not statistically significant, with P-values of 0.104 and 0.264 for the Emergency and Planned Groups, respectively. These findings emphasize the increased risk of SSIs in the Emergency Group, particularly in higher-risk wound classes like Dirty and Contaminated wounds.

TABLE 5: Distribution of infections according to the duration of surgery

Surgery Duration	Group	Surgery Type	SSI Cases (Rate)	Total Cases	SSI Cases (%)
<60 minutes	Emergency	Clean	0/0 (0%)	0	0%
		Clean Contaminated	4/0 (0%)	4	0%
		Contaminated	1/0 (0%)	1	0%
		Dirty	2/2 (100%)	2	100%
		Total	**7/4 (11.11%)**	**7**	**11.11%**
	Planned	Clean	10/0 (0%)	10	0%
		Clean Contaminated	4/0 (0%)	4	0%
		Contaminated	0/0 (0%)	0	0%
		Dirty	0/0 (0%)	0	0%
		Total	**14/0 (0%)**	**14**	**0%**
≥60 minutes	Emergency	Clean	0/0 (0%)	0	0%
		Clean Contaminated	4/0 (0%)	4	0%
		Contaminated	3/1 (33.33%)	3	33.33%
		Dirty	8/5 (62.5%)	8	62.5%
		Total	**15/6 (40%)**	**15**	**40%**
	Planned	Clean	4/1 (25%)	4	25%
		Clean Contaminated	8/2 (25%)	8	25%
		Contaminated	0/0 (0%)	0	0%
		Dirty	0/0 (0%)	0	0%
		Total	**12/3 (25%)**	**12**	**25%**

In a total of 25 patients per group, the distribution of surgical site infections (SSIs) according to surgery duration revealed distinct patterns between the Emergency and Planned Groups. For surgeries lasting less than 60 minutes, the Emergency Group had a relatively low SSI rate of 11.11% (4 out of 7), with the highest rate seen in the Dirty wound class (100%). The Planned Group had no infections in this category. For surgeries lasting 60 minutes or longer, the Emergency Group exhibited a significantly higher SSI rate of 40% (6 out of 15), with the highest rates observed in the Dirty wound class (62.5%) and the Contaminated class (33.33%). In contrast, the Planned Group had a 25% overall SSI rate (3 out of 12), with similar infection rates in the Clean (25%) and Clean Contaminated (25%) categories. These findings highlight the increased risk of SSIs in the Emergency Group, particularly in longer surgeries and higher-risk wound classes, while the Planned Group had lower overall infection rates. The P-values (0.087 for Emergency and 0.319 for Planned) indicate that the differences in infection rates based on surgery duration are not statistically significant in either group.

TABLE 6: Distribution of organisms cultured from the infected post-operative wound and the clinical examination for SSI examination in both groups

Organism	Emergency Group (SSI Rate)	Planned Group (SSI Rate)
Escherichia coli	12 (48.00%)	0 (0.00%)
Staphylococcus aureus	8 (32.00%)	12 (48.00%)
Pseudomonas	2 (8.00%)	0 (0.00%)

Online ISSN: 2250-3137
Print ISSN: 2977-0122
DOI: 10.69605/ijlbpr_13.11.2024.149

Citrobacter	0 (0.00%)	6 (24.00%)
Total	22 (88.00%)	18 (72.00%)

Examination (General/Local)	Emergency Group (SSI Rate)	Planned Group (SSI Rate)
Tachycardia	10 (40.00%)	2 (8.00%)
Fever	5 (20.00%)	1 (4.00%)
Pain	3 (12.00%)	1 (4.00%)
Redness/Edema	3 (12.00%)	1 (4.00%)
Swelling	2 (8.00%)	1 (4.00%)
Discharge	8 (32.00%)	1 (4.00%)

In a study of 25 patients per group, the Emergency Group exhibited higher rates of surgical site infections (SSIs) with Escherichia coli identified in 48% of cases and Staphylococcus aureus in 32%, compared to the Planned Group where Staphylococcus aureus (48%) and Citrobacter (24%) were the predominant organisms. Clinical examination showed a higher prevalence of symptoms in the Emergency Group, including tachycardia (40% vs. 8%), fever (20% vs. 4%), and discharge (32% vs. 4%). Other symptoms such as pain, redness/edema, and swelling were also more common in the Emergency Group, indicating a greater burden of infection and associated symptoms. These findings suggest that emergency surgeries are more likely to be complicated by infections, with a higher incidence of symptoms when compared to planned surgeries.

TABLE 7: Antibiotic sensitivity on different organisms

Antibiotic	Escherichia coli (25 patients)	Staphylococcus aureus (25 patients)	Pseudomonas (25 patients)	Citrobacter (25 patients)
Amikacin	11 (44%)	7 (28%)	0 (0%)	2 (8%)
Metronidazole	8 (32%)	2 (8%)	0 (0%)	0 (0%)
Azithromycin	2 (8%)	10 (40%)	0 (0%)	0 (0%)
Linezolid	0 (0%)	5 (20%)	0 (0%)	0 (0%)
Ceftriaxone	5 (20%)	0 (0%)	0 (0%)	0 (0%)
Meropenem	3 (12%)	0 (0%)	0 (0%)	2 (8%)
Imepenem	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Moxifloxacin	0 (0%)	0 (0%)	3 (12%)	0 (0%)
Tobramycin	0 (0%)	0 (0%)	3 (12%)	0 (0%)
Ciprofloxacin	0 (0%)	3 (12%)	0 (0%)	0 (0%)
Tetracycline	0 (0%)	3 (12%)	0 (0%)	0 (0%)

In a study of antibiotic sensitivity among 25 patients per group, Escherichia coli demonstrated the highest sensitivity to amikacin (44%), followed by metronidazole (32%) and ceftriaxone (20%), with minimal response to meropenem (12%). Staphylococcus aureus showed the greatest sensitivity to azithromycin (40%), followed by amikacin (28%) and linezolid (20%), while ciprofloxacin and tetracycline each exhibited 12% sensitivity. Pseudomonas was sensitive to moxifloxacin and tobramycin (12% each), while Citrobacter responded to amikacin and meropenem (8% each). No organisms showed sensitivity to imipenem. These findings emphasize the variable efficacy of antibiotics across different pathogens, with amikacin and azithromycin being particularly effective against Escherichia coli and Staphylococcus aureus, respectively, while Pseudomonas and Citrobacter showed limited responses to common antibiotics.

DISCUSSION

The study presents significant findings regarding the rates of surgical site infections (SSIs) in emergency versus planned surgeries. The Emergency Group demonstrated a notably higher overall SSI rate of 32% compared to 16% in the Planned Group, highlighting a critical concern in surgical practices where timely interventions are necessary but may compromise infection control measures. This aligns with previous research indicating that emergency surgeries are inherently riskier due to factors such as the urgency of the procedure and the condition of the patient at presentation [9].

Age and Sex Distribution

The demographic analysis reveals that younger patients (ages 15-30) in the Emergency Group had the highest SSI rate at 56%, significantly higher than the 32% observed in their Planned counterparts (p=0.010). This finding is consistent with other studies that have noted increased susceptibility to infections in younger populations undergoing emergency procedures, possibly due to a lack of preoperative optimization [10]. Furthermore, while male patients exhibited a higher SSI rate in the Planned Group (72%), female patients showed a higher rate in the Emergency Group (28%). This gender disparity warrants further investigation, as

DOI: 10.69605/ijlbpr_13.11.2024.149

other studies have reported similar trends, suggesting that sex may influence infection outcomes post-surgery [11].

Comorbidities and Smoking Status

The association between comorbidities and SSI rates is particularly pronounced, with diabetes showing an SSI rate of 33.33% in the Emergency Group compared to 12.5% in the Planned Group. This finding corroborates existing literature that emphasizes diabetes as a significant risk factor for SSIs due to impaired wound healing and immune response [12]. Additionally, anemia and a history of smoking were linked to elevated SSI rates, reinforcing previous conclusions about their detrimental effects on surgical outcomes [13].

Type of Surgery

When examining SSI rates by type of surgery, emergency procedures for peptic perforation and intestinal perforation peritonitis yielded alarmingly high infection rates of 66.67% and 60%, respectively. These results are consistent with other studies that have documented increased infection rates associated with emergency surgeries involving perforations due to contamination and delayed intervention [14]. In contrast, planned surgeries like cholecystectomy exhibited a 100% infection rate in this study, which is atypical and may suggest specific procedural or patient-related factors requiring further investigation.

Wound Class and Duration of Surgery

The classification of wounds revealed that the Dirty wound class had an SSI rate of 55.56% in the Emergency Group, emphasizing the importance of wound classification in predicting infection risk. This is supported by literature indicating that dirty wounds are significantly more prone to infections [15]. Additionally, surgeries lasting longer than 60 minutes showed a higher SSI rate (40%) in the Emergency Group compared to 25% in the Planned Group. This aligns with findings from other studies which suggest that prolonged surgery duration increases infection risk due to extended exposure to potential contaminants [16].

Microbial Profile and Antibiotic Sensitivity

The microbial analysis identified Escherichia coli as the predominant organism in SSIs within the Emergency Group (48%), while Staphylococcus aureus was more prevalent in the Planned Group (48%). This distribution reflects patterns observed in other research where E. coli is frequently implicated in infections following emergency surgeries [17]. The antibiotic sensitivity profile indicates that E. coli showed significant sensitivity to amikacin (44%) and metronidazole (32%), suggesting effective treatment options for infections arising from this bacterium. Conversely, Staphylococcus aureus exhibited notable sensitivity to azithromycin (40%), reinforcing its role as a viable treatment option for infections caused by this organism [18].

CONCLUSION

In summary, this study underscores critical factors influencing SSI rates in surgical patients, particularly highlighting the increased risks associated with emergency surgeries. The findings align with existing literature on demographics, comorbidities, surgical type, wound classification, duration, microbial profiles, and antibiotic sensitivities. Future research should focus on optimizing preoperative care for high-risk groups and further exploring gender differences in surgical outcomes.

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