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**Original Article**

# Incidence and Risk Factors for Surgical Site Infection in Patients Undergoing Abdominal Surgeries at A Tertiary Care Centre

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**Jotirmay Shaha[1]*, Anirudha Sardar[2], S M Akrumuzzamam[3], Bithi Ghosh[4], Kanak Hossain[5]**

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*Corresponding Author



***ABSTRACT***

***Introduction:*** *Surgical Site Infections (SSIs) are infections at incisional sites post-surgery, occurring within 30 days (or one year with prosthesis). SSIs, common hospital-acquired infections, have an estimated 2% incidence, potentially underestimated. In India, rates range from 6-39%, and in Bangladesh, 5.13-14.13%. Abdominal surgeries pose a higher risk due to bacterial concentration. Patient-related risk factors include age, malnutrition, diabetes, and immunosuppression.* ***Aim of the study:*** *This study aims to determine the rate of abdominal surgical site infections, identify associated risk factors, and assess the most common organisms encountered within a tertiary care center in Khulna.* ***Methods & Materials:*** *This one-year observational study at Khulna Medical College and Hospital focused on 132 individuals who underwent abdominal surgery between January 2022 to December 2023. Of these, 25 Surgical Site Infections (SSI) patients were analyzed. Inclusion criteria involved ages 15 to 60, both genders and SSIs from abdominal surgery.* ***Result:*** *The study examines surgical site infections (SSIs) in abdominal surgeries, presenting data on age, gender, obesity prevalence, wound types, surgery types (emergency vs. elective), and associated risk factors. Most patients were aged 46-60, with males comprising 58%. Clean-contaminated wounds had the highest SSI incidence. Emergency surgeries were more prone to SSIs (56%), with diabetes being a notable risk factor (44%). Anemia and hypoproteinemia exhibited equal incidence (28%), emphasizing their importance. Pseudomonas was the most common causative organism (40%), followed by Staphylococcus aureus (28%). The study underscores the significance of preoperative conditions and procedural factors in SSIs.* ***Conclusion:*** *The study investigates surgical site infections (SSIs) in abdominal surgeries at a Khulna tertiary care center, revealing a notable 18.94% SSI rate. Risk factors include age, gender, surgical wound type, emergency surgeries, comorbidities, hospitalization duration, drain placement, preoperative shaving, and extended surgical durations. Gram-negative bacteria like Pseudomonas and Escherichia coli are crucial considerations, emphasizing the importance of targeted interventions for infection prevention in abdominal surgery patients.*

***Keywords:*** *Risk factors, Surgical Site Infection (SSI), and abdominal surgeries.*

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1. *Senior Consultant, Surgery unit 1, Khulna Medical College Hospital, Khulna, Bangladesh*
2. *Resident Surgeon, Department of Surgery, Khulna Medical College Hospital, Khulna, Bangladesh*
3. *Assistant Professor, Surgery unit 2, Khulna Medical College Hospital, Khulna, Bangladesh*
4. *Radiologist, 250 Bed District Hospital Bagerhat, Bangladesh*
5. *Assistant Registrar, Department of Surgery, Khulna Medical College Hospital, Khulna, Bangladesh*

## INTRODUCTION

A surgical site infection (SSI) is characterized as an infection that occurs at the incisional site within 30 days following the procedure or one year if a prosthesis is implanted. This type of infection involves the multiplication of organisms at the surgical site [1] . SSIs, which are prevalent hospital-acquired infections (HAIs), are associated with significant morbidity and mortality [2]. The estimated incidence of SSIs in hospitalized patients is around 2%, although this figure might be underestimated due to incomplete postoperative discharge data [3,4]. Numerous studies in India have indicated SSI rates ranging from 6-39%, emphasizing that the presence of risk factors increases the likelihood of infection, leading to prolonged hospitalization and heightened healthcare expenditures [5]. In Bangladesh, studies have reported SSI prevalence rates ranging from 5.13% to 14.13% [6,7]. Furthermore, SSIs exhibit rates of 3-20% during specific procedures, with potentially higher incidences among high-risk patients. Each patient with an SSI requires at least six additional days of hospitalization, doubling hospital care costs [8]. Abdominal surgeries are identified as an independent risk factor associated with a high incidence of SSI [9]. The concentration of bacteria in the intestines is high, making abdominal operations more susceptible to bacterial contamination than other procedures. Studies following patients into the post-discharge period have found SSI incidence rates of 20% or more [9]. These infections are linked to various patient-related and procedure-related risk factors, each exerting different effects on SSI rates. Patient-related factors include advanced age, malnutrition, diabetes mellitus, smoking, morbid obesity, remote body site infection, and impaired immune systems due to conditions such as malignant disease or immunosuppressive treatments [9]. Extended preoperative hospital stays and an ASA score >2 (patient physical status as defined by the American Society of Anesthesiologists) are additional risk factors for SSIs [9]. These infections lead to substantial morbidity and long-term disabilities due to impaired wound healing and extensive tissue damage, imposing a significant economic burden and increasing healthcare costs. A study found that in the United Kingdom, the cost per patient increased by €814 to €6,626, while in the United States, the estimated cost increased by $1.8 billion annually [10,11]. Contrary to some beliefs, an SSI is not a minor illness with a benign course. The Centers for Disease Control and Prevention (CDC) in the United States defines an SSI as the occurrence of inflammatory signs or pus discharge within 30 days of a primarily closed surgical incision [12,13]. The CDC categorizes procedures into four classes (Classes I, II, III, and IV) based on the likelihood of contamination during the operation [14]. The incidence of SSIs is influenced by the type of surgical procedure and the clinical characteristics of patients undergoing surgery. An SSI results from interactions among bacterial inoculation, bacterial virulence, microenvironment of the surgical site, and host defense mechanisms. During the surgical procedure, microorganisms are introduced into the incision site, and pathogenic microorganisms can be acquired from various external sources such as surgical equipment, implants, gloves, air in the operating room, and medications administered during the procedure [15]. Most of these microorganisms are endogenous flora derived from the patient. This study aims to determine the rate of abdominal surgical site infections, identify associated risk factors, and assess the most common organisms encountered within a tertiary care center in Khulna.

## METHODS & MATERIALS

This observational study was conducted at the Department of General Surgery, Khulna Medical College and Hospital. The investigation spanned one year, beginning on January 2022 and concluding on December 2023. Throughout this timeframe, 132 individuals underwent abdominal surgery. Among them, 25 patients experienced Surgical Site Infections (SSI) and were included in the analysis for this study. Participants were provided with comprehensive study information through oral communication and written documentation.

**Inclusion criteria:**

- Patients' ages are 15 to more than 60 years.
- Both male and female.
- Patients with SSIs for abdominal surgery.

**Exclusion criteria:**

- Patients with previously infected wound sites.
- Patients with surgeries other than abdominal surgeries.

**Data collection:**

Following the acquisition of explicit consent from participants, a comprehensive physical examination encompassing general and detailed systemic assessments was conducted for each case. The examination involved various diagnostic procedures and investigations, including a complete blood count (CBC), blood glucose measurement, renal function assessments, liver function evaluations, serum electrolyte analysis, electrocardiogram (ECG), abdominal and chest radiographs, abdominal ultrasound, and other pertinent tests. Relevant details about the surgical intervention, such as whether it was a scheduled or emergency procedure, the degree of wound contamination, and the drains' positioning, were also documented.

**Laboratory procedures:**

In the microbiology department, samples were subjected to swab inoculation on blood agar plates, MacConkey's agar plates, and nutrient broth. The inoculated media underwent aerobic incubation at 37 degrees Celsius for 24-48 hours. In cases where the initial plates did not reveal any organisms, subculturing was performed using the nutrient broth. Bacterial identification was carried out based on their morphological and cultural characteristics. The sample processing involved several steps, including the direct microscopic examination of gram-stained smears, inoculating samples onto diverse culture media to detect aerobic and anaerobic organisms, preliminary identification, biochemical tests, and antibiotic sensitivity assessments. Subsequently, patients were monitored over one month.

**Data analysis:**

The information was systematically organized in tables or graphs based on their relationships. A clear explanation for better comprehension accompanied each table and graph. Statistical analysis utilized the Statistical Package for the Social Sciences (SPSS) on the Windows platform. Mean±SD represented continuous parameters, while frequency and percentage described categorical parameters.

## RESULT

Table 1 shows the age distribution of the study population where the majority of 8(32.00%) patients were aged 46-60 years, 28.00% were aged 31-45 years, 24.00% were aged 15-30 years, and 16% were older than 60 years. Figure 1 illustrates the gender distribution of this study, where males (58.00%) are more predominant than females (42.00%). Most patients had obesity (Table 2). According to the type of SSIs in Table 3, clean-contaminated wounds have the highest incidence of 9(36.00%) cases, followed by clean wounds at 24.00%. Contaminated and dirty wounds demonstrate equal incidence rates of 20.00% each. Emergency surgeries exhibit a higher incidence, representing 56.00% of cases, while elective surgeries account for 44.00% (Figure 2). Table 4 provides a comprehensive overview of various risk factors associated with surgical site infections (SSI) in our study population. Notably, anemia and hypoproteinemia exhibit the exact incidence at 28.00%, emphasizing the potential significance of these preoperative conditions in contributing to SSIs. Diabetes mellitus (DM) emerges as a prominent risk factor, with an incidence rate of 44.00%. Preop-RTI and Preop-UTI are associated with SSI rates of 48.00% and 32.00%, respectively, highlighting the impact of preexisting infections on postoperative outcomes. Longer surgical durations (>1.5 hours) and preoperative hospitalization exceeding five days are identified as significant risk factors, with incidence rates of 44.00% and 52.00%. It emphasizes the influence of procedural and preoperative factors on infection susceptibility. Additionally, drains and the type of surgical approach (open) are associated with SSI rates of 24.00% and 20.00%, respectively. Table 5 delineates the distribution of surgical site infections (SSI) among the types of organisms identified undergoing abdominal surgeries. Pseudomonas is the most frequently identified organism (40.00%), suggesting its prominence as a causative agent in SSIs within this cohort. Staphylococcus aureus (S. aureus) follows with an incidence of 28.00%, highlighting its substantial contribution to postoperative infections. Escherichia coli (E. Coli) is associated with 20.00% of infections, while Klebsiella accounts for 12.00%.

**Table – I: Age distribution of the study population (*n*=25)**

| Age (years) | Frequency (n) | Percentage (%) |
|---|---|---|
| 15-30 | 6 | 24.00 |
| 31-45 | 7 | 28.00 |
| 46-60 | 8 | 32.00 |
| >60 | 4 | 16.00 |

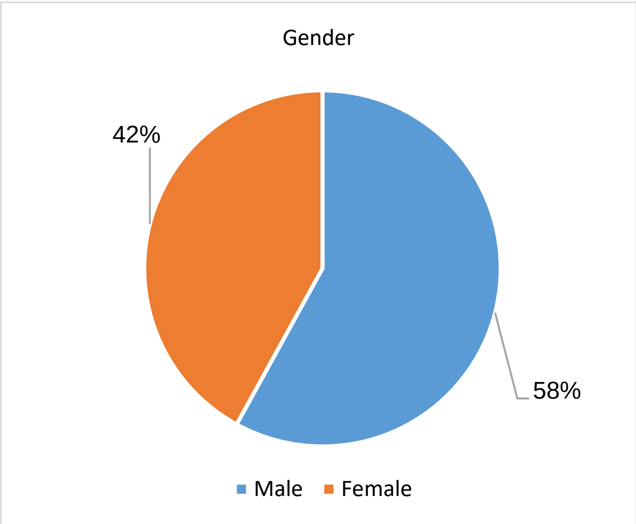


**Figure – 1: Gender distribution of the study population (*n*=25)**

**Table – II: BMI of Surgical site infected study population (*n*=25)**

| BMI | Frequency (n) | Percentage (%) |
|---|---|---|
| ≤20 | 5 | 20.00 |
| 21-24 | 5 | 20.00 |
| 25-29 | 6 | 24.00 |
| ≥30 | 9 | 36.00 |

**Table – III: Type of surgical site infection (*n*=25)**

| Type | Frequency (n) | Percentage (%) |
|---|---|---|
| Clean | 6 | 24.00 |
| Clean Contaminated | 9 | 36.00 |
| Contaminated | 5 | 20.00 |
| Dirty | 5 | 20.00 |

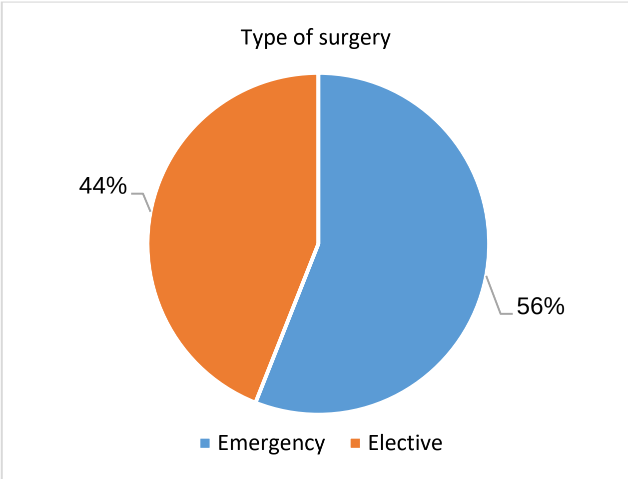


**Figure – 2: Type of surgery (*n*=25)**

**Table – 4: Risk factors of surgical site infection (*n*=25)**

| Risk factors | | Frequency (n) | Percentage (%) |
|---|---|---|---|
| Anemia | | 7 | 28.00 |
| Hypoproteinemia | | 7 | 28.00 |
| DM | | 11 | 44.00 |
| Preop-RTI | | 12 | 48.00 |
| Duration of surgery (hrs.) | <1.5 | 2 | 8.00 |
| | >1.5 | 11 | 44.00 |
| Preop-hospitalization (days) | <5 | 3 | 12.00 |
| | >5 | 13 | 52.00 |
| Preop shaving time (hrs.) | <6 | 3 | 12.00 |
| | >6 | 5 | 20.00 |
| Drain placement | Yes | 6 | 24.00 |
| | No | 3 | 12.00 |
| Type of surgical approach | Open | 5 | 20.00 |
| | Minimal invasive | 0 | 0.00 |
| Preop-UTI | | 8 | 32.00 |

**Table – 5: Type of organism in SSIs (*n*=25)**

| Organism | Frequency (n) | Percentage (%) |
|---|---|---|
| Pseudomonas | 10 | 40.00 |
| S. aureas | 7 | 28.00 |
| E. Coli | 5 | 20.00 |
| Klebsiella | 3 | 12.00 |

## DISCUSSION

This study involved examining 30 cases of abdominal surgeries with a subsequent 30-day follow-up. The surgical site infection (SSI) rate observed in this study was approximately 18.94%. A study in India reported infection rates ranging from 6% to 39%, while studies in Western countries demonstrated lower infection rates [16]. This discrepancy could be attributed to insufficient infrastructure, poor socioeconomic conditions, low literacy levels, and inadequate attention to hospitalization. The study affirmed that older individuals exhibited a higher incidence of infections, as indicated in Table 1. This aligns with previous research findings by Cruse and Foord [17,18]. Other studies by Owen et al. and Bharatnur et al. identified a higher SSI rate in the 36-50 age group [19,20]. In our study, males exhibited a significantly higher SSI rate at 56% compared to females at 44%, which contrasts with findings in a different study [21]. Various studies have reported divergent proportions, with some indicating higher SSIs in males than females [22]. Examining different types of surgical wounds, clean wounds in our study had an infection rate of 24%, clean-contaminated had 36%, and contaminated and dirty wounds had rates of 20%. A study by Syed in Iran found infection rates in clean wounds at 13.6%, clean-contaminated at 26.7%, contaminated at 45.8%, and dirty wounds at 14% [23]. Similar findings were reported by Mahesh et al., with infection rates in clean surgery at 11.53%, clean-contaminated at 23.33%, contaminated at 38.10%, and dirty wounds at 57.14% [24]. The variability in infection rates among wound types is influenced by internal host-related factors and external factors related to organisms. Our study revealed that emergency surgeries had a higher infection rate (56%) than elective surgeries (44%). This contrasts with findings from studies by Saravanakumar et al. and Syed, where infection rates were lower in elective surgeries [25]. The heightened infection rate in emergency surgeries is likely due to highly contaminated and dirty caseloads, inadequate pre-op preparation, and the presence of comorbid conditions. Patients with preoperative respiratory tract infections (48%) and diabetes (44%) exhibited higher SSI rates, highlighting the significance of comorbidities in SSI risk. This aligns with findings in a study by Mohan et al., where diabetes and smoking were identified as crucial risk factors for SSI [26]. Furthermore, a prolonged preoperative hospitalization exceeding five days correlated with an incidence of 52% for SSI. Longer pre-op hospitalization increases the risk of SSI due to increased colonization by nosocomial strains and reflects the severity of illness and associated comorbid conditions. This is consistent with studies by Mansour et al., where hospitalization less than 15 days had an infection rate of 18.6%, and longer than 15 days had a rate of 25.9% [23]. Drain placement in our study had an infection rate of 25.8%, whereas studies by Saravanakumar et al. and Nivitha et al. reported varying rates with and without drains [25,26]. The choice of drain placement is based on surgical requirements but poses a potential entry portal for organisms. Preoperative shaving was associated with increased infection risk, as observed in trials by Brown et al. and Rojanapirom et al. [27,28]. The likelihood of SSI also increased with prolonged operating time, with surgeries exceeding 1.5 hours exhibiting a higher infection rate of around 44%. Trail observations showed an SSI of 9.6% in patients with hair removal, whereas patients without hair had an SSI of 6%. A study by Cheng et al. shows that the likelihood of SSI increases with increased operating time [29]. In the present study, we found the infection rate of surgery less than 1.5 hours to be around 8%, and surgeries with more than 1.5 hours had an infection rate of around 44%. This effect is because the longer the duration of surgeries, the higher the chance of breakage of aseptic barriers. Kamat et al. performed a prospective study of surgical site infection in Goa and noted that the most common organisms associated were pseudomonas and staphylococcus pyogenes [30]. Regarding bacterial organisms, our study identified pseudomonas in 40% of infected wounds, staph aureus in 28%, E. coli in 20%, and Klebsiella in 12%. This distribution aligns with other studies reporting a predominance of gram-negative bacteria. Endogenous organisms from the gastrointestinal tract, notably pseudomonas and E. coli, play a significant role in hospital-acquired infections and pose challenges for eradication using standard antiseptic solutions.

### Limitations of the study:

While the study provides valuable insights into the incidence and risk factors for surgical site infection (SSI) in abdominal surgeries at a tertiary care centre in Khulna, several limitations need consideration. The small sample size of 25 patients with SSIs may not fully represent the diverse population undergoing abdominal surgeries. The study's single-centre nature at Khulna Medical College and Hospital may limit the generalizability of findings to other healthcare settings with different patient demographics and infrastructure. Additionally, the retrospective design and reliance on medical records might introduce bias due to incomplete or inaccurate documentation. The study's focus on a specific geographic location may not account for regional variations in healthcare practices and infection control measures, affecting the study's external validity. Future research with larger multicenter cohorts and prospective designs could address these limitations for a more comprehensive understanding of SSI dynamics.

## CONCLUSION AND RECOMMENDATIONS

In conclusion, our study sheds light on the incidence and risk factors for surgical site infections (SSIs) in patients undergoing abdominal surgeries at a tertiary care center in Khulna. The observed SSI rate of approximately 18.94% highlights the substantial impact of these infections on postoperative outcomes. Factors such as age, gender, type of surgical wound, emergency surgeries, comorbidities like diabetes, respiratory tract infections, prolonged preoperative hospitalization, drain placement, preoperative shaving, and extended surgical durations were identified as significant contributors to increased SSI risk. The distribution of bacterial organisms, with Pseudomonas, Staphylococcus aureus, Escherichia coli, and Klebsiella, emphasizes the importance of addressing gram-negative bacteria in infection prevention strategies. This study underscores the need for targeted interventions and vigilant preoperative management to mitigate the incidence of SSIs and their associated morbidity, mortality, and economic burden in abdominal surgery patients.

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