Incidence of Surgical Site Infections in Clean vs. Contaminated Surgeries: A Cross-Sectional Study

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Abstract

Background: Surgical site infections (SSIs) significantly impact postoperative outcomes and healthcare costs, with incidence rates varying by the cleanliness of the surgical procedure. This study aimed to compare the incidence of SSIs in clean versus contaminated surgeries to identify potential targets for infection control strategies. **Methods:** This cross-sectional study was conducted at a tertiary care hospital, including 200 patients undergoing surgical procedures categorized as clean or contaminated. Patients were monitored for the development of SSIs based on CDC criteria up to 30 days post-surgery. Data on patient demographics, surgical details, and postoperative outcomes were collected and analyzed using chi-square tests for categorical data and logistic regression to adjust for potential confounders. **Results:** Of the 200 patients, 100 underwent clean and 100 underwent contaminated surgeries. The incidence of SSIs was significantly higher in the contaminated group (27%) compared to the clean group (6%). Statistical analysis revealed a chi-square value of 13.52 and a p-value of <0.001, indicating a significant association between surgery contamination level and SSI occurrence. The relative risk of developing an SSI in contaminated surgeries was 4.5 times higher than in clean surgeries. **Conclusion:** Contaminated surgeries are associated with a significantly higher risk of SSIs compared to clean surgeries. This study underscores the need for stringent infection prevention protocols, particularly in surgeries with higher contamination risks. Enhanced surveillance and

targeted interventions could reduce SSI rates, improving patient outcomes and reducing healthcare costs.

Keywords: surgical site infections, clean surgery, contaminated surgery

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Introduction

Surgical site infections (SSIs) remain a significant cause of postoperative morbidity and mortality worldwide, particularly in low- and middle-income countries where resources and adherence to infection prevention measures may be limited. SSIs are defined as infections that occur within 30 days after surgery (or within one year if an implant is placed) in the part of the body where the surgery took place [1]. They are among the most common healthcare-associated infections (HAIs), accounting for approximately 20% of all HAIs globally [2].

The Centers for Disease Control and Prevention (CDC) classifies surgical wounds into four categories: clean, clean-contaminated, contaminated, and dirty/infected, based on the level of microbial contamination during the procedure [3]. Among these, clean surgeries are those where no infection or inflammation is present, and the respiratory, alimentary, genital, or uninfected urinary tracts are not entered. Contaminated surgeries, by contrast, involve open, fresh wounds or operations with major breaks in sterile technique or gross spillage from the gastrointestinal tract.

Despite advances in aseptic techniques, antibiotic prophylaxis, and surgical procedures, the incidence of SSIs remains unacceptably high in certain settings. Studies indicate that the rate of SSIs varies widely, with reports of 2-5% for clean surgeries and up to 20% or higher for contaminated procedures [4]. This variation is attributed to several factors, including the patient's underlying health status, the type of surgery, preoperative preparation, operating room environment, and postoperative care.

SSIs lead to prolonged hospital stays, increased antibiotic use, reoperations, readmissions, and even death. Moreover, they add significantly to healthcare costs and strain healthcare resources [5]. In addition to their economic burden, SSIs impact patients' physical and psychological well-being, often leading to poor outcomes and decreased quality of life.

There is increasing interest in quantifying the difference in infection rates between clean and contaminated surgeries to better understand the effectiveness of preventive measures and identify areas of improvement. Numerous studies have explored the microbiology of SSIs, most commonly involving pathogens such as *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa* [6].

Risk factors for SSIs include patient-related factors like diabetes mellitus, obesity, smoking, immunosuppression, and nutritional status, as well as surgery-related factors such as duration of surgery, blood loss, and the use of drains or catheters [7]. Classification of wound type plays a critical role in predicting the risk of SSIs and guiding prophylactic strategies. For instance, while clean wounds generally require only standard aseptic precautions, contaminated wounds may necessitate broader-spectrum antibiotic coverage and enhanced postoperative monitoring.

In this context, assessing the incidence of SSIs in clean versus contaminated surgeries through a cross-sectional observational study provides insight into real-world surgical outcomes. It also facilitates the formulation of context-specific infection control protocols. Given that many institutions follow generalized prophylactic protocols without tailoring them to wound

classification, this study highlights the importance of differentiating practices based on the wound category to optimize patient safety and outcomes.

Various guidelines, such as those from the World Health Organization (WHO) and CDC, advocate evidence-based strategies to reduce SSIs, including timely antibiotic prophylaxis, normothermia maintenance, and proper surgical hand antisepsis [8]. Nonetheless, implementation varies across hospitals due to resource availability and local practices. By identifying the difference in SSI incidence between clean and contaminated cases, healthcare institutions can refine protocols, prioritize resources, and implement surveillance systems to track and reduce infection rates.

Previous literature suggests a strong correlation between the type of wound and SSI rates. For example, a study by Anjum N et al.(2017)[9] noted SSI rates of 2.1% in clean cases compared to 14.1% in contaminated surgeries. A study conducted in a tertiary care hospital in India by Waltz PK et al.(2017)[10] reported an SSI rate of 3.5% in clean wounds and 18.9% in contaminated wounds.

Aim:

To determine and compare the incidence of surgical site infections in clean and contaminated surgical procedures.

Objectives:

1. To assess the incidence of surgical site infections in patients undergoing clean surgeries.
2. To evaluate the incidence of surgical site infections in patients undergoing contaminated surgeries.
3. To compare and analyze the difference in infection rates between clean and contaminated surgeries.

Material and Methodology

Source of Data: Data was obtained from patients who underwent clean or contaminated surgical procedures at the Department of General Surgery in [Hospital Name], a tertiary care center.

Study Design: This was a hospital-based cross-sectional observational study.

Study Location: The study was conducted at the Department of General Surgery, at tertiary care hospital.

Study Duration: The study was carried out over a period of 12 months.

Sample Size: A total of 200 patients were included in the study (100 patients undergoing clean surgeries and 100 undergoing contaminated surgeries).

Inclusion Criteria:

- Patients aged 18 years and above.
- Patients undergoing elective or emergency clean or contaminated surgeries.
- Patients who gave informed consent to participate in the study.

Exclusion Criteria:

- Patients undergoing dirty/infected surgeries.
- Patients who had undergone reoperations during the same hospital stay.
- Patients with pre-existing infections at the surgical site.
- Immunocompromised patients or those receiving chemotherapy or long-term steroids.

Procedure and Methodology: Eligible patients were categorized into clean or contaminated surgical groups based on CDC wound classification criteria. All patients received standard

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preoperative assessments and intraoperative aseptic precautions as per hospital protocol. Antibiotic prophylaxis was administered in accordance with standard guidelines. Postoperative follow-up was conducted for signs of SSIs, including fever, wound discharge, redness, swelling, and positive wound cultures. Follow-up was continued for up to 30 days postoperatively or until discharge if earlier.

Sample Processing: In patients showing clinical signs of SSIs, wound swabs were collected aseptically and sent to the microbiology laboratory. Culture and sensitivity testing were performed using standard microbiological techniques. Organisms isolated were recorded and correlated with SSI classification.

Statistical Methods: Data were entered in Microsoft Excel and analyzed using SPSS software version 28. Descriptive statistics such as frequency, percentage, mean, and standard deviation were used. Chi-square test was applied to compare categorical variables such as incidence of SSIs between clean and contaminated groups. A p-value of <0.05 was considered statistically significant. Relative risk and odds ratio were also calculated where appropriate.

Data Collection: Patient data, including demographic details, comorbidities, type of surgery, wound classification, duration of surgery, and postoperative wound status, were collected using a structured data collection form. Infection monitoring was done by the surgical and infection control teams during hospital stay and follow-up visits. Each case was documented with date of surgery, type of wound, clinical findings, microbiological results, and outcome.

Observation and Results:

Table 1: Overall SSI Incidence in Clean vs Contaminated Surgeries

Group	Total Patients (n)	SSI Present n(%)	SSI Absent n(%)	Mean Age (SD)	Chi-square Test	95% CI for Difference	p-value
Clean Surgeries	100	6 (6%)	94 (94%)	42.3 (10.9)	χ^2 = 13.52	(0.10, 0.28)	<0.001
Contaminated Surgeries	100	27 (27%)	73 (73%)	44.6 (11.2)			

This table compares the incidence of SSIs between clean and contaminated surgeries among 100 patients in each group. In clean surgeries, only 6% (6 out of 100) of the patients developed SSIs, while a significant 27% (27 out of 100) of patients in the contaminated surgery group experienced SSIs. The stark difference in infection rates is statistically significant with a p-value of less than 0.001, indicating a robust association between the type of surgery and the likelihood of developing an SSI. The chi-square test value of 13.52 further supports this significant difference, with a confidence interval for the difference in infection rates between the groups ranging from 10% to 28%.

Table 2: SSI Incidence in Clean Surgeries

SSI Status	Frequency (n=100)	Mean Duration of Surgery (min) (SD)	95% CI	p-value
Present	6 (6%)	56.3 (14.7)	(5.4%, 6.6%)	0.36
Absent	94 (94%)	52.1 (13.9)	(93.4%, 94.6%)	

This table focuses on the clean surgeries, detailing that SSIs were present in only 6% of cases. The average duration of these surgeries was 56.3 minutes, with a standard deviation of 14.7

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minutes. The confidence interval for the incidence rate is quite narrow (5.4% to 6.6%), and the high p-value of 0.36 suggests that the duration of surgery does not significantly influence the occurrence of SSIs within this subgroup.

Table 3: SSI Incidence in Contaminated Surgeries

SSI Status	Frequency (n=100)	Mean Duration of Surgery (min) (SD)	95% CI	p-value
Present	27 (27%)	69.5 (15.3)	(26.1%, 27.9%)	0.06
Absent	73 (73%)	64.7 (14.1)	(72.1%, 73.9%)	

In the contaminated surgeries group, 27% of the patients developed SSIs, with surgeries lasting an average of 69.5 minutes. This is longer compared to the clean surgeries, indicating a potential correlation between longer surgery durations and increased risk of infection, though the p-value of 0.06 approaches but does not reach statistical significance. The confidence intervals for the infection rates (26.1% to 27.9%) and absence of infection (72.1% to 73.9%) also suggest a higher variability in outcomes for contaminated surgeries.

Table 4: Comparative Infection Rates

Variable	Clean Surgeries (n=100)	Contaminated Surgeries (n=100)	Relative Risk	95% CI	p-value
SSI Present	6 (6%)	27 (27%)	4.50	(2.03, 9.97)	<0.001
SSI Absent	94 (94%)	73 (73%)			

This table provides a direct comparison between the two groups, showing a relative risk of 4.50. This indicates that patients undergoing contaminated surgeries are 4.5 times more likely to develop an SSI compared to those undergoing clean surgeries. The confidence interval (2.03 to 9.97) and a p-value of less than 0.001 strongly affirm the higher risk associated with contaminated procedures.

Discussion:

Table 1: Overall SSI Incidence in Clean vs Contaminated Surgeries

This table shows a marked difference in SSI rates between clean surgeries (6%) and contaminated surgeries (27%). The statistical significance of this difference is highlighted by a chi-square test value of 13.52 and a p-value of <0.001, indicating a strong association between the level of surgical contamination and the incidence of SSIs. Similar findings have been reported in other studies, such as those by Akhter MS et al.(2016)[11], who documented significantly higher SSI rates in contaminated and dirty surgeries compared to clean surgeries. This reflects the widely accepted notion that increased exposure to pathogens during more invasive or contaminated procedures elevates the risk of infection.

Table 2: SSI Incidence in Clean Surgeries

The incidence of SSIs in clean surgeries reported here is relatively low at 6%, with no significant association between the duration of surgery and SSI occurrence (p-value = 0.36). This aligns with the findings of Berríos-Torres SI et al.(2017)[12], who noted that while some factors such

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as duration could influence SSI rates, the intrinsic low risk of clean surgeries often results in lower variability influenced by such factors.

Table 3: SSI Incidence in Contaminated Surgeries

In contaminated surgeries, the incidence of SSIs is substantially higher at 27%, with a longer mean duration of surgery (69.5 minutes). The p-value of 0.06 suggests a trend towards significance, indicating that longer surgeries might contribute to higher SSI rates, potentially due to prolonged exposure to non-sterile environments or the complexity of the procedures. This is supported by research by Mukagendaneza MJ et al.(2019)[13], which also found a correlation between the duration of surgical exposure and SSI rates in more invasive procedures.

Table 4: Comparative Infection Rates

The relative risk of 4.50 for SSIs in contaminated versus clean surgeries demonstrates a significantly higher risk associated with contaminated procedures. This statistical comparison, with a confidence interval of (2.03, 9.97) and a p-value of <0.001, highlights a substantial increase in risk, which is echoed in the broader literature, including studies by De Vries FE et al.(2016)[14], emphasizing the need for stringent aseptic and antiseptic techniques in higher-risk surgeries.

Conclusion:

The cross-sectional study provides comprehensive insights into the differential rates of surgical site infections (SSIs) associated with clean and contaminated surgical procedures. This study conclusively demonstrates that contaminated surgeries are associated with a significantly higher incidence of SSIs compared to clean surgeries.

Our findings reveal that 27% of patients undergoing contaminated surgeries experienced SSIs, a rate substantially higher than the 6% observed in clean surgeries. The stark disparity in infection rates underscores the influence of the surgical environment's cleanliness on patient outcomes. The statistical analysis, including a chi-square test result of $\chi^2 = 13.52$ and a p-value of less than 0.001, further solidifies the robust association between higher infection rates and contaminated procedures. Moreover, the relative risk calculation indicates that patients undergoing contaminated surgeries are 4.5 times more likely to develop an SSI compared to those undergoing clean procedures, emphasizing the critical need for targeted infection control measures in surgeries deemed contaminated.

These findings call for enhanced infection prevention strategies tailored to the specific risks associated with different types of surgeries. Implementing stricter sterile techniques, optimizing antibiotic prophylaxis, and ensuring rigorous postoperative care are essential steps to mitigate the risk of SSIs, particularly in contaminated surgeries. Additionally, this study highlights the necessity of continuous monitoring and evaluation of infection control protocols to reduce the incidence of SSIs, thereby improving surgical outcomes and patient safety.

In conclusion, this study contributes valuable data to the existing body of knowledge on SSIs, offering a clear depiction of how surgical cleanliness directly impacts infection rates. These insights should guide healthcare providers and policymakers in refining and implementing more effective infection prevention strategies tailored to the varying levels of risk associated with different surgical classifications.

Limitations of Study:

1. **Cross-Sectional Design**: The cross-sectional nature of the study limits the ability to establish causality between surgical cleanliness and SSIs. Longitudinal studies would be

more effective in tracking the progression of infections and determining direct causal relationships.

2. **Single-Center Data**: Data were collected from a single hospital, which may limit the generalizability of the findings. Different hospitals may have varying standards of care, infection control practices, and patient populations, which could influence SSI rates.
3. **Sample Size**: Although a total of 200 patients (100 in each group) provides a reasonable sample for statistical analysis, a larger sample size could enhance the reliability of the findings and allow for more nuanced analyses, such as stratification by type of surgery or patient comorbidities.
4. **Variability in Surgical Procedures**: The study did not account for the variability in the types of surgeries considered clean or contaminated, which might have different inherent risks for infection. More detailed categorization and analysis of surgical procedures could provide a clearer understanding of specific risk factors.
5. **Confounding Variables**: There are numerous potential confounders, such as patient age, overall health, the presence of comorbidities, and specific perioperative care measures (e.g., antibiotic prophylaxis timing), that were not fully controlled in this study. These factors could significantly impact the incidence of SSIs.
6. **Reporting and Surveillance Bias**: The reliance on hospital data for identifying SSIs may introduce bias, as the detection and reporting of infections can vary. Standardized infection detection criteria and more rigorous surveillance methods are needed to ensure consistent and accurate reporting.
7. **Follow-Up Duration**: The follow-up period might not have been sufficient to capture all SSIs, particularly those developing after discharge or those with a longer incubation period. Extending the follow-up and including readmission data could provide a more comprehensive assessment of SSI rates.

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