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Email :editorijhess@gmail.com

Factors Associated with Surgical Site Infections in Hospital Settings

Nurvita Anggraini[1)], Fera Novitry [2)*], Deli Lilia [3)]

[1,2,3)] Program Studi S-1 Kesehatan Masyarakat, STIKes Al-Ma'arif Baturaja, Indonesia
*Coresponding Author: fera novitry
Email : keinaraaybike@gmail.com

Abstract

Surgical Site Infection (SSI) remains a common postoperative complication that increases patient morbidity and healthcare costs. Effective prevention and control of SSI are key indicators of the quality of surgical care in hospitals. This study aimed to analyze the factors associated with SSI among postoperative patients in a hospital setting. An analytical study with a cross-sectional design was conducted involving 75 respondents selected using a total sampling technique. Data were collected through structured interviews, observations, and medical record reviews. Data analysis employed univariate and bivariate tests using the Chi-Square test. The results showed that the incidence of SSI was 14.7%, and all independent variables demonstrated a significant relationship with SSI, including room sanitation (p=0.000), personal hygiene (p=0.000), standard operating procedure compliance (p=0.000), and appropriate treatment (p=0.000). The study concluded that environmental quality, hygiene behavior, adherence to standard procedures, and proper treatment play crucial roles in preventing SSI. It is recommended that hospitals strengthen infection control interventions through regular audits, enhanced patient hygiene education, strict SOP enforcement, environmental sanitation monitoring, and treatment optimization to improve patient safety.

***Keywords**: Infection; Postoperative Complications; Surgical Procedures, Operative; Wound Infection*

INTRODUCTION

Surgical site infections (SSIs) are significant postoperative complications that contribute to increased patient morbidity in healthcare facilities (Berríos-Torres et al., 2017). These infections prolong hospital stays, leading to a substantial rise in healthcare costs (Calderwood et al., 2023), and reduce postoperative recovery quality (Carter et al., 2017). Hospitals are required to implement effective infection control measures as core indicators of surgical procedure success (Allegranzi et al., 2016). Inadequate prevention efforts result in serious clinical consequences for patients (Al Salmi et al., 2019). Patient safety programs aim to minimize the occurrence of these complications (Albert et al., 2019), and integrated prevention strategies are essential in modern surgical practice (Calderwood et al., 2023).

Evidence-based international guidelines provide clear recommendations for SSI prevention (Berríos-Torres et al., 2017), emphasizing infection control throughout the preoperative, intraoperative, and postoperative phases (Allegranzi et al., 2016). Compliance with these guidelines among healthcare personnel is crucial to achieving preventive success (Calderwood et al., 2023). Ongoing evaluation of guideline implementation is necessary to improve surgical service quality (Carter et al., 2017), alongside consistent monitoring to ensure adherence to safe procedures (Dean et al., 2020). High-quality prevention efforts significantly reduce infection rates (Davidson et al., 2020), and hospitals must maintain continuity in infection control programs (Caruso et al., 2019).

Evidence-based preventive bundles have shown substantial effectiveness in reducing SSI rates (Albert et al., 2019). These bundles integrate multiple interventions to limit surgical site contamination (Carter et al., 2017), thereby enhancing patient safety (Dean et al., 2020). Successful bundle implementation requires collaborative interdisciplinary teamwork in the surgical environment (Caruso et al., 2019). Hospitals may adapt bundles according to institutional context (Davidson et al., 2020), supporting long-term reductions in postoperative complications (Calderwood et al., 2023) and ensuring optimal preventive outcomes (Berríos-Torres et al., 2017).

Preoperative antisepsis plays a crucial role in preventing bacterial entry into the surgical field (Chen et al., 2020). Appropriate antiseptic selection enhances infection prevention effectiveness (Allegranzi et al., 2016), with chlorhexidine demonstrating superior outcomes compared to alternative agents (Chen et al., 2020). Standardized antisepsis procedures must be applied consistently across healthcare facilities (Al Salmi et al., 2019). Adherence to antiseptic protocols reduces microbial load at the surgical site (Calderwood et al., 2023), and compliance among healthcare personnel remains a critical determinant of success (Carter et al., 2017). Hospitals must ensure availability of antiseptic resources that align with clinical guidelines (Allegranzi et al., 2016).

Preoperative prophylactic antibiotics are key interventions to prevent SSIs (de Jonge et al., 2021). Appropriate timing of antibiotic administration enhances preventive effectiveness (Berríos-Torres et al., 2017), while selecting antibiotics according to surgical risk minimizes pathogen proliferation (Calderwood et al., 2023). Routine evaluation of antibiotic protocols supports rational antibiotic stewardship (de Jonge et al., 2021). Non-compliance with timing and dosage recommendations significantly increases infection risk (Carter et al., 2017), requiring healthcare personnel to ensure timely and accurate administration (Al Salmi et al., 2019). Effective antibiotic utilization strengthens hospital infection control systems (Dean et al., 2020).

Surgical wound irrigation with saline before closure decreases local contamination (Ambe et al., 2020), facilitating removal of necrotic tissue that may harbor microbial colonization (Calderwood et al., 2023). Proper postoperative wound care is essential for maintaining tissue integrity and preventing infection (Caruso et al., 2019). Regular wound assessments enable early detection of infection indicators (Davidson et al., 2020), while wound care education helps prevent post-discharge complications (Dean et al., 2020). Aseptic wound closure techniques further minimize microbial colonization risks (Berríos-Torres et al., 2017) and support optimal recovery (Al Salmi et al., 2019).

Perioperative glycemic control effectively reduces infection risk in diabetic patients (Bellon et al., 2023). Hyperglycemia increases susceptibility to SSIs (Carter et al., 2017), thus intensive glucose monitoring is necessary before and after surgery (Calderwood et al., 2023). Multidisciplinary collaboration improves metabolic management outcomes (Dean et al., 2020), enhancing safety among high-risk patients (Caruso et al., 2019). Clinical optimization promotes successful surgical recovery (Berríos-Torres et al., 2017), and effective glucose regulation lowers postoperative complications significantly (Bellon et al., 2023).

Comprehensive evaluation of all elements within SSI prevention bundles must be conducted continuously (Calderwood et al., 2023). Advancements in clinical knowledge inform ongoing updates to infection prevention guidelines (Berríos-Torres et al., 2017). Hospitals should assess healthcare worker adherence to ensure implementation effectiveness (Dean et al., 2020), as staff commitment remains pivotal in infection control success (Albert et al., 2019). Observational data can identify persisting risk factors requiring targeted interventions (Danwang et al., 2020), and strengthening institutional policies reinforces patient safety sustainability (Davidson et al., 2020). Therefore, investigating factors associated with SSIs is essential to support infection prevention efforts within hospitals.

RESEARCH METHODS

This study employed an analytic design with a cross-sectional approach to analyze the factors associated with the incidence of Surgical Site Infections (SSI). This approach was selected because it allows researchers to measure independent and dependent variables simultaneously at one point in time, making it more efficient in terms of time and resources. This method also enables the identification of relationships between ward sanitation, personal hygiene, compliance with standard operating procedures (SOPs), and treatment with the occurrence of SSIs among patients undergoing surgical procedures.

The study was conducted in a hospital located in Ogan Komering Ulu Regency, which serves as a referral healthcare facility with a relatively large number of surgical procedures. The site was selected based on the consideration that the hospital is currently developing its infection control system, allowing research data to support the improvement of service quality. Data collection was scheduled from July to August 2025 according to the readiness of the facility, respondents, and coordination with hospital management.

The study population consisted of all surgical patients in the hospital during 2024–2025 with a total of 75 patients. The sampling technique used was total sampling, so all members of the population were included as study samples because the number was still manageable for comprehensive assessment. This technique was chosen to ensure the research findings are more representative of actual conditions in the field and to minimize selection bias.

The research procedures included structured interviews with respondents using questionnaires, direct observations of patients and the care room environment, and medical record reviews to determine clinical SSI status. The combination of these three techniques provided an advantage in obtaining more comprehensive data because it covered behavioral, environmental, and clinical aspects of patients. All data collection procedures were carried out by the researcher with assistance from inpatient ward nurses to ensure procedural order.

The research instrument consisted of a questionnaire developed based on the operational definition of each variable. The independent variables measured included ward sanitation, personal hygiene, SOP compliance, and treatment, with assessment categories of "eligible–not eligible" or "performed–not performed." The dependent variable, SSI incidence, was determined based on clinical examinations and medical record information with the categories "positive" or "negative." All instruments were tested prior to use to ensure ease of understanding by respondents.

Data processing stages included editing to ensure completeness and data eligibility, coding to convert data into numerical form, data entry using statistical software, and cleaning to remove input errors or duplication. Data analysis was carried out univariately to describe the distribution of each variable and bivariately using the Chi-Square test with a 95% confidence level to determine the presence or absence of a relationship between research variables. A p-value ≤ 0.05 was established as the criterion for statistical significance.

This research applied ethical principles of health research, including informed consent, anonymity, confidentiality, and justice for all respondents. Informed consent was obtained from all respondents to ensure voluntary participation after fully understanding the research objectives and procedures. Respondent identities were not included in the questionnaire to ensure anonymity, while data confidentiality was maintained by reporting only in aggregate form without disclosing personal information. All respondents were treated equally without any form of discrimination throughout the research process.

RESULTS AND DISCUSSION

The results of this study are presented to provide an overview of the frequency distribution of research variables as well as the relationship between ward sanitation, personal hygiene, SOP compliance, and treatment with the incidence of SSIs. The results of the univariate and bivariate analyses are presented in tables and interpretive descriptions to scientifically support the research findings. The following presents the characteristics of respondents based on the research variables measured (Table 1).

Table 1. Frequency Distribution of Research Variables in Postoperative Patients

Variabel	Frequency (n)	Percentage (%)
Surgical Site Infection (SSI) Occurrence		
Positive	11	14,7
Negative	64	85,3
Ward Sanitation		
Not Eligible / Does Not Meet Standards	18	24
Eligible / Meets Standards	57	76
Personal Hygiene		
Not Performed	12	16
Performed	63	84
SOP Compliance		
Not Performed	11	14,7
Performed	64	85,3
Treatment		
Not Eligible / Does Not Meet Standards	11	14,7
Eligible / Meets Standards	64	85,3

The results of the study show that out of 75 respondents, the majority of patients did not experience Surgical Site Infections, with 64 respondents (85.3%). The sanitation condition of the treatment rooms was mostly categorized as meeting the required standards, totaling 57 respondents (76%). Most patients also practiced good personal hygiene, with 63 respondents (84%). Compliance with surgical service SOPs was well-implemented in 64 respondents (85.3%). In addition, the majority of patients received treatment that met clinical standards, also with 64 respondents (85.3%). These findings indicate that in general, postoperative patient care systems—both environmental aspects and clinical procedural practices—were in good category. However, 14.7% of SSI cases were still identified, suggesting that quality improvement measures are still required to achieve an infection incidence rate approaching zero.

Table 2. The Relationship Between Ward Sanitation, Personal Hygiene, SOP Compliance, and Treatment with the Incidence of Surgical Site Infections

Variabel	**Surgical Site Infection (SSI) Occurrence**				Total		*ρ Value*
	Positive		Negative				
	f	%	f	%	f	%	
Ward Sanitation							0,000
Not Eligible / Does Not Meet Standards	8	72,7	10	15,6	18	24	
Eligible / Meets Standards	3	27,3	54	84,4	57	76	
Personal Hygiene							
Not Performed	8	72,7	4	6,3	12	16	0,000
Performed	3	27,3	60	93,8	63	84	

SOP Compliance							0,000
Not Performed	8	72,7	3	4,7	11	14,7	
Performed	3	27,3	61	95,3	64	85,3	
Treatment							0,000
Not Eligible / Does Not Meet Standards	9	81,8	2	3,1	11	14,7	
Eligible / Meets Standards	2	18,2	62	96,9	64	85,3	

The Chi-Square test results indicated that ward sanitation had a significant association with the incidence of SSIs, with a p-value of 0.000. Respondents in rooms with inadequate sanitation showed a higher proportion of SSIs (72.7%) compared to those in adequately sanitized rooms (15.6%). This finding indicates that the quality of ward sanitation plays an important role in preventing the risk of surgical wound infections. Personal hygiene also demonstrated a significant association with SSI incidence (p = 0.000). Patients with poor personal hygiene had a much higher risk of SSIs (72.7%) compared to those who practiced adequate personal hygiene (6.3%). This suggests that patient hygiene behaviors greatly influence the prevention of postoperative infection.

Compliance with SOPs in wound care procedures showed a significant relationship with SSI incidence (p = 0.000). Patients receiving care where SOPs were not followed exhibited a higher rate of SSIs (72.7%) than those treated according to SOPs (4.7%). This emphasizes that adherence to SOPs by healthcare workers is a key pillar of patient safety practices. The treatment variable also showed a significant association with SSIs (p = 0.000). Patients receiving treatment that did not meet clinical standards showed the highest SSI proportion (81.8%) compared to those receiving standardized treatment (3.1%). These findings indicate that accurate treatment regimens are crucial in determining the effectiveness of postoperative wound healing. Overall, all factors examined in this study were significantly associated with the incidence of Surgical Site Infections, indicating that quality improvement interventions should focus simultaneously on these four aspects to comprehensively reduce the risk of this complication.

The results of this study show that SSIs still occur even though most service quality indicators fall within good categories. This finding reinforces that SSIs remain a complication that may arise despite the application of standardized surgical care (Ban et al., 2017). This condition may occur because SSIs are influenced by multiple interrelated factors throughout the continuum of patient care (Calderwood et al., 2023). Suboptimal surgical services contribute to increased risk of postoperative infections (Anderson et al., 2014). Comprehensive infection control implementation is a strategic effort to reduce SSI rates in healthcare facilities (Allegranzi et al., 2016). Evidence-based programs must be adopted to improve clinical outcomes for surgical patients (Albert et al., 2019). Therefore, continuous evaluation is necessary to achieve optimal surgical patient safety standards (Caruso et al., 2019).

Ward sanitation in this study was significantly associated with SSI incidence based on statistical analysis (Cima et al., 2013). An inpatient environment that does not meet cleanliness standards can serve as a source of microbial growth causing infections (Anderson et al., 2014). Hospitals must ensure strict control of cleanliness, including room surfaces and care-support equipment (Ban et al., 2017). Proper implementation of sanitation guidelines helps prevent bacterial colonization in areas prone to contamination (Berríos-Torres et al., 2017). Continuous sanitation improvement should be supported by the infection control team (Calderwood et al., 2023). Behavioral changes among cleaning personnel are also essential to improve the quality of the

care environment (Albert et al., 2019). Thus, good sanitation plays an important role in eliminating infection sources in healthcare facilities (Allegranzi et al., 2016).

The patient personal hygiene factor was also significantly associated with SSI incidence (Carter et al., 2017). Patient body cleanliness strongly influences bacterial colonization on the skin surface at surgical sites (Anderson et al., 2014). Education programs on personal hygiene before and after surgery have proven effective in preventing infectious complications (Allegranzi et al., 2016). Patient compliance with hygiene instructions supports successful wound healing (Dean et al., 2020). Healthcare workers must optimize education on hygiene procedures at both pre- and postoperative phases (Caruso et al., 2019). Systematic hygiene care practices contribute significantly to preventing surgical infections (Albert et al., 2019). Therefore, personal hygiene is a critical factor in surgical patient safety management (Ban et al., 2017).

Compliance with Standard Operating Procedures (SOPs) in surgical intervention was significantly related to SSI incidence (Calderwood et al., 2023). SOP implementation ensures that all wound care processes are standardized to reduce infection risk (Ban et al., 2017). Non-compliance with SOPs increases the probability of procedural errors that may lead to bacterial colonization (Berríos-Torres et al., 2017). Routine evaluation of SOP compliance must be conducted by nursing and infection control teams (Anderson et al., 2014). Regular training on infection prevention SOPs improves the quality of surgical services (Dean et al., 2020). A zero-tolerance approach to SOP violations can significantly reduce SSI incidence (Albert et al., 2019). Thus, SOP adherence is the foundation of postoperative patient safety (Caruso et al., 2019).

The treatment factor was also significantly associated with SSIs (Dean et al., 2020). Appropriate treatment, including antibiotic therapy, strongly affects postoperative wound healing success (de Jonge et al., 2021). Prophylactic antibiotic protocols help suppress bacterial colonization causing infection (Calderwood et al., 2023). Inaccurate antibiotic selection increases the risk of bacterial resistance and therapy failure (Ban et al., 2017). Treatment regimens must be monitored by physicians and nurses to ensure suitability for age, condition, and type of surgery (Berríos-Torres et al., 2017). Standardized therapeutic approaches contribute to improved clinical outcomes in surgical patients (Carter et al., 2017). Appropriate antibiotic stewardship strengthens infection control success in hospitals (Anderson et al., 2014).

Bundle-based interventions are strategies that can comprehensively address SSI risk factors in surgical care (Albert et al., 2019). Combined interventions in pre-, intra-, and postoperative phases produce more significant outcomes compared to single interventions (Allegranzi et al., 2016). Bundle approaches are effective choices in consistently reducing infection rates in various healthcare facilities (Calderwood et al., 2023). Multidisciplinary collaboration is a key aspect in ensuring bundle implementation success (Caruso et al., 2019). Bundle implementation requires managerial support and continuous training for clinical staff (Carter et al., 2017). Global evidence shows that bundles significantly reduce SSIs even in resource-limited hospitals (Dean et al., 2020). Therefore, bundles should be widely adopted as surgical infection control policies (Ban et al., 2017).

Perioperative glycemic control is another critical supporting factor that reinforces the success of infection prevention bundles (Bellon et al., 2023). Patients with diabetes have a higher risk of experiencing infectious complications due to impaired immune systems (Carter et al., 2017). Intensive glucose monitoring can reduce the likelihood of wound infections (Calderwood et al., 2023). The integration of endocrine and surgical teams is important to manage patient metabolic

conditions optimally (Dean et al., 2020). Implementation of glycemic control protocols accelerates postoperative recovery (Caruso et al., 2019). Routine glucose monitoring is an integral part of modern perioperative services (Berríos-Torres et al., 2017). Therefore, glycemic control must be a mandatory component in SOPs of surgical infection prevention (Ban et al., 2017).

The findings of this study reinforce that SSI prevention requires a systemic approach that includes environmental factors, patient behavioral factors, procedural compliance, and appropriate clinical treatment (Calderwood et al., 2023). Surgical service quality improvement must be carried out through continuous enhancement across all phases of patient care (Ban et al., 2017). Patient education should be strengthened as part of a collaborative infection control model (Carter et al., 2017). Strengthening patient safety culture is the key to maintaining the quality of surgical services (Albert et al., 2019). Hospital management must play an active role in monitoring the implementation of infection prevention policies (Dean et al., 2020). Scientific evidence shows that comprehensive strategies can significantly reduce infection rates in various countries (Allegranzi et al., 2016). Therefore, strengthening all factors related to SSIs becomes the primary recommendation of this study (Caruso et al., 2019).

CONCLUSION

This study concludes that Surgical Site Infections (SSIs) remain present in hospitals despite most service quality indicators being in good categories, and the statistical findings indicate that ward sanitation, personal hygiene, compliance with standard operating procedures (SOPs), and treatment have significant associations with SSI incidence; therefore, quality improvement efforts should focus on strengthening environmental cleanliness, enhancing patient hygiene education, ensuring healthcare worker adherence to SOPs, and optimizing treatment administration in accordance with clinical standards. Based on these findings, the researcher recommends that the hospital conduct routine audits of infection control procedure implementation, strengthen healthcare worker training related to SOPs, reinforce monitoring of patient personal hygiene, improve supervision of ward sanitation quality, ensure the accuracy of therapeutic regimens and antibiotic administration according to established guidelines, and conduct periodic evaluations through interprofessional collaboration to achieve sustainable reductions in SSI incidence and ensure that patient safety remains the highest priority in surgical services.

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