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Comparison of the Implementation of Surgical Site Infection Bundles on the Incidence of Infection in Clean and Clean-Contaminated Wounds in the Surgery Room of the General Hospital in North Aceh Regency

[1] Erlina, [2] Darmawati Darmawati, [3] Cut Husna

[1] Master of Nursing Program, Faculty of Nursing, Universitas Syiah Kuala, Banda Aceh, Indonesia
[2] Department of Maternity, Faculty of Nursing, Universitas Syiah Kuala, Banda Aceh, Indonesia
[3] Department of Medical Surgical Nursing, Faculty of Nursing, Universitas Syiah Kuala, Banda Aceh, Indonesia

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Corresponding Author: **Darmawati Darmawati**

Abstract

Prevention and control of infections in hospitals is a crucial component of healthcare service quality. Surgical site infections (SSIs) are a common and often preventable issue. SSIs can lead to increased morbidity, mortality, longer hospital stays, higher costs, and patient claims, all of which are closely linked to hospital quality and services. The aim of this study is to determine the impact of seven infection control bundles on post-operative patients with clean and clean-contaminated wounds and the incidence of infections in the surgical room of the General Hospital in North Aceh Regency. The study population consisted of 208 post-operative patients treated in the surgical room. Samples were taken using a non-probability sampling technique. The analysis method used was binary logistic regression. Variables associated with infection incidence in the clean wound group included pre-operative bathing (p=.005), prophylactic antibiotics (p=.000), temperature monitoring (p=.000), perioperative skin antiseptics (p=.000), oxygen supplementation (p=.000), and blood glucose control (p=.008), while the surgical risk index calculation was not associated (p=.362). In the clean-contaminated wound group, pre-operative bathing was associated with infection incidence (p=.001). There was no single dominant factor affecting infection incidence in the clean wound group (p>.05), while the most dominant factor in the clean-contaminated wound group was pre-operative bathing (p=.001).

Keywords: Surgical Site Infections, Clean Wound, Clean-Contaminated Wound, Incidence of Infection

Introduction

Prevention and control of infections in hospitals are crucial components of healthcare service quality. Infections acquired in hospitals are known as nosocomial infections or, more recently, Hospital Acquired Infections (HAIs) [1]. Hospitals are part of the healthcare system and include surveillance systems aimed at prevention and control, including infection control. One form of HAIs is surgical site infections. Healthcare associated infections (HAIs) are infections acquired by patients after more than 48 hours of care, where the patient was not in the incubation period [2]. The impacts of healthcare associated infections include increased morbidity, increased mortality, and longer patient hospital stays [3].

Healthcare associated infections (HAIs) are a significant health issue in many countries worldwide, including Indonesia. One form of HAIs is surgical site infections (SSIs). SSIs are infections resulting from surgical procedures that can affect various tissue layers of the body and occur 30-60 days after the surgery [2]. SSIs are a common problem, with a global incidence rate reaching up to 18%. Errors in treatment are the most frequent but are preventable. One method of preventing SSIs is chemoprophylaxis during the pre-surgical period. For optimal results, antibiotics should be administered 60 minutes before the first incision [4].

According to the World Health Organanization, the global incidence rate of Surgical Site Infections (SSIs) ranges from 5% to 34%. The National Health Service Scotland reports an incidence rate of 15.9%. In the UK, as in other developed countries, the SSI rate is 15.9%. In Indonesia, there is no precise data on the incidence rate of SSIs, making it difficult to determine. The incidence rate of SSIs at Central General Hospital in Palembang was 0.01% in 2019 and 0.04% in 2020, meaning it is still below the standard (<2%) and categorized as within normal limits [1].

The incidence rate of HAIs in Indonesia, derived from 10 General Teaching Hospitals conducting active surveillance, ranges from 6% to 16%, with an average of 9.8% [5]. A survey by the Association for Infection Control (Perdalin) Jaya and Prof. Dr. Sulianti Saroso Infectious Diseases Hospital in Jakarta, covering 11 hospitals in DKI Jakarta, found nosocomial infection rates of 18.9% for surgical site infections, 15.1% for urinary tract infections, 26.4% for peripheral bloodstream infections, 24.5% for ventilator-associated pneumonia (VAP), 25.1% for other respiratory tract infections, and 32.1% for other infections [3]. The importance of preventing and controlling surgical site infections has been widely recognized. Surgical site infection (SSI) bundles assess five points: 1) surgical risk index calculation (American Society of Anesthesiologists score (ASA), duration of surgery, and type of surgery), 2) preoperative bathing, 3) hair removal, 4) prophylactic antibiotics, and 5) body temperature control [6]. The SSI prevention bundle includes preoperative antimicrobial prophylaxis, perioperative skin antiseptics, a perioperative safety checklist, normothermia, supplemental oxygen, and glucose control [7].

In North Aceh Regency Hospital, there were no reports of SSI incidence in 2022. In October 2022, there were no SSIs with a denominator value of 33, which is within the hospital's established standard of 2%. The SSI bundle care has been implemented since 2016, but there have been no reports or data on infection incidence, considering the number of surgical cases per year at the researcher's workplace. This has prompted the researcher to further investigate the implementation of the SSI bundle.

Methods and Materials

This study employed a cross-sectional design. This study was conducted over 21 days from May 7 to May 28, 2024, in the male and female surgical wards at the Regional General Hospital in North Aceh Regency, with a sample size of 208. The clean wound group consisted of 105 samples, and the clean-contaminated wound group consisted of 103 samples, based on the number of patients meeting the inclusion criteria. The data collection tool in this study was a questionnaire that included patient identity (age, gender, date of the study), patient condition upon hospital admission, and a checklist for implementing the bundle before surgery. There were 7 questions for the independent variable (X) and 6 questions about infection incidence for the dependent variable (Y). Each question for variable X was scored 1 for positive responses (performed, given, measured) and 0 for negative responses (not performed, not given, not measured). For variable Y, a score of 1 was given if an infection occurred, and 0 if there were no signs of infection.

Inclusion criteria were:

1. Post-operative patients who have undergone minor, moderate, or major surgeries.
2. Patients without any verbal communication impairments.
3. Patients willing to participate as respondents by signing informed consent.
4. Patients with compos mentis consciousness.
5. Patients treated in the male and female surgical wards at Regional General Hospital, North Aceh Regency.
6. Patients without a history of prior diseases (lung disease and heart failure).

Specific Inclusion Criteria: Clean Wounds: 1) No inflammation present, 2) Wound is closed. Clean-contaminated Wounds: 1) Inflammation is present, 2) Open wound types resulting from accidents, open fracture. Exclusion criteria is patients with dirty post-operative wounds or those who have undergone laparotomy.

This study was conducted after passing an ethical review by the Ethics Committee at the Faculty of Nursing, Syiah Kuala University, with the Research Code: 112011210224. Data were analyzed using the Chi-square test and binary logistic regression analysis.

Results

This study aimed to determine the impact of infection bundles on post-operative patients with clean and clean-contaminated wounds, focusing on the incidence of surgical site infections in the surgery room of the General Hospital. The study results are presented in the following tables and graphs.

Distribution of Respondent Characteristics

Table 1 shows that the average age in the clean wound group is 43.98 years. The majority of respondents in this group are male, with 47 respondents (44.8%). Most respondents in the clean wound group have a high school education or equivalent, totaling 81 respondents (77.1%). The majority of respondents have an income of ≤ Rp 3,126,000, totaling 105 respondents (100.0%). Most respondents are unemployed or housewives, totaling 51 respondents (48.9%). The majority of respondents have BPJS Kesehatan health insurance, with 103 respondents (98.1%), and most have no comorbidities, with 103 respondents (98.1%).

In the clean-contaminated wound group, the average age of respondents is 43.31 years. The majority are male, with 63 respondents (61.2%). Most respondents have a high school education or equivalent, totaling 83 respondents (80.6%). The majority have an income of ≤ Rp 3,126,000, with 103 respondents (100.0%). Most respondents are farmers/fishermen/general workers or unemployed/housewives, totaling 45 respondents (43.7%). All respondents have BPJS Kesehatan health insurance, with 103 respondents (100%), and the majority do not have comorbidities, with 98 respondents (95.1%).

Table 1: Frequency Distribution of Respondent Characteristics (n=208)

Sociodemographics	Clean Wound		Clean-Contaminated Wound	
	Frequency	Percent	Frequency	Percent
Age (M±SD)	(43,9±17,1)		(43,3±15,5)	
Gender				
Male	47	44,8	63	61,2
Female	58	55,2	40	38,8
Education				
Low Education	24	22,9	18	17,5
Medium Education	81	77,1	83	80,6
Higher Education	0	0	2	1,9
Income				
Rp ≤ 3.126.000	105	100	103	100
Occupation				
Farmer/Fisherman/General	34	32,4	45	43,7
Entrepreneur	18	17,1	12	11,7
Retired	2	1,9	1	1,0
Unemployed/Housewife	51	48,9	45	43,7
Health Insurance				
BPJS	103	98,1	103	100
Jasa Raharja	2	1,9	0	0
Comorbidities				
None	103	98,1	98	95,1
Present (Hypertension & DM)	2	1,9	5	4,9

Table 2 shows that the variables associated with the incidence of infection in the clean wound group are preoperative bathing (p=0.005), prophylactic antibiotics (p=0.000), temperature measurement (p=0.000), perioperative skin antiseptics (p=0.000), oxygen supplementation (p=0.000), and blood glucose control (p=0.008). The variable that is not associated with infection incidence is the surgical risk index calculation (p=0.362).

Table 3 indicates that for the clean-contaminated wound group, preoperative bathing is associated with the incidence of infection (p=0.001). Variables not associated with infection incidence include the surgical risk index calculation (p=1.000), prophylactic antibiotics (p=1.000), temperature measurement (p=1.000), perioperative skin antiseptics (p=1.000), oxygen supplementation (p=1.000), and blood glucose control (p=1.000).

Table 2: Relationship Between the Implementation of Surgical Site Infection Bundles and Infection Incidence in Clean Wound Patients (N=105)

Surgical Site Infection Bundles	Infection Incidence				Total		p-value
	No Infection		Infection				
	Frequency	Percent	Frequency	Percent	Frequency	Percent	
Surgical Risk Index Calculation							
No	3	3	9	9	6	6	0.362
Yes	81	77	12	11	99	94	
Preoperative Bathing							
No	1	1	4	4	5	5	0.000
Yes	83	79	17	16	100	95	
Prophylactic Antibiotics							
No	4	4	9	9	13	13	0.000
Yes	80	76	12	11	92	87	
Temperature Measurement							
No	5	5	8	8	13	13	0.000
Yes	79	75	13	13	92	87	
Perioperative Skin Antiseptic							
No	3	3	9	9	12	12	0.000
Yes	81	77	12	11	93	88	
Oxygen Supplementation							
No	2	2	7	7	9	19	0.000
Yes	82	78	14	13	96	81	
Blood Glucose Control							
No	3	3	5	5	8	8	0.008
Yes	81	77	16	15	97	92	

Table 3: Relationship Between the Implementation of Surgical Site Infection Bundles and Infection Incidence in Clean-Contaminated Wound Patients (N=103)

Surgical Site Infection Bundles	Infection Incidence				Total		p-value
	No Infection		Infection				
	Frequency	Percent	Frequency	Percent	Frequency	Percent	
Surgical Risk Index Calculation							1.000
No	15	15	1	1	16	15	
Yes	80	78	7	7	87	85	
Preoperative Bathing							0.001
No	79	77	2	1	98	78	
Yes	16	16	6	6	5	22	
Prophylactic Antibiotics							1.000
No	5	5	0	0	5	5	
Yes	90	87	8	8	98	95	
Temperature Measurement							1.000
No	2	5	0	0	2	5	
Yes	93	87	8	8	101	95	
Perioperative Skin Antiseptic							1.000
No	2	5	0	0	2	5	
Yes	93	87	8	8	101	95	
Oxygen Supplementation							1.000
No	2	5	0	0	2	5	
Yes	93	87	8	8	101	95	
Blood Glucose Control							1.000
No	3	3	0	0	2	5	
Yes	92	89	8	8	101	95	

Table 4: Multivariate Analysis of Surgical Site Infection Bundle Variables with Infection Incidence in Clean Wound Patients (N=105)

Surgical Site Infection Bundle	B	S.E	*p-value*	Exp (B)	95% C.I	
					Lower	Upper
Surgical Risk Index	22,386	20295,770	0,999	52762	0,000	-
Preoperative Bathing	-0,388	1,650	0,814	0,678	0,027	17,207
Prophylactic Antibiotics	1,931	0,996	0,52	6,893	0,980	48,507
Temperature Measurement	-20,946	20295,770	0,999	0,000	0,000	-
Perioperative Skin Antiseptic	22,480	20295,770	0,999	57943	0,000	-
Oxygen Supplementation	1,345	1,609	0,403	3,839	0,164	89,930
Blood Glucose Control	-1,318	1,871	0,481	2,68	0,007	10,484

Table 5: Multivariate Analysis of Surgical Site Infection Bundle Variables with Infection Incidence in Clean-Contaminated Wound Patients (N=103)

Surgical Site Infection Bundle	B	S.E	*p-value*	Exp (B)	95% C.I	
					Lower	Upper
Surgical Risk Index	0,089	1,205	0,941	1,093	0,103	11,598
Preoperative Bathing	-2,703	0,872	0,002	0,067	0,012	0,370
Prophylactic Antibiotics	-19,125	21201,615	0,999	0,000	0,000	-
Temperature Measurement	19,125	53592,768	1,000	202147546,0	0,000	-
Blood Glucose Control	-17,575	40192,970	1,000	0,000	0,000	-

In Table 4, it is shown that no single factor is the most dominant in influencing infection incidence in the clean wound group (p>0.05). In contrast, Table 5 reveals that only one indicator is most dominant in relation to infection incidence, which is preoperative bathing (p=0.002). This indicates that preoperative bathing is the only factor with significant influence on infection incidence in the clean-contaminated wound group.

Discussion

Based on the bivariate analysis, it was found that there is a significant relationship between the Surgical Risk Index Calculation and infection incidence in the clean wound group (p=0.001). However, no significant relationship was observed between the Surgical Risk Index Calculation and infection incidence in the clean-contaminated wound group (p=1.000). These findings align with the research conducted by Yuwono (2013) at RSMH Palembang, which reported (p=0.004; OR=2.4) [8]. This suggests that the ASA score in the Surgical Risk Index Calculation has a significant relationship with infection incidence. In the researcher’s view, the Surgical Risk Index Calculation has an indirect influence on infection incidence. Patients with higher ASA scores are still operated on with monitoring by an anesthesiologist during the procedure. Additionally, patients with systemic disease as indicated by the ASA score may affect the postoperative healing process.

Patients undergoing anesthesia and surgery can be classified into various physical status categories initially proposed and used by the American Society of Anesthesiologists (ASA). The patient's condition before surgery is assessed based on the ASA score classification. The ASA score is used to determine the physical condition of the patient prior to the operation. It serves as a tool to define whether a patient has systemic abnormalities or not.

One method to prevent surgical site infections is the use of disinfectants. Disinfectants are chemicals that prevent infections or contamination by microorganisms such as bacteria and viruses, and are used to kill or reduce the number of disease-causing microorganisms. Cleaning the surgical field is highly recommended, both 12 hours before the surgical procedure and immediately before using antiseptics. This process aims to remove fats and dirt from the skin surface, making the subsequent antiseptic solution more effective [9].

Based on the analysis results, 100 respondents (95.2%) in the clean wound group practiced preoperative bathing, while 81 respondents (78.6%) in the clean-contaminated wound group did not practice preoperative bathing. Bathing before surgery with chlorhexidine gluconate can reduce bacteria on the patient's skin surface, particularly in the area of the surgical incision. Patients who have been admitted and are scheduled for surgery the next day are instructed by nurses to bathe at least 2 hours before the procedure [3]. Research by Dramowski *et al*. (2021) indicates that bathing before surgery with chlorhexidine (CHG) can reduce bacterial colonization on the skin. However, CHG was found to be ineffective in reducing surgical site infections compared to a placebo. This is likely because to achieve maximum effectiveness, chlorhexidine needs to remain on the skin for at least 5 minutes before being washed off, which can be a limiting factor in its use [10].

This is supported by p-values of 0.000 and 0.001, indicating a significant relationship between preoperative bathing and the incidence of surgical site infections in both clean and clean-contaminated wound groups. In general, preoperative bathing with soap (whether antimicrobial or non-antimicrobial) is beneficial before surgery. However, recommendations regarding the timing and most effective protocols for preoperative bathing remain unresolved issues. It is still recommended to bathe at least twice before surgery [11].

Countries with high incidences of multi-drug-resistant organisms may consider using antiseptics instead of regular soap for preoperative bathing. In some Asian countries where allergies to chlorhexidine (CHG) are common or where CHG is not available, alternative agents such as octenidine may be used.

In the principles of antibiotic prevention, besides accurate selection, the concentration of antibiotics in the tissue at the beginning and during the surgery must also be considered. Based on the data, it can be concluded that prophylactic antibiotic use is not related to the incidence of surgical site infections in this study. This is supported by a p-value of 1.000 (which is >0.05) in the clean-contaminated wound group, indicating that there is no significant relationship between prophylactic antibiotics and the occurrence of surgical site infections.

Research conducted by Wandoko and Suryadi (2017) found no significant relationship between premedication processes and surgical wound infection incidence (p=0.231). Prophylactic antibiotics are preventive treatments administered before incision or surgical procedures. The aim of prophylactic antibiotics in surgical cases is to prevent infections resulting from surgical interventions, specifically surgical wound infections [12].

Research by Berrondo *et al*. (2022) showed that patients who did not receive prophylactic antibiotics had a longer average hospital stay (57.3±12.1 hours) compared to those who received antibiotics (38.5±9.2 hours), due to longer healing times caused by infections. The types of antibiotics used are generally in line with national and international guidelines. Commonly used prophylactic antibiotics include metronidazole, cefuroxime, cefazolin, and ceftriaxone. Other antimicrobial agents used include cefotaxime, amoxicillin/clavulanic acid, cephalexin, and amoxicillin [13]. This aligns with practices at General Hospital, where the most commonly used prophylactic antibiotics are cefotaxime and ceftriaxone. In the opinion of the researcher, prophylactic antibiotics should ideally be narrow-spectrum to reduce the risk of bacterial resistance, have low toxicity, do not induce adverse reactions with anesthetic agents, be bactericidal, and be cost-effective.

Temperature is the degree of heat or cold measured using a thermometer, typically in degrees celsius (ºC). The normal temperature range is between 36.5ºC and 37ºC. A temperature above 37.5ºC is classified as hyperthermia, while a temperature below the normal range indicates hypothermia. Hypothermia can lead to vasoconstriction, reduced oxygen tension, increased bleeding, and prolonged hospital stay.

Bivariate analysis indicates a significant relationship between temperature measurement and infection incidence in the clean wound group (p=0.000), while no significant relationship was found between temperature measurement and infection incidence in the contaminated clean wound group (p=1.000). Research conducted at RSMH Palembang showed that preoperative body temperature outside the normal range (fever) occurred in 26 patients, with 77.8% of them experiencing surgical site infections. Patients with abnormal temperatures were 3.1 times more likely to experience surgical site infections compared to those with normal temperatures [14].

Research by Zukhri *et al*. (2020), indicates that surgical site infections were more frequently observed in respondents with normal body temperatures, with 75 respondents (48.7%), yielding a p-value of 0.748, suggesting no significant effect of body temperature on the incidence of surgical site infections in post-operative caesarean section patients at Islam Klaten general Hospital [15].

According to the researcher’s opinion, definitive signs of infection can be observed only after surgery. Temperature-related issues can be managed by addressing elevated preoperative temperatures and using warm blankets if hypothermia occurs preoperatively, intraoperatively, or postoperatively.

Temperature significantly influences the occurrence of surgical site infections. Hypothermia can impair immune function (oxidative killing by neutrophils), leading to vasoconstriction of the skin and reduced blood flow to the surgical site, which increases the risk of surgical site infections.

Research by Essler *et al*. (1996) demonstrated that patients whose sutures were removed one day post-operation and who experienced hypothermia had an extended hospital stay of 2.6 days compared to those with normothermia (p = 0.002). Hypothermia can delay wound healing and make patients more susceptible to wound infections. Maintaining normothermia during surgery is likely to reduce the incidence of infectious complications in patients undergoing colorectal surgery and shorten their hospital stay [16].

Bivariate analysis indicates a significant relationship between perioperative skin antiseptic and the occurrence of infections in the clean wound group (p=0.000), while no significant relationship was found in the clean contaminated wound group (p=1.000). These findings align with research by Agustina (2017), which demonstrated that perioperative skin antiseptic increases the risk of surgical site infections by 6.00 times compared to patients who underwent preoperative shaving, highlighting it as a risk factor for surgical site infections at Surabaya General Hospital from January 2016 to March 2017. Similarly, Sutin (2023) found a relationship between skin preparation factors and the incidence of surgical site infections.

In the opinion of the researcher, shaving with a razor or blade can create lesions or wounds that serve as entry points for bacteria. If shaving is necessary, using a razor should be avoided, and clippers should be used instead [17]. Shaving is still performed for patients undergoing cesarean sections at hospitals in North Aceh due to the presence of hair in the suprapubic area, which could interfere with the surgical procedure.

Surgical site infections (SSIs) remain a challenge due to the presence of underlying medical conditions in patients, including perioperative management of diabetes mellitus (DM). Diabetes mellitus is known to be a risk factor for surgical site infections across various surgical specialties, including cardiothoracic, hepatobiliary, and colorectal surgery [18].

Based on the bivariate analysis, there is a significant relationship between blood glucose control and the occurrence of infections in the clean wound group (p=0.008), whereas no significant relationship is found between blood glucose control and infection occurrence in the clean contaminated wound group (p=1.000). This is consistent with research conducted by Hikata *et al*. (2014), which shows that patients with an HbA1c level <7% have an infection rate of 0%, while those with an HbA1c level >7% have an infection rate of 35.3% [19]. Additionally, Gachabayov *et al*. (2018) reported a positive correlation between stress hyperglycemia and surgical site infection rates, regardless of diabetes status. However, the impact of perioperative stress hyperglycemia on surgical site infections is not widely recognized in non-diabetic patients [20]. Implementing preoperative and intraoperative glycemic control with blood glucose levels <200 mg/dL is recommended for both diabetic and non-diabetic patients [21].

Based on the multivariate analysis using binary logistic regression, no single indicator was found to be the most dominant factor influencing infection occurrence in the clean wound group. This result is attributed to the nature of the surgeries in the clean wound group, which are predominantly elective. Elective surgeries are those that can be scheduled or postponed without endangering the patient's life. Even minor surgical procedures carry a risk of infection, and microbial contamination at the site of surgery is a significant factor in infection development.

For the clean contaminated wound group, it was found that preoperative bathing is the most dominant predictor of infection occurrence (p=0,001). This is because patients with clean contaminated wounds are often those undergoing cytological procedures, and the majority of these patients did not bathe before the operation. Surgical site infections can be prevented, in part, by using antiseptics before the surgical procedure. Chlorhexidine is one such antiseptic that can be used for disinfecting the surgical area.

Chlorhexidine demonstrates broad-spectrum activity in inhibiting Gram-positive bacteria, Gram-negative non-spore bacteria, fungi, and enveloped viruses including HIV. The mechanism of action of chlorhexidine is diverse, and it maintains high concentrations on the skin surface. Its antimicrobial activity is nearly comparable to that of povidone iodine; however, chlorhexidine is not inactivated by blood or serum proteins and suppresses microbial growth for several hours after application. Available concentrations of chlorhexidine in the market range from 0.12% to 4%, and it is often combined with isopropyl alcohol or ethanol to enhance its bactericidal and viricidal properties [22].

Conclusion

In efforts to prevent and control infections in healthcare facilities, it is crucial that both staff and policymakers understand the basic concepts of infectious diseases. Therefore, it is essential to develop guidelines for infection prevention and control in healthcare facilities to ensure high-quality healthcare services. These guidelines should serve as a reference for all parties involved in implementing infection prevention and control measures, protecting the public, and achieving patient safety. Ultimately, this will also impact the efficiency of healthcare facility management and improve the quality of care.

The implementation of Infection Control Bundles for patients undergoing or recovering from surgery can reduce the risk of surgical site infections. Average Length of Stay (AVLOS) refers to the average duration of a patient's stay. This indicator not only provides insight into the efficiency of care but also reflects the quality of service. When applied to specific diagnoses, it may highlight areas requiring further observation. Generally, an ideal AVLOS is between 6 to 9 days.

Recommendations

This study recommends that nursing staff continually enhance their knowledge and adherence to the implementation of Surgical Site Infection (SSI) Bundles to prevent postoperative infections. This is crucial for providing safe surgical care to patients and for monitoring patient actions and conditions regularly, including postoperatively.

Hospitals are advised to always provide guidelines and routinely evaluate the implementation of SSI Bundles. It is also essential to offer training, seminars, and evaluations for nurses to support the application of preoperative and postoperative care, thus improving the quality of nursing care in the hospital.

This study has several limitations, including the diverse types of surgeries and varying severity of patients at the North Aceh Regional General Hospital, which made it challenging for the researchers to classify patients according to inclusion criteria during the study period.

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