

A CLINICAL STUDY ON SURGICAL SITE INFECTIONS

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ABSTRACT

Background: Surgical site infections (SSIs) are the most common healthcare burden worldwide, causing clinical and economic problems. SSIs occur within 30 days after surgery or one year after implant surgery, affecting the incision or deep tissues. The timing of hair removal and antibiotic prophylaxis are modifiable factors for SSI, with varying hospital protocols. This study aimed to compare preoperative hair removal techniques and the timing of antibiotic administration. **Materials and Methods:** This prospective study included 100 patients between June 2015 and June 2017. Data on age, sex, symptom duration, laboratory findings, operative procedure, complications, and definitive procedure were recorded from patient history, clinical examination, operative notes, and follow-up records. Preoperative antibiotic use, preparation, procedure time, complications, hospital stay, postoperative pain, discharge, and redness were documented. **Result:** Males predominated (64% vs. 56% for antibiotic timing, 60% vs. 54% for hair removal). Complications were higher with antibiotics administered 1 h before surgery versus induction: fever (30% vs. 12%), warmth/redness (36% vs. 10%), and pain (34% vs. 12%). Similar patterns were observed between shaving and clipping; recovery improved with antibiotics at induction (68% vs. 33%) and clipping (60% vs. 22%). Superficial SSI rates were higher with 1-hour-before antibiotics (39% vs. 10%) and shaving (51% vs. 16%). Deep SSI exhibited similar patterns. Common isolates were *S. aureus* (27-33%), *E. coli* (17-27%), and *S. epidermidis* (17-18%). **Conclusion:** Antibiotics benefit surgeries, for surgeries over 2 hours, repeating antibiotics reduces infections. SSI increase hospital stay and costs, and laparoscopic surgery reduces SSIs.

INTRODUCTION

Surgical site infections (SSIs) are the most common healthcare burden worldwide, with significant clinical and economic problems even with modern surgical advancements and are an important quality parameter of surgical performance. SSIs are defined as the occurrence of infection up to 30 days after surgery or one year after surgery with implants that affect the incision or deep tissues. The incidence is 0.5 to 3%, with a maximum of 20%, this rate depends on the surgical type and surveillance methods.^[1,2] SSIs extend hospital stay by an average of 9.6 days and increase cost by 16,242 dollars per admission, with risk factors including MRSA and decreased serum albumin and are associated with morbidity, mortality and reduced quality of life.^[3] Though modern techniques, antibiotic prophylaxis and aseptic practice were implemented, SSIs were a significant challenge, with approximately 50% preventable through evidence-based practices with

modifiable preoperative practices with targeted interventions.^[4]

A study by Berríos-Torres et al. reported that 50% of SSIs are preventable, and the risk factors can be categorised as patient-related (smoking, obesity, diabetes, malnutrition and MRSA colonisation).^[5,6] Risk factors related to procedures include operation duration, level of contamination, operation room traffic and perioperative practice-related factors includes timing of antibiotic prophylaxis, skin antisepsis and irrigation techniques.^[7,8] Preoperative hair removal is performed to facilitate surgery by improving adherence of adhesive dressings, reducing wound care discomfort, but does not reduce the risk of SSIs irrespective of the techniques (razor shaving and clipping).^[9] The razor shaving method reported an increased risk of infection (RR: 1.64), and the clipping or depilatory creams showed a less difference from no hair removal, while razor shaving also reported more skin injury than clipping (RR: 1.74).^[10]

Preoperative antibiotic prophylaxis timing is important for reducing SSIs with the administration of drugs within a specific window before the incision, reducing the risk of infection, although real-world practice was variable. A meta-analysis by de Jonge reported that the risk of SSIs was doubled when antibiotics were administered after incision (OR: 1.89) and increased four times when administered > 120 min before incision (OR: 5.26).^[11] The optimal timing for preoperative antibiotic prophylaxis is 60-30 min before surgical incision, as it significantly reduces SSIs when timed correctly to achieve adequate tissue concentration at incision; incorrect timing of administration can result in inadequate protection at subtherapeutic efficacy levels. Variability in timing practices is an important issue across centres with a need for process improvement initiatives adhering to the national guidelines.^[12,13] SSIs are a common complication that causes morbidity, extended hospital stays, further surgeries, and financial stress. Hair removal is an important factor in surgery, but timing is also important for antibiotic prophylaxis, which is essential for surgery. Antibiotic prophylaxis is important because it requires adequate drug concentrations in the tissues at the time of incision. The effectiveness of antibiotics is diminished if they are administered too early or too late. However, compliance with antibiotic prophylaxis varies widely during surgery. Both hair removal and antibiotic prophylaxis timing are modifiable factors for SSI; however, these factors are rarely assessed together.

Aim: This study aimed to compare various techniques for preoperative hair removal and the timing of preoperative antibiotics.

MATERIALS AND METHODS

This prospective study was conducted in 100 patients admitted to the surgical ward of Government Mohan Kumara Mangalam Medical College Hospital, Salem, between June 2015 and June 2017. The Institutional Ethics Committee (IEC) approved the study, and written informed consent was obtained from all patients before the initiation of the study.

Inclusion and Exclusion criteria

This study included patients undergoing elective surgeries with clean wounds and clean contaminated

wounds without comorbid conditions. Patients with dirty wounds, emergency surgeries, and elective surgeries with comorbid illnesses were excluded from the study.

Materials

Data collection sheets, patient case records, clinical examination findings, laboratory reports, operative notes, and follow up records were used for the study. The parameters recorded included age, sex, duration of symptoms, laboratory findings, operative procedure details, and postoperative complications.

Methods: Patient details, including age, sex, duration of symptoms, laboratory findings, operative procedure, postoperative period complications, and definitive procedure as per case notes were entered into the data collection sheet. Data were extracted from the patient history, clinical examination, operative notes, and follow-up records. Preoperative antibiotic use, preoperative preparation, procedure time, intraoperative complications, postoperative complications, duration of hospital stays, pain in the postoperative period, discharge in the postoperative period, and redness in the postoperative period were recorded.

Statistical analysis: Data are expressed as numbers and percentages. Categorical variables were compared using the chi-square test. Continuity correction and likelihood ratio values were applied where necessary. Fisher's exact test was used for expected cell counts below 5. Crosstabulation analysis was used to compare postoperative complications between groups based on the timing of antibiotic administration and hair removal method. Statistical significance was set at $p < 0.05$ using a two-sided test. Data were analysed using IBM SPSS version 21.0 (IBM SPSS Science Inc., Chicago, IL, USA).

RESULTS

Male patients were predominant across groups in both antibiotic timing and hair removal methods. Regarding antibiotic timing, males were 64% in the 1-hour-before group and 56% in the at-induction group, with females at 36% and 44%. In terms of hair removal, males comprised 60% and 54% of the shaving and clipping groups, respectively, while females comprised 40% and 46% [Table 1].

Table 1: Comparison of Sex Distribution

Parameters		Pre operative antibiotic		Pre operative hair removal	
		Antibiotic 1 hr Before (n=50)	Antibiotic at Induction (n=50)	Hair Shaving (n=50)	Hair Clipping (n=50)
Sex	Male	32 (64%)	28 (56%)	30 (60%)	27 (54%)
	Female	18 (36%)	22 (44%)	20 (40%)	23 (46%)

For antibiotic timing, fever occurred in 16% versus 9% at induction, warmth/redness in 20% versus 8%, and pain in 19% versus 9%, showing higher rates in the antibiotic-1-hour group. Serous discharge was 5% versus 3%, whereas pus discharge and wound dehiscence occurred in 3% versus 2% of patients. Uneventful recovery was higher in the antibiotic-at-

induction group (68%) than in the antibiotic-1-hour group (33%).

For hair removal, fever and pain occurred in 25% of patients with shaving versus 12% with clipping. Warmth/redness occurred in 15% and 9% of patients, and serous discharge was observed in 4% of cases for both methods. Pus and wound dehiscence occurred in

5% of patients who underwent shaving and in 1% of those who underwent clipping. Uneventful recovery

was higher with clipping (60%) than with shaving (22%) [Table 2].

Table 2: Distribution of Post-operative Complications

Parameters		Pre operative antibiotic		Pre operative hair removal	
		Antibiotic 1 hr (n=50)	Antibiotic Induction (n=50)	Hair Shaving (n=50)	Hair Clipping (n=50)
Complication	Fever	15 (16%)	6 (9%)	25 (25%)	8 (12%)
	Warmth / Redness	18 (20%)	5 (8%)	15 (15%)	6 (9%)
	Pain	17 (19%)	6 (9%)	25 (25%)	8 (12%)
	Serous discharge	5 (5%)	2 (3%)	4 (4%)	3 (4%)
	Pus	3 (3%)	1 (2%)	5 (5%)	1 (1%)
	Wound dehiscence	3 (3%)	1 (2%)	5 (5%)	1 (1%)
	Uneventful	30 (33%)	44 (68%)	22 (22%)	41 (60%)

In post-operative complications, fever occurred in 30% of patients receiving antibiotics 1 h before surgery versus 12% at induction ($p=0.027$) and was more frequent with hair shaving (50%) than clipping (16%) ($p<0.001$). Warmth/redness occurred in 36% versus 10% in the antibiotic-1-hour-before and induction groups ($p=0.002$), with similar patterns between shaving (30%) and clipping (12%) ($p=0.027$). Pain was reported in 34% versus 12% of the patients in the antibiotic timing groups ($p=0.009$) and was higher with shaving (50%) than with clipping (16%) ($p<0.001$).

Serous discharge occurred in 10% and 4% of the antibiotic timing groups ($p=0.24$) and was similar between the shaving (8%) and clipping (6%) groups ($p=0.695$). Pus discharge occurred in 6% versus 2% of antibiotic timing groups ($p=0.307$) and was higher in the shaving (10%) than in the clipping (2%) groups ($p=0.092$). Wound dehiscence showed an identical distribution, with 6% versus 2% in the antibiotic timing groups and 10% versus 2% in the hair removal groups ($p=0.092$) [Table 3].

Table 3: Comparison of Post-operative Wound Complications

Parameters		Pre operative antibiotic				p value	Pre operative hair removal				p value
		Antibiotic before 1 hr (n=50)		Antibiotic at Induction (n=50)			Hair Shaving (n=50)		Hair Clipping (n=50)		
		Yes	No	Yes	No		Yes	No	Yes	No	
Complication	Fever	15 (30%)	35 (70%)	6 (12%)	44 (88%)	0.027	25 (50%)	25 (50%)	8 (16%)	42 (84%)	<0.001
	Warmth / Redness	18 (36%)	32 (64%)	5 (10%)	45 (90%)	0.002	15 (30%)	35 (70%)	6 (12%)	44 (88%)	0.027
	Pain	17 (34%)	33 (66%)	6 (12%)	44 (88%)	0.009	25 (50%)	25 (50%)	8 (16%)	42 (84%)	<0.001
	Serous discharge	5 (10%)	45 (90%)	2 (4%)	48 (96%)	0.24	4 (8%)	46 (92%)	3 (6%)	47 (94%)	0.695
	Pus Discharge	3 (6%)	47 (94%)	1 (2%)	49 (98%)	0.307	5 (10%)	45 (90%)	1 (2%)	49 (98%)	0.092
	Wound dehiscence	3 (6%)	47 (94%)	1 (2%)	49 (98%)	0.307	5 (10%)	45 (90%)	1 (2%)	49 (98%)	0.092

Regarding antibiotic timing, superficial SSI was reported in 39% of patients receiving antibiotics 1 h before surgery versus 10% receiving antibiotics at induction. Deep SSI rates were 6% and 2%, respectively. Uneventful outcomes without SSI were 56% in the antibiotic-1-hour-before group and 88%

in the antibiotic-at-induction group. For hair removal, superficial SSI occurred in 51% of shaved patients versus 16% of clipped patients. Deep SSI affected 9% of the shaving group and 2% of the clipping group. Uneventful outcomes were lower with shaving (40%) than with clipping (82%) [Table 4].

Table 4: Comparison of Surgical Site Infection Outcomes

Parameters		Pre operative antibiotic		Pre operative hair removal	
		Antibiotic 1 hr Before (n=50)	Antibiotic at Induction (n=50)	Hair Shaving (n=50)	Hair Clipping (n=50)
SSI Outcome	Superficial SSI	21 (39%)	5 (10%)	28 (51%)	8 (16%)
	Deep SSI	3 (6%)	1 (2%)	5 (9%)	1 (2%)
	No SSI (Uneventful)	30 (56%)	44 (88%)	22 (40%)	41 (82%)

Staphylococcus aureus and Escherichia coli were each found in 27% of the samples, followed by Staphylococcus epidermidis (18%). Pseudomonas,

Enterococcus, and Klebsiella were present in 9% of the samples. For hair removal, Staphylococcus aureus predominated at 33%, followed by

Escherichia coli and Staphylococcus epidermidis at 17% each. Pseudomonas, Enterococcus, Klebsiella,

and Streptococcus pyogenes each represented 8% of the isolates [Table 5].

Table 5: Distribution of Bacterial Isolates in Pus Culture

Parameters		Isolates n (%)	
		Pre operative antibiotic	Pre operative hair removal
Pus Culture	Staphylococcus aureus	3(27%)	4(33%)
	E. coli	3(27%)	2(17%)
	S. epidermidis	2(18%)	2(17%)
	Pseudomonas	1(9%)	1(8%)
	Enterococcus	1(9%)	1(8%)
	Klebsiella	1(9%)	1(8%)
	Streptococcus pyogenes	-	1(8%)

DISCUSSION

In our study, male patients formed the majority of the preoperative antibiotic timing and hair removal method groups. The similar sex distribution indicated that it would not affect the outcome. A study by Dhamanaskar et al. reported that the number of males (66.16%) was almost twice that of females (33.84%) with an average age of 42.47 years, showing male predominance with a balanced distribution.^[14] The balanced sex distribution across groups suggests that sex was not a confounding factor in postoperative outcomes.

In our study, postoperative inflammatory features such as fever, warmth, redness, and pain occurred more frequently in patients receiving antibiotics one hour before surgery than at induction. Similarly, shaving showed higher inflammation than clipping. A study by Alied et al. reported that preoperative hair removal does not significantly impact SSI rates. Clipping is safer than shaving; depilatory creams are less damaging.^[15] These findings suggest fewer complications with antibiotic administration at induction and clipping.

A study by Dhamanaskar et al. reported that preoperative shaving did not significantly increase overall SSI (11.42%) rates compared to not shaving, except in subgroups with clean-contaminated surgeries and surgeries lasting less than 2 hours ($p > 0.05$).^[14] Shi et al. reported no significant difference in SSIs among the hair removal methods, and clipping is suggested to be more effective than shaving or depilatory cream when necessary.^[16] However, a meta-analysis by Lefebvre et al. found clipping, chemical depilation, and no hair removal all showed significantly fewer infections than shaving (RR 0.55-0.56), but no significant differences among these three alternatives.^[17] Antibiotic administration at induction and clipping instead of shaving may be considered for reducing wound complications.

In our study, serous discharge, pus discharge, and wound dehiscence were less frequent in the antibiotic-at-induction group than in the one-hour-before group. Clipping resulted in fewer cases of purulent discharge and wound dehiscence than shaving, with similar serous discharge rates. Both the timing of antibiotic administration at induction and clipping were associated with fewer wound complications. A meta-analysis by Alied et al. (17

studies, 5,407 patients) found razor shaving was associated with higher skin damage but only increased SSI risk compared to clipping, and this difference was not significant.^[15] Prajwal et al., reporting 8.6%, Arif et al., reporting 7.5% SSI in the antibiotic group and Reddy et al., reported serous discharge (10.9%) and purulent discharge (1.09%).^[18-20] Optimal antibiotic timing and hair clipping improve wound healing and reduce adverse events after surgery.

In our study, surgical site infections occurred more frequently with pre-surgery than with induction-time antibiotics. Shaving increased the infection risk compared to clipping. The absence of infection was higher with the induction of antibiotics and clipping, showing their protective effects. A network meta-analysis of 19 RCTs by Lefebvre et al. confirmed that clipping resulted in fewer SSIs than shaving.^[17] Hawn et al. found no significant association between prophylactic antibiotic timing and SSI in adjusted analyses, despite observing higher unadjusted SSI rates when antibiotics were administered >60 min before incision, and concluded that timing is not significantly associated with SSI occurrence.^[21] Induction-time antibiotic prophylaxis with clipping reduces surgical site infection better than earlier dosing and shaving.

In our study, the bacteriological pattern of pus culture isolates was similar across the antibiotic timing and hair removal groups. Staphylococcus aureus was the predominant pathogen, followed by gram-negative organisms and coagulase-negative Staphylococci. Although the interventions influenced infection rates, the spectrum of organisms remained consistent. This is supported by a study by Naz et al., who reported S. aureus as the most common isolate (51.5%) and in contrast, Manohar et al. found gram-negative bacilli most common overall, with Klebsiella pneumoniae accounting for 58% of gram-negative isolates.^[22,23] Regarding hair removal methods, Dingmei Shi et al. found no significant differences in SSI rates between shaving, clipping, or no removal, supporting the similar patterns across hair removal groups.^[16] Preventive strategies affected infection rates rather than pathogen type, indicating standard antimicrobial coverage remains appropriate.

CONCLUSION

In our study of 100 cases, preoperative antibiotics administered 1 h before anaesthesia led to 39% superficial SSI and 6% deep SSI. When given at induction, 6% of patients developed superficial SSI, and 2% developed deep SSI, indicating a lower risk. The selection of specific antibiotics for surgery is beneficial. For surgeries lasting over 2 hours, repeated antibiotic induction reduces the risk of infection. Higher SSI rates lead to extended hospital stays, increased morbidity, and higher costs. Laparoscopic surgery results in fewer SSIs and shorter hospital stays. Preoperative skin preparation timing affects infection rates, with same-day preparation showing lower SSI than previous-day preparation.

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