Prognosticators of surgical site infections (SSIs) among patients undergoing major surgery at general hospital Funtua, Katsina State, Nigeria

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Abstract

This study explores the prognosticators of surgical site infection among studied group. Surgical site infection (SSI) continues to be a major source of morbidity and mortality in developing countries regardless of modern advances in aseptic techniques. Therefore it was essential to conduct this study to determine the prognosticators of surgical site infection at General Hospital Funtua, Katsina State, Nigeria.

A descriptive cross sectional study was used involving all subjects who underwent major surgery in surgical wards. A non- probability purposive sampling technique was employed to recruit the total sample size of one hundred and twenty seven (127). After informed written consent for the study , all subjects who met inclusion criteria were successively enrolled in to the study. Pre-operative, intra-operative and postoperative data were collected using standardized data collection form based on CDC/WHO criteria. Wound specimens were collected and processed as per standard operative procedure. Data were analysed using SPSS and STATA software.

Using odds ratio analysis, inadequate operating room ventilation and surgical hand scrub for < 2 minutes were found to have an increased risk for SSI by 34, fold. Subjects within the age limit between 21-30 years have increased risk for SSI by 2 fold, and subjects with co-existing illness (fever), have an increased risk for SSI by 4 fold, OR (3.9). Sterilization technique by the use of high level disinfectant and pre morbidity has been found to be an independent prognosticator of SSI, *P*-valve < 0.05.

The study concluded that prognosticators for surgical site infections are associated with modifiable risk factors that the surgeons, nursing staffs and hospital management can dealt with in a greater details. Prevention strategies focusing on factors associated with surgical site infection is necessary in order to reduce the rate of SSI in our setting.

Key words: prognosticators, surgical site infection, surgical patient.

Background

Surgical site infections (SSIs) have been reported to be one of the most common causes of nosocomial infections; accounting for 20 to 25% of all nosocomial infections worldwide [1]. Globally, surgical site infection rates have been reported to range from 2.5% to 41.9% [2, 3]. In the United States, approximately 2% to 5% of the 16 million patients undergoing surgical procedures each year have postoperative surgical site infections. In Tanzania, surgical site infections are still one of the leading causes of morbidity and mortality among patients undergoing major surgery. Previous studies conducted in a district and a tertiary hospital in Tanzania reported the surgical site infections rate of 24% and 19.4% respectively [4, 5].

SSIs have been responsible for increasing cost; morbidity and mortality related to surgical operations and continue to be a major problem worldwide. Surgical site infection is one of the most common preventable complications following major surgery and represents a significant burden in terms of patient morbidity, mortality and hospital costs [2]. Despite improvements in operating room practices, instrument sterilization methods, better surgical technique and the best efforts of infection prevention strategies, surgical site infections remain a major cause of hospital-acquired infections and rates are increasing globally even in hospitals with

most modern facilities and standard protocols of pre-operative preparation and antibiotic prophylaxis.

Report from some Nigeria hospitals have revealed high incidence of SSI. Ohajuru reported an incidence of 21% SSI at Obafemi Awolowo University Teaching Hospital Complex [6]. Oni *et al.* revealed 9.4% incidence of SSI in University College Hospital, Ibadan [7]. Reports of SSI incidence in Aminu Kano Teaching Hospital Kano revealed 9.1% following caesarean section [8].

Surgical site infections have a significant effect on quality life for the patient. They are associated with considerable morbidity and extended hospital stay. In addition, surgical site infections result in a considerable financial burden to heath care providers.

Since the incidence level is on the increase, it has become necessary to establish prognosticators of SSI at General Hospital Funtua, Katsina State, Nigeria. This established the bases for this study.

Material and methods

Research design

This was a descriptive cross-sectional study involving all subjects who have undergone major surgery in surgical wards within the period of study at General Hospital Funtua Kastina state.

Research setting

General Hospital Funtua of Katsina state is in the North-West part of geopolitical zone of Nigeria. The hospital was established in 1975 with an average bed capacity of one hundred and twenty (186) as a secondary centre for healthcare delivery. The hospital has 8 wards each of which has a surgical unit. The hospital has about one hundred and seventy nurses (84) with an average of about four hundred and twenty surgical patients outflow annually. The hospital has two operating theatres and various surgeries are performed to include appendectomy, prostatectomy, herniotomy, caesarean section, hysterectomy, myomectomy, laparotomy, excision biopsy among others.

Target population

This involves all subjects (children and adult: male and female) undergoing major surgery in General Hospital Funtua

Sampling techniques and sample size

A non- probability purposive sampling method was used to select subjects that have undergone major surgery during the study period. A total of 127 respondents were used for the study.

Ethical consideration

Ethical consent was obtained from the ethical review board of the hospital and informed consent was obtained from each subject or subjects care giver before being enrolled in to the study.

Instrument for data collection

A questionnaire was developed using the CDC/WHO Criteria for determining SSIs. The instrument was tested for validity and reliability through pilot study. Also two full-time nurses' assistants were trained on the use of the instrument The questionnaire was used to obtain prognosticator variables such as patient demographic characteristics, pre-operative, Intra-operative and post-operative data such as type of surgery, wound class, type and duration of operation, antimicrobial prophylaxis, use of drain, preoperative hospital stay and admission until time of discharge.

Data collection and laboratory procedures

The questionnaire was developed using the CDC/WHO criteria for determining SSIs which was used to obtain prognosticator variables such as patient demographic characteristics, pre-operative, Intra operative and post-operative data such as type of surgery, wound class, type and duration of operation, antimicrobial prophylaxis, use of drain, preoperative hospital stay and admission until time of discharge.

Surgical wounds are inspected after 48 hours post-operatively and at the time of first dressing (5^{th} day postoperatively), and wound swabs were collected from a clinically infected wound for bacteriological examination. Superficial surgical site infection was diagnosed; if any one of the following was fulfilled: purulent drainage from the superficial incision, organisms isolated from an aseptically obtained culture of fluid, at least one of the following signs and symptoms of infection: pain or tenderness, localized swelling, redness or heat.

Deep surgical site infection is diagnosed; if any one of the following criteria was fulfilled in addition to culture positivity: purulent drainage from the deep incision but from the organ/space component of the surgical site, a deep incision spontaneously dehisced. The subject must have at least one of the following signs or symptoms: fever (> 38°), or localized pain or tenderness.

Swabs of the clinically infected wounds detected in a population of studied patients were taken and cultured for aerobic bacteria. The sample specimen were inoculated on blood agar, chocolate and mac Conkey agar and incubated at 37°C, while the choc was incubated in a Candle jar for 24 hours, a gram stained smear was examined under microscope using ×100

Objective lens with immersion oil. The colonial morphologies of the organism grown were recorded. A presumptive identification of all isolates were made base on morphology, hemolysis, pigments as well as primary and secondary gram stain appearance (Cowan, 1974). A culture-negative finding does not meet this criterion.

Data analysis

Data were entered into a computer using SPSS software version 16 and analysed using STATA software 12 according to the objectives of the study. χ^2 was used to determine for the significance associations between the prognosticator and outcome variables to all categorical variables and odds ratios were calculated to test for the strength of association between predictor variables. In each variable reference variable was labelled as 1 in case of pre-morbidity each variable was compared to all others. Significance was defined as a *p*-value of < 0.05. In addition univariate analysis and multivariate logistic regression analysis was performed.

Results

As reflected on Table 1, the age of the subjects ranged from 11 years to 65 years with mean age of 38 years. Over 39% were in the age group (11-20), over 77% of the subjects were females and 74.8% were married. On the educational level, 59.8% hold senior secondary while 14.96% hold no formal education. In the area of occupation, 59.8% were not working while only 5.51% were professionals.

The Table 2 revealed subjects' factor associated with SSI. It was shown that 28 subjects had surgical site infection and 99 did not. Over 28% of surgical site infection rate was between the age group of 21-30 years, odd ratio (2.34). More than 33% of surgical site infection rate was at the age > 40 years, odd ratio (1.9) and the least surgical site infection rate observed was in the age group between 11-20 years,

The table indicated that majority of the subjects with SSI were female, 20 (71.4%) with odd ratio 0.6. and male subjects were 8(28.6%), with odd ratio 1.4 which shows female preponderance.

Regarding body mass index 15 (53.6%) of subjects were 20-24 with odd ratio 1. 9 while (32.2%) were between 25-29.

The findings according to table 3 further shows that subjects distribution based on co-existing illnesses were fever 4 (14.3%) with odd ratio 3.96, high blood pressure 3 (10.7%) with odd ratio of zero. It was revealed that 20 (71.4%) did not have co-existing illness.

It was also revealed that total subjects with pre-morbidity of surgical site infection were 8 (28.6%) with odd ratio 2.9 and those subjects without pre-morbidity were 20 (71.4%) as shown by the Table 2.

The Table 3 revealed preoperative factors associated with surgical site infections indicating a total of 28 subjects with surgical site infection and 99 subjects without surgical site infections. 18 (64.3%) subjects with SSI had pre-operative stay of ≤ 7 days, 2 (7.1%), subjects with SSI had pre-operative stay of ≥ 7 days with odd ratio 6.8, while 8 (28.6%) subjects had emergency surgeries with odd ratio 1.6.

Over 85% of subjects with surgical site infection had preoperative shaving in the morning of the surgery with odd ratio 0.53. While 10% of subjects spent a day before surgery with odd ratio 1.6 and others are seen in the Table.

Table 1. Socio-demographic data

Frequency distribution of respondents by demographic characteristics		
Variable	**Frequency**	**Percent**
Age (grouped)		
11-20	50	39.40
21-30	35	27.60
31-40	24	18.90
>40	18	14.20
Total	127	100.0
Sex		
Male	29	22.80
Female	98	77.20
Total	127	100.0
Marital Status:		
Single	32	25.20
Married	95	74.80
Total	127	100.0
Highest Education Level:		
No Education	19	14.96
Primary	17	13.38
Junior Secondary	12	9.45
Senior Secondary	76	59.84
Higher Education	3	2.37
Total	127	100.0
Patients' Occupation:		
Not working	76	59.84
Unskilled manual	7	5.51
Skilled manual	4	3.16
Services	12	9.45
Sales	14	11.02
Clerical	7	5.51
Professionals	7	5.51
Total	127	100.0

Table 2. Subjects' factors associated with surgical site infection (SSI)

Variable	SSI					
	Yes, *n* (%) *n* = 28	No, *n* (%) *n* = 99	*P*-value	Odds ratio	95% CI	SSI_{Rate}(%)
Age (in years)						
11-20	7 (25.0%)	43 (43.4%)	0.678	0.4	0.008-22.005	14.0
21-30	10 (35.7%)	25 (25.3%)	0.907	2.45	0.017-101.110	28.6
31-40	5 (17.9%)	19 (19.2%)	0.911	0.5	0.018-36.472	20.8
> 40	6 (21.4%)	12 (12.1%)	–	1.9	–	33.3
Sex						
Male	8 (28.6%)	21 (21.2)	0.991	1.4	–	27.6
Female	20 (71.4%)	78 (78.8%)	–	0.6	–	20.4
BMI						
< 20	3 (10.7%)	16 (16.2%)	–	0.8	–	15.8
20-24	15 (53.6%)	64 (64.6%)	–	1.2	–	19.0
25-29	9 (32.1%)	17 (17.2%)	–	0	–	34.6
30-34	0 (0.0%)	2 (2.0%)	–	0	–	0.0
> 34	1 (3.6%)	0	–	0	–	100.0
Co-existing illnesses						
Diabetes	0 (0.0%)	1 (1.0%)	0.998	0	–	0
HIV	1 (3.6%)	0 (0.0%)	0.999	0	–	100
Hypertension	3 (10.7%)	7 (7.1%)	0.852	0	0.026-20.675	30
Fever	4 (14.3%)	4 (4.0%)	0.998	3.96	–	50
No illnesses	20 (71.4%)	87 (87.9%)	–	0	–	18.7
Pre-morbidity						
Absent	20 (71.4%)	87	0.3	0.040	1.048-8.027	18.7
Present	8 (28.6%)	12	2.9	–	–	–

Over 96% of subjects had a combination of all the antisepsis used for skin preparation during surgery, while 3.6% had iodine only. More so, over 96% of subjects had their surgeries hand scrub by the surgical team for < 2 minutes with odd ratio 34, while 3.6% for ≥ 5 minutes

Majority of subjects over 92% had their surgeries with an autoclaved instruments while 7.1% with high level disinfectant odd ratio 2.4.

The Table 4 above revealed intra operative factors associated with surgical site infection, indicating a total of 28 subjects with SSI and 99 subjects without SSI. About 75% of subjects had emergency surgeries while 25% had elective surgeries.

Over 85% of subjects who had SSI did not have surgical drain while 14.3% had surgical drain *in situ*.

Majority of the subjects (89.3%) had their surgeries which lasted for < 1 hour while 10.7% lasted for between 1-2 hours. Over 96% of subjects had their surgeries in a moderately operating theatre with odd ratio 34 while 3.6% in a ventilated room.

Most of the subjects 82% had clean surgeries, 10.7% clean contaminated and 7.1% contaminated with odd ratio 7.5.

Discussion

The major prognosticators in this study are 1) use of disinfectants for sterilization and 2) subjects pre morbidity. Some studies have identified pre morbid conditions as significant prognosticators [9-11]. Findings on group surgeries reported postoperative remote infection, maternal preoperative conditions and increased in surgical blood lost as prognosticators for SSIs [12], while advanced age and body mass index were also re-

Table 3. Pre-operative factors associated with surgical site infection

Variable	Surgical Site Infection (SSI)					
	Yes, *n* (%) *n* = 28	No, *n* (%) *n* = 99	*P*-value	Odds ratio	95% CI	SSI_{Rate}(%)
Pre-operative Stay						
Emergency	8 (28.6%)	18 (18.2%)	0.246	1.6	0.018-2.280	30.8
≤ 7 days	18 (64.3%)	80 (80.1%)	0.081	0.15	0.10-1.309	–
> 7 days	2 (7.1%)	1 (1.0%)	–	6.8	–	66.7
Pre-operative shaving						
No shaving	1 (3.6%)	0 (0.0%)	–	0	–	100.0
Morning of surgery	24 (85.7%)	91 (91.9%)	1.000	0.53	–	20.9
Day before surgery	3 (10.7%)	7 (7.1%)	0.998	1.6	–	30.0
Night of surgery	0 (0.0%)	1 (1.0%)	–	0	–	0
Use of skin antisepsis						
Iodine only	1 (3.6%)	3 (3.0%)	1.000	1.18	–	25.0
Methylated spirit	0 (0.0%)	1 (1.0%)	0.996	0	–	0
Combination of all	27 (96.4%)	95 (96.0%)	–	1.12	–	22.1
Hand scrubbing						
< 2minutes	27 (96.4%)	97 (98.0%)	0.997	34	–	21.8
≥ 5 minutes	1 (3.6%)	2 (2.0)	–	0	–	33.3
Pre-operative transfusion						
Yes	19 (67.9%)	74 (74.7%)	0.406	0.7	0.267-1.707	20.4
No	9 (32.1%)	25 (25.3%)	–	1.4	–	26.5
Sterilization techniques						
Auto claving	26 (92.9%)	95 (96.0)	0.000	0.5	4.80E-2.00E	21.5
High level disinfection	2 (7.1%)	3 (3.0%)	–	2.4	8.51E-8.5E	40.0
Use of cidex	0	1 (1.01%)	–	0	–	0.0

ported as prognosticators for post discharge SSIs [13] and post-operative transfusion, current smoking and use of anti-platelet drugs were equally associated with SSIs [14]. The cited findings can be linked to the SSIs prognosticators in both in-patients and post discharge patients, unlike the present study which was limited to the in-patients only.

The study findings regarding factors that are highly inclined to SSI development, includes number of potential risk factors for postoperative surgical site infection to include patients related, surgery related and physiological factors that heighten the risk for SSIs. Prolong pre-operative duration of hospitalization with exposure to hospital environment has been reported to increase the rate of surgical site infection [2]. In this study a hospitalization of more than > 7 days before surgery with exposure to hospital environment increased the risk of SSI by 7 fold, OR (6.8).This is consistent with the reports of a previous studies conducted in North-western Tanzania which revealed a hospitalization of subjects for more than 7 days before surgery increased the risk of SSI by 2 fold [2]. This is usually subject dependents and pre-operative preparations.

The study also found that subjects with pre morbid history (fever) increased the risk of SSI by 4 fold, OR (3.9) and by 3 fold with co-existing illnesses, OR (2.9). This is due to the fact that these subjects are at high risk of developing SSI due to their low immunity, and alteration in thermoregulation increases blood loss and then need for transfusion during surgery. In vitro studies suggest that perioperative hypothermia may aggravate surgical bleeding by impairing the function of platelet and the activity of clotting factors [15]. So also the study found that surgical hand scrub for < 2 minutes increased the risk of SSI by 34 fold, OR (34). This is in agreement with the previous studies [16]. This could be explained by the fact that more than 70% of *Staphylococcus* dwells on the skin surface of the hand, therefore inappropriate hand washing may not get rid of the microbes. Surgical wound classification has long been established as an important predictor of the postoperative surgical site infections [5]. In this study as in previous studies the risk of SSI was statistically higher in contaminated wounds than in clean wound. The study revealed that clean contaminated surgeries increased SSI risk by 5 fold, OR (5) and by 8 fold OR (7.5) in a contaminated surgeries. This finding is consistent with the

Table 4. Intra operative factors associated with surgical site infection

Variable	Surgical Site Infection (SSI)					
	Yes, *n* (%) *n* = 28	No, *n* (%) *n* = 99	*P*-value	Odds ratio	95% CI	SSI_{Rate}(%)
Type of surgery						
Elective	7 (25.0%)	19 (19.2%)	0.991	1	–	26.9
Emergency	21 (75.0%)	80 (80.8%)	–	0	–	20.8
Use of surgical drain						
Yes	4 (14.3%)	7 (7.1%)	0.129	2.19	0.422-891.319	36.4
No	24 (85.7%)	92 (92.9%)	–	0.4	–	20.7
Duration of surgery						
0-1 hour	25 (89.3%)	92 (92.9%)	–	0.63	3.4-3.423	21.4
1-2 hours	3 (10.7%)	7 (7.1%)	–	1.5	–	30.0
Operating room ventilation						
Well ventilated	1 (3.6%)	4 (4.0%)	0.998	0	–	20.0
Moderately ventilated	27 (96.4%)	95 (96.0%)	–	34	–	22.1
Wound classification						
Clean	23 (82.1%)	96 (97.0%)	0.086	0.144	0.010-1.358	19.3
Clean contaminated	3 (10.7%)	2 (2.0%)	0.787	5.82	0.032-13.537	60.0
Contaminated	2 (7.1%)	1 (1.0%)	–	7.5	–	66.7

reports of other previous study [17] who obtained 4.2% in refined clean wound, 4.6% in clean wound, 6.0% in contaminated wound and 10% in a dirty wound. This could be explained by the fact that bacterial contaminations are already evidenced in the contaminated wounds. The study also found that surgeries done in a moderately ventilated operating room increased the risk of SSI by 34 fold, OR (34). This could be explained by the facts that in adequate ventilations increase bacterial viability and virulence. In addition the use of surgical drain has been reported to be associated with an increased risk of SSI which was confirmed in this study.

The study further revealed that subjects who had surgical drain in situ were two times more likely at risk to developing SSI, OR (2) compared to those without surgical drain. This finding is in agreement with the results of the previous study [2]. This is not counter intuitive because of favourability for bacterial growth at the surgical wound site.

The study discovered that there were no significant differences in the rate of SSI between subjects who had perioperative transfusions and those who did not. This finding is contrary to the previous reports [16]. There is a theoretical assertion that blood transfusion may increase susceptibility to surgical wound infections by impairing immune function. This was not confirmed in this study. The study revealed that there was no significant differences in the rate of SSI between subjects who had iodine only for the skin preparation, OR [1] and those who had a combination of all the antiseptics. This finding is contrary to the previous studies which observed that the use of povidone alone was found to be associated with higher SSI by 14 times than when use in combination with either cholorhexidine or alcohol related solutions [2]. Povidone iodine has a shorter activity than cholorhexidine and is inactivated by blood and serum protein. This could be explained by the fact that various antiseptics have more strength to oxidative killing of bacteria. Though, there is a theoretical association of age, sex, and body mass index, on the development of SSI [18] but this was not confirmed in this study. As described in the literature cigarette smoking has been reported to have an impact on wound healing through impairment of tissue oxygenation and local hypoxia via vasoconstriction and cigarette decreases oxygen in tissue for nearly an hour after each cigarette and this alters thermoregulation producing further oxygen reduction [2, 19] this was not equally confirmed in this study due to lack of a referenced group. Increased in length of surgical procedure > 2 hours theoretically increases the susceptibility of the wound by increasing bacterial exposure and the extent of tissue trauma (more extensive surgical procedure) and decreasing the tissue level of the prophylactic antibiotic but however

the present study did not involve surgical procedure of > 2 hours, hence there wasn't enough evidence to confirmed it in this study.

Conclusions

This study concluded that prognosticator of SSI are associated with modifiable risk factors that surgeons, nursing staff and hospital management can deal with in a greater details.

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