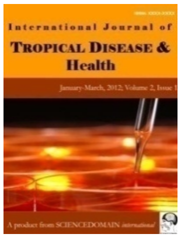

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Rates and Risk Factors Associated with Surgical Site Infections in a Tertiary Care Center in South-Western Nigeria

O. E. Amoran[1*], A. O. Sogebi[2] and O. M. Fatugase[3]

[1]Department of Community Medicine and Primary Care, Nigeria.
[2]Department of Ear, Nose and Throat, Nigeria.
[3]Department of Anaesthesia, College of Health Sciences, Olabisi Onabanjo University, Teaching Hospital, Sagamu, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author AOS participated in the study design and conducted data collection. Author OEA conceived the study theme, participated in the study design, supervised data collection and prepared the final manuscript. Author OMF was involved in Data collection and analysis. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

Background: Surgical site infections [SSI] are one of the most common nosocomial infections. This study was therefore carried out to determine the incidence and risk factors associated with surgical site infection among patients in a tertiary care center in Western Nigeria.
Methods: The study was a 6 months Retrospective cohort study which reviewed case files obtained from the surgical departments. The study was carried out between 23rd January 2012 and 3rd february 2012 at Olabisi Onabanjo University Teaching Hospital, Sagamu, Nigeria.
Result: A total of 386 surgical patients were recruited into the study. The overall incidence rate of SSI was 13.0%. The children had the highest infection rate of 22.9%. Factors associated with SSI were Pre-existing Medical Condition [X2=70.76, p=0.00001] Department of Care [X2=11.68, p=0.039] and age[X2=9.50, p=0.05]. There was no statistically significant difference in the SSI rate among the respondents due to Sex

**Corresponding author: Email: drfamoran@yahoo.com;*

[X2=1.74, p=0.187], Operation site [X2=9.01, p=0.109] and Occupation [X2=5.84, p=0.12]. Forty-nine (98.0%) out of the 50 clinical surgical site infections were culture-positive and 20 (40.0%) of them had polymicrobial infection. The most frequently isolated bacteria were *Staphyloccocus aureus*, 16 [32.7%] and *E. Coli* 17 [34.7]. Pre-existing medical condition [OR=0.46, C.I=0.36-0.59] and length of post operative stay in the hospital [OR=0.33, C.I=0.21-0.50] were predictors of risk of surgical site infection.

Conclusion: The study suggests that pre-existing medical condition and length of post operative stay in the hospital were predictors of risk of surgical site infection. This suggest that home based care of surgical wounds in patients that are ambulatory should be encouraged.

Keywords: Surgical site infection; rates; risk factors; surgical wards; Nigeria.

1. INTRODUCTION

Nosocomial infections are hospital-acquired infections that develop within a hospital or are acquired within a hospital. The most common type of nosocomial infection is urinary tract infection, followed by pneumonia, surgical site infections, and *Clostridium difficile*–associated diarrhoea [1-3]. Surgical site Infection is a type of healthcare-associated infection in which a wound infection occurs after an invasive (surgical) procedure. The US Centers for Disease Control (CDC) definition states that only infections occurring within 30 days of surgery (or within a year in the case of implants) should be classified as SSIs.

SSIs are among the most common hospital acquired infections comprising 14–16 percent of inpatient infections [4-5]. A survey sponsored by World Health Organization demonstrated a prevalence of nosocomial infections varying from 3-21% with Surgical site Infections accounting for 5-34% [6]. Several studies have reported community based data from national registries for nososocomial infections [7-8] and the incidence rates of SSI in patients from developed countries [9-11]. The incidence of hospital acquired infections related to surgical wound is as high as 10% and cost the National Health Service in the UK alone approximately 1 billion pounds [6,12]. In the United States alone, these infections number approximately 500,000 per year, among an estimated 27 million surgical procedures, and account for approximately one quarter of the estimated 2 million nosocomial infections in the United States each year [7,13].

The incidence of SSI in African countries is higher than those in developed countries. In an Algerian study, the cumulative incidence of surgical site infection was reported to be 11.9% in 2001 [14]. In another Tanzanian study, 19.4% of patients developed surgical site infections after surgery [15], In a Ugandan study, the overall cumulative incidence of surgical site infection was 10% among surgical patients in general and 9.4% among women who underwent caesarean section [16]. In Nigeria, the cumulative incidence was 23.6 per 100 operations [17].

Postoperative nosocomial infections (NIs) are the single most common class of complication that can reach excessive levels while attracting very little attention. Many health care providers and organizations such as the US Centers for Disease Control and Prevention (CDC), the Joint Commission on Accreditation of Healthcare Organizations and the Surgical Infection Society, consider that periodic audits of postoperative NIs should be mandatory because surveys of this nature decrease infection rates by raising awareness of the issue [7]. Unfortunately, economic constraints make it difficult to perform such studies. SSIs have a significant effect on quality of life for the patient and are associated with considerable morbidity and extended hospital stay resulting in a considerable financial burden to healthcare seekers.

Periodic studies to determine the risk of SSI should frequently be embarked upon. Identification of risk factors for surgical site infections should encouraged the development of national recommendations for prevention. However most of the studies have been done on hospital acquired infections generally [18-22] with few of this studies actually focussing on surgical site infection in Africa. This study was therefore carried out to determine the incidence and risk factors associated with surgical site infection among patients in a tertiary care center in Western Nigeria.

2. METHODOLOGY

2.1 Study Population

A systematic chart review was carried out of all surgical interventions performed in the operating room between October 2010 and March 2011, as recorded in the operating room log book. Surgeries not involving an incision (*n* = 25) such as dilatation and curettage and closed reductions were also excluded.

2.2 Study Design

The type of study carried out was a 6 months Retrospective cohort study designed to know the incidence of surgical site infections in the hospital. This reviewed Case files obtained from the departments of Surgery, O&G, ENT and Ophthalmology. This study was carried out between 23rd January 2012 and 3rd February 2012.

2.3 Study Location

The study was conducted in Olabisi Onabanjo University Teaching Hospital, Sagamu and Southwest Nigeria. This 160 bedded hospital is funded by the government of Ogun State, in Southwest Nigeria and it serves as the referral centre for other health facilities in all the Local Government Areas in Remo and Ijebu regions of the State. These regions have a projected population of 1,186,282 people. In addition to providing emergency medical services to women referred from other centres, the hospital also provides outpatient services for Sagamu community and neighbouring towns.

2.4 Data Collection

The following data were collected on standardized pre-coded forms: age, sex, admission, operation and discharge date, presence of an underlying disease, smoking habits, type of operation (elective or emergency), wound class, duration of the operation, number of medical personnel during the operation, whether drainage was performed, duration of drainage, and American Society of Anesthesiologists' (ASA) preoperative assessment score, which categorizes patients into five subgroups according to preoperative physical status. These diagnosis were made by the attending surgeons in the wards.

The CDC standardized surveillance criteria for defining surgical site infections, which involve interpretation of clinical and laboratory findings, were used to detect nosocomial infections.

According to these criteria, a surgical site infection is an infection which occurs within 30 days after the operation if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operation.

The tool used was a Questionnaire designed to extract relevant information from the case-notes obtained via Stratified random sampling method. It was administered and filled in with pertinent information from the case notes by data collectors. The data collectors were medical students rotating through the Community Medicine and primary health care department of the Olabisi Onabanjo University Teaching Hospital during the period of the study and one resident doctor. The record brochure of surgeries carried out at the Hospital theatre between October 2010 and March 2011 were obtained from the medical records department.

2.5 Ethical Approval and Consent

Ethical approval was obtained from the Olabisi Onabanjo Teaching Hospital Ethics Board. Confidentiality on candidate's information was maintained. Permission was also obtained from the Chief Medical Director of the teaching hospital before the commencement of the review of the Case files obtained from the departments of Surgery, O&G, ENT and Ophthalmology which was used for the study.

2.6 Statistical Analysis

Point estimates and 95% confidence intervals (95% CI) for incidence rate of surgical site infections were computed. χ^2 test (for categorical data) and *t* test (for variables with normal distribution) or Mann-Whitney U test (for parametric heterogeneous data) were performed to assess the relation between potential risk factors and outcome of interest. Results were expressed as a percentage or as mean±standard deviation. Univariate analyses of the categorical outcome (development of surgical site infection) and each individual associated factor were conducted. Variables associated with surgical site infection in the univariate analysis were introduced to stepwise forward-Wald multivariate logistic regression analysis, with entry probability of 0.5 and probability of removal of 0.1. The -2 log-likelihood ratio test was used to test the overall significance of the predictive equation. The significance of the variables in the model was assessed by the Wald χ^2 test and confidence intervals. The fit of the model was assessed by the Hosmer-Leme show goodness-of-fit χ^2 test. List-wise deletion was used as conventional method for handling the missing data.

The level of statistical significance was set at $P<0.05$. Analyses were performed using the Statistical Package for Social Sciences, version 15.0 (SPSS Inc, Chicago, IL, USA).

3. RESULTS

3.1 Study population and Patient Characteristics

A total of 386 surgical patients were recruited into the study, 198 [51.3%] were males and 188 [48.7%] were females. 48 [12.4%] of the participants were children, 87 [22.5%] were aged 15-30yrs, 141 [36.5%] were 31-45yrs, 65 [16.8%] were 45-59yrs and 45 [11.7%] were elderly above 60yrs. The mean age of the patients studied was 39.46 ± 7.32. About one-third 140 [36.3%] were self employed, 114 [29.5%] had a white collar job, 88 [22.8%] were unemployed and 44 [11.4%] were students. The body mass index for 20 patients (5.2%) was above 30, indicating obesity. About one-fifth of the patients (75 cases) suffered from accompanying conditions such as diabetes [5.2%], malignancy [3.4%], HIV [5.7%]. The rest [80.6%] were free of accompanying pre-existing medical conditions (Table 1). One hundred and thirty seven [35.5%] were receiving care at the General Surgery department, 85 [22.0%] at Orthopedics department, 74 [19.2%] at Obstetrics and Gynaecology department, 41 [10.6%] at Paediatrics Surgery, 36 [9.3%] at Ophthalmology and 13 [3.4%] at Ear, nose and throat department. The socio-demographic characteristics of the participants are summarized in Table 1.

Table 1. Socio-demographic characteristics and surgical wound infection

Socio-demographic characteristics	Total	Surgical site infection rate	Nil surgical site infection	X^2, p-value
Age				
<15 yrs	48 [12.4]	11 [22.9]	37[11.0]	9.50,0.05
16-30 yrs	87 [22.5]	7 [8.0]	80 [23.8]	
31-44 yrs	141 [36.5]	20 [14.2]	121 [36.0]	
45-59 yrs	65 [16.8]	10 [15.4]	55 [16.4]	
>60	45 [11.7]	2 [4.4]	43 [12.8]	
Total	386 [100.0]	50 [13.0]	336 [100.0]	
Sex				
Male	198 [51.3]	30 [15.2]	168 [50.0]	1.74, 0.187
Female	188 [48.7]	20 [10.4]	168 [50.0]	
Occupation				
White collar job	114 [29.5]	19 [16.7]	95 [28.3]	5.84, 0.12
Self employed	140 [36.3]	14 [10.0]	126[37.5]	
Unemployed	88 [22.8]	8 [9.1]	80 [23.8]	
Students	44 [11.4]	9 [20.5]	35 [10.4]	
Dept of Care				
General surgery	137 [35.5]	18 [13.1]	119 [35.4]	11.68, 0.039
Orthopedics	85 [22.0]	18 [21.2]	67 [19.9]	
Obs/gynae	74 [19.2]	7 [9.5]	67 [19.9]	
Paediatric surgery	41 [10.6]	6 [14.6]	35 [10.4]	
Opthalmology	36 [9.3]	0 [0.0]	36 [10.7]	
Ear, nose & throat	13 [3.4]	1 [7.7]	12 [3.6]	

3.2 Incidence of Wound Infection among Surgical Patients

The overall incidence rate of wound infection among the surgical patients was 13.0%. None of the patients had more than one surgical site infection. The children had the highest infection rate of 22.9% followed by [15.4%] among age 45-59 yrs. This was statistically significant [X2=9.50, p=0.05]. Males [15.2%] had a higher infection rate than [10.6%] females [X2=1.74, p=0.187]. Students [20.5%] had the highest infection rate among the occupational group followed by those with white collar jobs [16.7%]. Those that are self employed [10.0%] and unemployed [9.1%] had the least infection rates. Those with Orthopaedics cases [21.2%] had the highest incidence of wound infection followed by Paediatrics Surgery [14.6%] while Ophthalmology had no case of wound infection. The SSI for Diabetes Mellitus was 25.0%, Obesity [35.0%] HIV/AIDS [45.5%] and Malignancies [61.5%] (Table 2).

Table 2. Surgical characteristics and surgical site infection

	Total	Wound infection rate	Nil surgical site infection	X^2, p-value
Pre-existing medical condition				
Nil	311 [80.6]	20 [6.4]	291 [86.6]	70.76, 0.00001
Diabetes mellitus	20 [5.2]	5 [25.0]	15 [4.5]	
Obesity	20 [5.2]	7 [35.0]	13 [3.9]	
HIV/AIDS	22 [5.7]	10 [45.5]	12 [3.6]	
Malignancy	13 [3.4]	8 [61.5]	5 [1.5]	
Others				
Type of cases				8.71, 0.003
Minor cases	75 [19.4]	2 [2.7]	73 [21.7]	
Major cases	311 [80.6]	48 [97.3]	263 [78.3]	
Operation site				
Head and neck	67 [17.4]	2 [3.0]	65 [19.3]	9.01, 0.109
Thorax	16 [4.1]	3 [18.8]	13 [3.9]	
Upper limb	27 [7.0]	6 [22.2]	21 [6.3]	
Lower limb	63 [16.3]	10 [15.9]	53 [15.8]	
Abdomen	160 [41.5]	22 [13.8]	138 [41.1]	
Pelvis and perineum	53 [13.7]	7 [13.2]	46 [13.7]	
Length of post operative stay in hospital				
< 7 days	75 [19.4]	2 [2.7]	73 [21.7]	47.65, 0.0001
8-14 days	167 [43.3]	11 [6.6]	156 [46.4]	
15-21 days	104 [26.9]	20 [19.2]	84 [25.0]	
>21 days	40 [10.4]	17 [42.5]	23 [6.8]	

Those operated on the Upper limb [22.2%] and thorax [18.8%] had the highest incidence, followed by those operated on Lower Limb [15.9%], Abdomen [13.8%], and Pelvis and Perineum [13.2%]. The Head and Neck [3.0%] had the least infection rate.

3.3 Pathogens

Forty-nine (98.0%) out of the 50 clinical surgical site infections were culture-positive and 20 (40.0%) of them had polymicrobial infection. The most frequently isolated bacteria were *Staphyloccocus aureus*, Organism isolated from the wound biopsy were Staph aereus 16 [32.7%], *E. Coli* 17 [34.7], Proteus *Miraidis Spp*. 7 [14.3] and *Klebsiella* Spp. 9 [18.4%]. It was observed that 84.2% of the patients submitted to clean surgery and 98.7% of the contaminated ones, used prophylactic antibiotics on average. Prophylaxis antibiotics used included Cefrazone [12.0%], Metronidazone [32.0%], Ampiclox [18.0%] Genticin [20.0%] and Ciprofloxacin [18.0%].

3.4 Impact of Surgical Site Infections

The mean length of postoperative stay was significantly longer for patients with surgical site infections than for those without these infections (mean of 18.2 vs 7.5 days; *P*<0.001).

Surgical wound infection rate was statistically significantly associated with Length of post operative stay in the hospital [X2=47.65, p=0.0001].

3.5 Factors Associated with Surgical Site Infection

Factors associated with surgical wound infection were Pre-existing Medical Condition [X2=70.76, p=0.00001] Department of Care [X2=11.68, p=0.039] and age[X2=9.50, p=0.05]. There was no statistically significant difference in the Surgical wound infection rate among the respondents due to Sex [X2=1.74, p=0.187], Operation site [X2=9.01, p=0.109] and Occupation [X2=5.84, p=0.12] as shown in Table 1 below.

In the multiple logistic regression models, two variables were found to be independently associated with Surgical wound infection rate among the patients. These are pre-existing medical condition [OR=0.46, C.I=0.36-0.59] and length of post operative stay in hospital [OR=0.33, C.I=0.21-0.50]. This is as shown in Table 3.

Table 3. Multivariate analysis- predictors of surgical site infection

	Unadjusted OR [95% C.I]	Adjusted OR [95% C.I]
Age		
<15 yrs	2.28 [1.07-4.83]	1.26 [0.89-1.80]
>15 yrs	1.00	1.00
Pre-existing medical condition		
Nil disease	0.10 [0.05-0.2]	0.46 [0.36-0.59]
Had a Chronic Disease	1.00	1.00
Length of post operative stay in hospital		
< 7 days	0.15 [0.04-0.63]	0.33 [0.21-0.50]
> 7 days	1.00	1.00
Dept of care		
General surgery	1.03 [0.55-1.91]	1.27 [0.92-1.76]
Specialty surgery	1.00	1.00

4. DISCUSSION

The incidence rate of surgical site infections found in the present study was 13.0%. The incidence rate in our study was remarkably lower than those reported in previous studies in the country [17] but higher than the incidence rates in patients from developed countries [9-11]. It is however similar to the rates in other African countries [14-16] High rates of contaminated, dirty, and trauma-related wounds in our study might have contributed to the high incidence of surgical site infections. On the other hand, the elevated surgical site infection rates can be explained by the lack of financial resources, outdated equipment, and limited ventilation in the operating theatre, as well as limited application of infection control measures.

The mean length of postoperative stay was significantly longer for patients with surgical site infections than for those without these infections (mean of 18.2 vs 7.5 days; $P<0.001$). This supports the previously published results that an infection following the surgical intervention prolongs the length of hospitalization [23-24]. In the study from the United Republic of Tanzania [15] the mean postoperative hospital stay was 5.4 days for uninfected patients compared with 13 days for those with surgical site infection. A study from Ethiopia [25] reported that a delay in hospital discharge was attributable to surgical site infection in 14.7% of patients. In another Ethiopian study [26] the mean postoperative stay was 19.6 days in patients with surgical site infection compared with 11.3 days in uninfected patients. SSI is a dangerous condition, a heavy burden on the patient and social health system. Potential sources of infection are the patient (especially contamination by alimentary tract bacteria), hospital environment, food, other patients, staff, infected surgical instruments, dressings, and even drugs and injections; and by extension the reduction of hospitalisation duration in post surgical patients. However prolonged hospitalisation alone from extensive surgical clean wound allows patients to be more exposed to these named factors predisposing them to SSIs. Thus post-operation bed stay and SSI may be like two edged sword with one leading to the other. This suggest that home based care of surgical wounds in patients that are ambulatory should be encouraged.

Paediatric age group was found to be statistically significantly associated with surgical site infection in this study. This has been reported by various studies [1-3,27]. This may be due to the fact that children may likely present with dirty and contaminated wounds before surgery and a fall in the body immunological efficiency, causing more extensive SSI. Key measures for achieving basic infection control in health-care settings have been highlighted by WHO and should be strictly implemented in paediatric surgical wards. These include core components for infection prevention and control programmes, strategies for injection and blood transfusion safety, safe medical waste management, standards for sterilization and disinfection, water and sanitation, and occupational health measures. The fact that SSI is not statistically significantly associated with sex, in this study is in agreement with several other reported studies [23-24].

The pre-existing medical conditions varying between HIV/AIDS, Malignancy, Obesity and Diabetes mellitus was significantly associated with SSI. The study did not show any site or organism preference. The literature shows that SSI increases with obesity, one reason being a decrease in blood circulation in fat tissues [27]. HIV/AIDS and other immunosuppression related conditions such as malignancy and diabetes mellitus are associated with lowered immunity to infections and these are strong factors predisposing to SSI [3]. The rate of SSIs was particularly high (45.5%) among HIV positive patients, prevention and control of SSI in HIV patients should be taken serious especially in areas of high HIV endemicity such as in this Nigerian population.

Staphylococcus aureus and gram negative bacteria were the predominant causative agents, as in other studies in a similar setting [28]. Eradication of *Staphylococcus aureus* nasal carriage with mupirocin was found to be effective, this measure reduced the surgical site infections rates in some studies [29]. Currently, the use of prophylactic antibiotics is recommended in contaminated procedures. In clean surgeries it is indicated when prostheses are implanted, or in patients with risk factors (obesity, diabetes, immunosuppression, etc.) and also in cases in which an infection could lead to catastrophic results, such as neurosurgical procedures [22, 30-31]. However, there are controversies about the use of antibiotics in clean surgeries, even with polypropylene prostheses, such as inguinal hernias [32]. The procedures considered dirty or infected deserve therapeutic use, i.e. for an extended period.

It was observed that 84.2% of the patients submitted to clean surgery and 98.7% of the contaminated ones, used prophylactic antibiotics on average for a slightly longer time than recommended in the literature. It is known that the antimicrobials should be used carefully in order to avoid selecting multi-resistant pathogens [30-31]. The agents most commonly involved in the development of infection in the clean procedures are from the patient's normal microflora, generally *S. aureus* and *Coagulase-negative* S, while in the contaminated procedures the infection is generally polymicrobial [33]. The antimiocrobials used in this study were in accordance with the probable microflora of the surgical area involved. The antibiotic should be administered about half an hour to one hour before the incision, so that at the beginning of the procedure it will achieve minimum inhibitory concentration in the tissue. It is unnecessary to use it for a long time, after 24 hours, during the postoperative period, and recent studies show that it does not improve the rates of infection [34]. Although the study was performed at a university hospital, with the active presence of the Hospital Infection Control Committee and Antibiotics Committee, and in-house publication of standards and periodical meetings with the medical services, the rates of infection and the duration of antibiotic use were above the recommended level.

SSI rates were found to be highest in Orthopaedic cases. This may be because of the increase in rate of infection in amputations due to arterial compromise. Studies [31, 33] have reported that host factors such as poor tissue oxygenation increase the risk of infection. O/G and general surgical cases had a relatively high degree of SSIs, considering that most of their cases were clean compared with the other surgical specialties. Ear, nose and throat (ENT) had an SSI rate of 2.0% and Ophthalmology SSI rate of [0.0%]. We can relate this low infection rate to the high degree of oxygen tension in the richly vascular head and neck area [35]. In addition, the mean duration of procedures is short, which minimizes infections.

This study has several major limitations. It was retrospective and based only on data that was available in clinical and public health records. We could not independently verify the accuracy of these records, nor could we collect additional data needed to confirm or refute our findings. This impacts variables such as those measuring the presence of an adverse event. We have no detail information of every patient in this study. However, this is beyond our control. Also because of the difficulty of contacting those who developed SSI, our study could not address some of the other factors leading to this infection. Despite these limitations, we believe that our data provide useful information for the assessment and Identification of risk factors for surgical site infections. This will encouraged the development of national recommendations for prevention of SSI and will also inform policy decision in Nigeria and other low income countries.

5. CONCLUSION

The study suggests that pre-existing medical condition and length of post operative stay in the hospital were predictors of risk of surgical site infection. Reduction of post-operation bed stay may decrease the incidence of SSI. Surgical site infections are a considerable problem in surgical wards in Nigeria, with incidence rates being much higher than in other countries, particularly in clean wounds. This suggest that home based care of surgical wounds in patients that are ambulatory should be encouraged. Identification of risk factors for surgical site infections should encouraged the development of national recommendations for prevention. A monitoring system for surgical wound infections is necessary to suggest preventive and control measures which can result in a lowering of the infection.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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