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Role of premorbid status and wound related factors in surgical site infection in a tertiary hospital in sub-saharan Africa

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Abstract

Background: Surgical site infection (SSI) is the commonest hospital acquired infection in surgical patients globally. It has remained a major cause of morbidity and mortality and a major source of worry to both the patients, doctors, hospitals and the community as a whole.

Aim: To determine the role of premorbid status, wound class and cadre of surgeons on the prevalence rate of surgical site infections.

Materials and methods: This was a cross-sectional study involving 200 randomly recruited surgical patients between April and June 2012 at Nnamdi Azikiwe University Teaching Hospital, Nnewi. Pre-tested, interviewer administered questionnaires and laboratory test results were used to collect data, which were analyzed using Statistical Package for Social Sciences, version 16.

Results: The prevalence of surgical site infection was 15.5% (or 31 of 200) among the participants. Premorbid status, as well as, wound class, of the patients affected the rate of SSI (p=0.007) and (p=0.009), respectively. However, the wound location did not show any significant effect on the prevalence of SSI.

Conclusion: The study found a high prevalence of SSI which was dependent on the class of wound, and premorbid status of the patient.

Keywords: Surgical site infection, wound class, nosocomial infection, premorbid status

Introduction

Background

Surgical site infection (SSI) is the commonest hospital acquired infection in surgical patients globally [1,2]. SSI was previously referred to as surgical wound infection but recently it's been defined as infection occurring within 30 days after a surgical operation (or within one year if an implant is left in place after the procedure) and affecting either the incision or deep tissue at the operation site [2,3]. The infection could either be superficial or deep, incisional, or involving organs or body spaces.

In United States of America, SSI annual incidence is between 2.0% and 5.0% despite the improvement in surgical technique, advances in infection control practices, and a near universal practice of peri-operative antibiotic prophylaxis [4].

SSI rate in Japan is 15.0% of all nosocomial infections [5]. According to WHO, the risk of SSI in developing countries is higher than in equivalent surgical procedures carried out in high-income countries. This is especially so in sub-Saharan Africa [6,7].

SSI rate in Tanzania is 26%, while the incidence for Uganda is 58.5% [8,9].

SSI rate in children undergoing surgery operation in Zaria is 23.6% [10]. Ameh et al., reported SSI rate of 14.3% in clean incisions, 19.3% in clean-contaminated incisions, 27.3% in contaminated incisions, and 60% in dirty incisions. Emergency procedure has a higher rate (25.8%) than elective procedure (20.8%). Poor nursing services and poor hospital hygiene have also been implicated as risk factors in the study [10].

Osifor et al., found SSI rate of 11.8% in neonatal surgical operation in Benin City [11]. Ojiyi et al., working in a tertiary hospital, in southeastern Nigeria found SSI rate of 11.0% among patients who had caesarean section [12].

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The effect of SSI on the patient include discomfort, delay in wound healing, wound dehiscence, gas gangrene and tetanus. Consequently, SSI could lead to prolonged hospitalization, increased economic burden to the patient/family and may impose substantial demand on healthcare resources.

Without medical insurance, dependence on cash payment at point of service by patients may lead to untold hardship to the families of the sick. Hence many families risk selling off or mortgaging family lands in order to settle hospital bills.

It is therefore, important to elucidate some of the factors associated with SSI in our hospitals. This will contribute to the literature and knowledge necessary for a change in the approach to a better surgical management.

Risk factors for SSI may be grouped under the following headings; patient factors, surgeon's factor, environmental factors and non-surveillance in health facilities.

General objective
To determine the association between premorbid status and wound related risk factors on the prevalence rate of surgical site infections in NAUTH, Nnewi.

Specific objectives
Specifically, to determine the effect of premorbid status on SSI; and to identify wound related risk factors associated with SSI in the study population.

Methods
Study location
The study location was Nnamdi Azikiwe University Teaching Hospital, (NAUTH), Nnewi, a tertiary Federal Government owned health institution with various surgical sub-specialties. The hospital has well equipped main theatre with four surgical operating suites, and a dedicated theatre for obstetrics and gynaecologic emergencies. Approximately, 45 surgical procedures were performed weekly or a total of 1,726 in 2012.

Study design
This was a cross sectional study involving patients who were operated upon at NAUTH, Nnewi between April and June 2012.

Study population
The study population was adults aged 18 years and above, who were operated at NAUTH and who were admitted in the surgical wards.

Inclusion criteria
All surgical patients aged 18 years and above whose surgical operation were done at NAUTH, Nnewi within the study period.

Exclusion criteria
Critically ill patients including patients with full blown AIDS and those involved in road traffic accidents. Patients whose surgical operation were not done at NAUTH, Nnewi were excluded from the study.

Sample size determination
This was calculated from the formula $N=Z^2pq/d^2$ [13]. Where N=Desired sample size; Z=Standard normal deviation (1.96. or 95% confidence interval); P=Incidence of SSI in Anambra state by Ojiyi et al=11% [12].

Q=1-P; and d=Degree of accuracy/precision expected=0.05. The sample size was increased to 200 [14].

Sample/data collection
The surgical wards were visited daily for collection of wound swab for the 3 months duration of the study. The nursing staffs of the surgical wards assisted by keeping the researchers informed of the time that the wound dressing would be opened for inspection and changing of wound dressing. Care was exercised in order not to contaminate the wound.

Sampling technique
The researchers obtained daily list of eligible patients for surgical operation to be included in the study from the theatre staff. Numbered ballot papers were assigned to each name on the list and there after, they were packed into a nylon bag. Half of the number of the eligible people were blindly picked from the nylon bag by simple random method and these selected persons were then approached to participate in the study. After thorough explanation, those that consented signed a written consent form, and were enrolled into the study. Surgical wounds were observed on the 3rd post-operative day for infection before change of dressing. The wound was also observed on the 5th and 7th post-operative days before removal of alternate sutures, or whenever there was suspicion or evidence of infection, and finally at discharge.

Aseptic procedures of hand washing, use of sterile gloves and masking was observed by the researcher every time the wound was exposed. Wound swab was collected with sterile swab stick from surgical sites of each enrolled patient. The evidence of SSI include fever, redness, discharge or dehiscence. The specimens were immediately transported to the microbiology laboratory, within 10 minutes of collection. All the patients enrolled into the study were monitored for SSI until discharged from the hospital.

The study instruments include pre-tested questionnaires, weighing scale, and sterile swab sticks.

Process of microscopy, culture and sensitivity
In the microbiology laboratory, the wound swabs were cultured onto chocolate agar and MacConkey agar and incubated aerobically at 37°C for 18-24 hours. It was extended to 48 hours if no bacterial growth was seen within 24 hours.

Morphological measurement
Using a validated weighing scale combined with stadiometer manufactured by Techmel and Techmel USA TT 120, the weight

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was read off to the nearest 0.1kg. The validity of the scale was checked every day before data collection using a known weighted object (10kg). The height was taken with the stadiometer with the patients standing upright looking straight forward, with back straight, heels against the scale, without shoes, cap or scarf. The pointer of the height meter was pressed firmly against the scalp and read off on the meter scale to the nearest 0.5cm. The manufacturer's standing operating procedures were followed.

Data collection
Data was collected using pretested interviewer administered questionnaire on the following items; socio-demographic, pre-morbid status, surgical wound site, surgeon, pre-operative antibiotic used, outcome of wound swab culture, and outcome of the surgical operation.

Definitions and diagnostic criteria
Site of surgical operation
Surgical procedures were categorized into abdominal surgical procedure, head and neck, chest, back and extremities.

Type of operation
The type of surgical operation is referred to as minor or major based on NAUTH, Nnewi surgery categorization. Minor surgical procedures include lumpectomy, lipoma excision, incision and drainage, simple herniorrhaphy and thoracotomy, while major surgical operation include caesarean section, laparotomy, hysterectomy, gastrectomy, myomectomy and complicated herniorrhaphy.

Wound classification [2]
Class1 or Clean*:* An uninfected operative wound in which no inflammation is encountered and no viscus is entered.

Class II or Clean-Contaminated: An operative wound in which the respiratory, alimentary, genital, or urinary tracts are entered under controlled conditions and without unusual contamination.

Class III or Contaminated: Open, fresh, accidental wounds. Surgical procedures with major breaks in sterile technique or gross spillage from the gastrointestinal tract. Class IV or Dirty-Infected*:* Old traumatic wounds with retained devitalized tissue.

Criteria for defining surgical site infections [*2*]
Superficial incisional SSI
Infection occurs within 30 days after the operation and infection involves only skin or subcutaneous tissue of the incision and at least *one* of the following:
1. Purulent drainage, from the superficial incision.
2. Organisms isolated from fluid or tissue from the superficial incision.
3. At least one of the following; pain or tenderness, swell ing, redness, or heat.
4. Diagnosis of superficial incisional SSI.

Deep incisional SSI
Infection occurs within 30 days after the operation if no implant is left in place, or within one year if implant is in place and the infection appears to be related to the operation, or involves deep soft tissues (e.g., fascia and muscle layers) of the incision and at least one of the following:
1. Purulent drainage from the deep incision but not from the organ/space component of the surgical site.
2. A deep incision spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least one of the following signs or symptoms: Fever (>38°C), localized pain or tenderness, unless site is culture-negative.
3. An abscess or other evidence of infection involving the deep incision is found on direct examination, during reoperation, or by histopathology or radiologic examination.
4. Diagnosis of a deep incisional SSI by a surgeon or an attending physician.

Note: Infection that involves both superficial and deep incision sites are reported as deep incisional SSI. An organ/space SSI that drains through the incision is reported as a deep incisional SSI.

Organ/space SSI
Infection occurs within 30 days after the operation if no implant is left in place or within one year if implant is in place and the infection appears to be related to the operation and infection involves any part of the anatomy (e.g., organs or spaces) other than the incision, which was opened or manipulated during an operation and at least one of the following:
1. Purulent drainage from a drain that is placed through a stab wound into the organ/space.
2. Organisms isolated from an aseptically obtained culture of fluid or tissue in the organ/space.
3. An abscess or other evidence of infection involving the organ/space that is found on direct examination, during reoperation, or by histopathology or radiologic examination.
4. Diagnosis of an organ/space SSI by a surgeon or attending physician.

Socio-Economic Classification was done along classification reported in Wikipedia [**15**].

Data analysis
Analysis was done using Statistical Package for the Social Sciences (SPSS) version 16. The level of statistical significance was 5%.

Ethical precepts
Ethical clearance was obtained from the ethical committee of NAUTH. Confidentiality was maintained throughout the study. The patients were informed of their right to withdraw from the study any time they wished to do so without consequences. Patients included in the study were informed

of their BMI and the results of the wound swab culture and sensitivity was voluntarily handed over to the surgical team managing the patients.

Results

The age range of the participants was 18 years to 75 years, Mean±STD of 34.47±11.77 years. Highest proportion of the participants consisted of those younger than 30 years 91 (45.5%), the least were those in the 50-59 age group (5.0%) (**Table 1**).

Females were more in proportion (144, 72%) than males (56, 28%), giving a male-female ratio of 1:2.6.

A higher percentage of the participants (114, 57.0%) had secondary education, while the least had no formal eduction (4, 2.0%).

Table 1. Distribution of socio-demographic characteristics.

	Frequency (n)	Percentage (%)
Age in years		
<30	91	45.5
30-39	67	33.5
40-49	19	9.5
50-59	10	5.0
≥60	13	6.5
Sex		
Male	56	28
Female	144	72
Educational level		
Tertiary	45	22.5
Secondary	114	57.0
Primary	37	18.5
None	4	2.0
Occupational status		
Trading	85	42.5
Student/unemployed	42	21.0
Civil servant	25	12.5
Technicians	22	11.0
Others	14	7.0
Professionals	12	6.0
Socio-economic class		
Higher	23	11.5
Middle	73	36.5
Lower	104	52.0
Marital status		
Married	158	79.0
Single	30	15.0
Widowed	11	5.5
Separated	1	0.5
Body mass index (Kg/m^2)		
Under weight (<18)	1	0.5
Normal (18-25)	42	21.0
Over weight (26-29)	106	53.0
Obesity (30-35)	37	18.5
Morbid obesity (>35)	14	7.0

Traders were more (85, 42.5%), while professionals constituted the least (12, 6.0%). More than half of the participants belong to the lower socioeconomic, while less than one quarter were in the higher socioeconomic class 23 (11.5).

A majority of the participants were married (158, 79.0%), while 15.0% were single. A majority of the participants were overweight, (106, 53.0%), only 21% had normal BMI.

The entire 31 swabs collected and cultured from SSI's yielded growth on culture (see **Table 2**) with *Staphylococcus aureus* being the commonest isolated organism (19 of 31, 61.3%) and *Streptococcus pyogenes* (3, 9.7%) the least.

Approximately, half of the participants had the clean wound (103, 51.5%), while dirty wound was the least (9, 4.5%). Abdominal surgery was the commonest (182, 91.0%) (see **Table 3**). Others surgeries, involving the back, chest and extremities made-up 18, 9.0. A majority of the surgical procedure was classified as major (179, 89.5%).

Most of the surgeries were performed by the senior registrars (144, 72.0%), while consultants did 53, 26.5% of the surgeries.

Table 2. Distribution of preoperative antibiotics and culture yield.

	Frequency (n)	Percentage (%)
Preoperative antibiotics		
Amixyclavulanate+metronidazole	111	55.5
Ceftriaxone+metronidazole	82	41.0
Others	7	3.5
Total	200	100
Culture yields and microscopy		
Staphylococcus aureus	19	61.3
Klebsiella spp	5	16.1
Pseudomonas aeruginosa	4	12.9
Streptococcus pyogenes	3	9.7
Total	31	100

Table 3. Distribution of wound characteristic of participants.

	Frequency (n)	Percentage (%)
Wound class		
Clean	103	51.5
Clean/contaminated	78	39.0
Contaminated	10	5.0
Dirty	9	4.5
Site of surgery (wound)		
Abdomen	182	91.0
Others	18	9.0
Type of surgery		
Major	179	89.5
Minor	21	10.5
Cadre of surgeons		
Consultant	53	26.5
Senior registrar	144	72.0
Registrar	3	1.5

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Only 31 (15.5%) participants developed SSI (and had cultures and sensitivity done), while others (169, 84.5%) did not develop SSI.

A higher proportion of respondents (18, 58.1%), who developed SSI didn't have pre-morbid health problem, while the rest (13, 41.9%) had coexisting ill-health. The association between SSI and pre-morbid status (**Table 4**) was statistically significant (p=0.007).

There was no statistically significant relationship (p>0.05) between the development of SSI and any of the following factors- age, sex, marital status, educational levels, body mass index (BMI), occupation and socioeconomic class of the subjects.

Table 4. Relationship between development of SSI and operation related characteristics.

	Development of SSI			
	Yes (%)	No (%)	X^2	P-value
Types of operation				
Major	31 (16.4)	158 (83.6)	2.135	0.149
Minor	0 (0.0)	11 (100.0)	--	--
Wound class				
Clean	12 (11.7)	91 (88.3)	11.621	0.009
Clean/contaminated	11 (14.1)	67 (85.9)	--	--
Contaminated	4 (40.0)	6 (60.0)	--	--
Dirty	4 (44.4)	5 (55.6)	--	--
Premorbid status of patient				
Yes	13 (20.0)	52 (80.0)	20.979	0.007
No	18 (13.3)	117 (86.7)	--	--
Cadre of surgeons				
Consultant	9 (17.0)	44 (83.0)	0.644	0.725
Senior registrar	22 (15.3)	122 (84.7)	--	--
Registrar	0 (0.0)	3 (100.0)	--	--
Total	31 (15.5)	169 (84.5)	--	--

Discussion

The prevalence of SSI in this was between study and found to be 15.5% with majority 26 of 31 (83.9%) of them developing supperficial incisional SSI, 4 of 31 (12.9%) deep incisional SSI and 1 of 31 (3.2%) organ space SSI.

This prevalence rate appears to be higher than that obtained by Suljagic et al., in Serbia (6.3%), Askarian et al., in Iran (2.4%) and Anderson et al., in USA [4,16,17]. It is however lower than the SSI rate obtained in some African countries by Fehr et al., in Tanzania (22%), and Anguzu et al., in Uganda (58.5%) [8,9]. The prevalence from other parts of Nigeria also showed higher rates of SSI, e.g., 17.3% in Lagos, and 23.6% in Zaria [18,19].

The reason for the high rate of surgical site infection in this study may be due to poor application of aseptic techniques such as inadequate sterilization of surgical operative equipment, inadequate environmental hygiene and lack of running tap water which sometimes may not be available in the hospital. Heavy traffic in the theatre comprising of medical students with unwashed personal theatre wears, may all contribute to the increased rate of SSI.

The lower rate of SSI found in this study compared to rates insome low resource countries such as Uganda and Tanzania may be due to the locationof the study; being in rural or remote community practice with minimal standards of hygiene may be responsible for the difference. The level of infrastructural development and application of acceptable surgical technique may count.

Antimicrobial prophylaxis

It had been severally documented that appropriate use of prophylactic antibiotics pre-operatively lowers the risk of developing SSI [20]. The relationship between SSI and antimicrobial prophylaxis was not significant in this study (p=0.558). The finding in this study does not agree with the study by Duque-Estrada et al., Mawalla et al., and Shah et al., where the relationship was statistically significant [21-23].

The reason for the finding in this study may be due to a very high prevalent use of prophylactic antibiotics. Third generation cephalosporins and metronidazole were used in more than 40% of the patients. Others, obstetrics patients mainly, received Augmentin and metronidazole. The minor surgeries received ciprofloxacin for 5 days.

Parenteral route of administration was commonly used for 3 days in major surgeries after which it was changed to orals to complete 5 days course of prophylactic antibiotics. Although no studies had been done, most surgeons insist on Rocephine and Mesporin and commonly reject unbranded ceftriaxone. There is no uniform drug formulary for antimicrobial prophylaxis. Each surgeon administers antibiotics according to preference or inherent local practice in a center.

The finding in this study showed that most prophylactic antibiotics was commenced after the surgery. Hence, it became obvious that the rationale for prophylactic use of antibiotics was to compensate for inadequacies in surgical techniques, e.g., wound care, infection control and aseptic techniques.

The liberal use of peri-operative antibiotics in this study is of particular concern giving the rising emergence of multidrug resistant organisms.

Wound class and SSI

The likelihood of developing SSI is higher in wounds that are contaminated or dirty. The association between developing SSI and wound class in this study is statistically significant p=0.009. This study shows that 40-44% of patients with contaminated/dirty surgical wound class had SSI. The figures compared favourably with the finding by Ameh et al., in Zaria [10]. Erikson et al., in Tanzania recorded similar findings [24]. This similarity is not surprising and it is biologically plausible, because the offending organisms are already established and proliferating in the site before incision.

Premorbid status and SSI

More than half of the patients who developed SSI had some form of premorbid illness or the other. The association between SSI and premorbid status is statistically significant p=0.007. The patients that had other co-morbid status of sickle cell disease, cancer, anemia, hepatitis, asthma, etc, have the highest rate of SSI.

Diabetes and HIV have severally been documented as a risk factor for surgical site infections [25,26]. The reason for this includes depression of the patient's immunity, thus bacteria colonization of surgical site easily transforms into established infection.

Conclusion

The prevalence of SSI in this study is high (15.5%) with *Staphylococcus aureus* as the commonest implicated pathogen in southeastern Nigeria. The wound-related risk factors associated with SSI were wound class, and premorbid health conditions. Based on this study, the authors make the following recommendations:

1. Optimization of pre-morbid health conditions of patients before elective surgical operation is undertaken.
2. There is need for further research on comparative analysis of patients with premorbidity and control.
3. Improving the surgical techniques, e.g., adequate aseptic techniques, infection control and surgical operating skills.

Limitations of the study

1. Observer bias in identifying SSI. However it is possible that under-reporting and over-reporting on both side will cancel out, leaving the report to be valid.
2. Inability to culture anaerobic organisms could affect the interpretation of type of micro-organism.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Authors' contributions	OJO	GAN	CRO	UA	HNC
Research concept and design	✓	✓	✓	✓	✓
Collection and/or assembly of data	✓	✓	✓	✓	✓
Data analysis and interpretation	✓	✓	--	--	--
Writing the article	✓	✓	✓	✓	✓
Critical revision of the article	✓	✓	--	--	--
Final approval of article	✓	✓	--	--	--
Statistical analysis	✓	✓	--	--	--

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