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Incidence rate of postsurgical wound infection among post operative patient in secondary health facilities

Anyanwu Onwukwe Ethelbert[1*], Bright Ekejiuba Bertrand Nwoke[2], Stanley James Ozims[3]
[1] Department of Public Health, Federal University of Technology Owerri, Nigeria
[2] Department of Animal and Environmental Biology, Imo State University, Owerri, Nigeria
[3] Department of Public Health, Imo State University, Owerri,
Nigeria

Abstract
Postsurgical wound infections are the mostly studied health acquired infection and has been a major concern among healthcare personnel in both developed and developing countries. However, small number of reports on the pattern of postsurgical wound infections has been presented in developing countries such as Nigeria. Hence, this study aimed at isolating and identifying the occurrence of common bacterial isolated in postsurgical wound infection in some secondary health facilities in Imo State. The study included 180 patients with postsurgical wound infections in the general surgery, obstetrics, gynecology, and orthopedic wards from three secondary health facilities namely: General Hospital Okigwe Holy Rosary Hospital Emekuku and General Hospital Awo-mamma randomly selected from the three geopolitical zones of the state. Samples were collected using sterile cotton swabs from patients during the duration of surgical wound dressing before cleaning of the wound with antiseptic solution and identified using different bacteria culture media. Data was collected using structured questionnaire and analyzed using the SPSS software and Microsoft Office Excel 2010. P-value < 0.05 was considered to be statistically significant. A total of 252 aerobic bacteria were isolated from the 180 sampled cases, out of which 160(63.5%) isolates were Gram negative Organisms and were more common than Gram positive bacteria 92(36.5%) of the organisms. Staphylococcus aureus 70(27.8%) was the most isolated organism followed by Pseudomonasa aeruginosa 50(19.8%) and Escherichia coli 42(16.7%).

Keywords: incidence rate, isolating and identifying, postsurgical wound infection, secondary health facilities

Introduction
A wound is a break in the skin and the exposure of subcutaneous tissue (that is the innermost layer of the skin) following a loss of skin integrity, which gives room to a moist, warm, and nutritious environment that is favorable to microbial colonization and proliferation (Bowler *et al*., 2001; Shittu *et al*., 2002) [6, 25]. A wound can be a simple or a severe damage to an organ or a tissue. Wounds bacterial disease are the common hospital acquired infections leading to more than 80% of the mortality (Manikandan and Amsath, 2013) [13]. Wounds contamination have been well known as the most serious problem particularly in the presence of foreign materials that raises the risk of serious infection even with relatively small bacterial infection (Rubin, 2006).
A wound infection is the most common and the most wearisome disorder of wound healing (Nicholas, 1992) [19]. Since beginning of surgery as a treatment modality, postsurgical wound infections have constituted a challenge. Wound infection is most generally defined as discharge of pus from the surgical wound as complication of surgery with the exceptions of anaerobic infections and gas gangrene (Rao and Chakravarthy, 2016) [22]. Thus, any secretion from the surgical wound after 48 hours from which micro-organisms may be cultured means wound infection (Rao and Chakravarthy, 2016) [22]. The development in anti-bacteria agents has resulted to prevention and control of these bacterial infections. The use of antiseptics is seen as a well thought-out approach that offers significant landmark on the path to safe surgery. The breakthrough in anti-microbial agents has also made it easy for surgeries to be carried out in various conditions, which were formerly considered to be impracticable in the era preceding antibiotic period, as a result of the risk of infections (Pea *et al*., 2003) [21].
There are various reasons that have been said that make people seek surgery. This can probably be due to emergency or elective reasons. In healthcare today, the primary concern is the prevention of infection (Seltzer, 2002) [24]. The foremost type of infection among hospitalized patients is surgical site infections (SSIs). The chances of SSIs can be reduced by properly handling of surgical equipment. Also, it is possible to reduce the morbidity and mortality related to SSIs by maintaining the best practice standards.
This study was conducted as part of hospital observation on postsurgical wound infection in some secondary health facilities. It intends to prospectively determine the incidence rate of postsurgical wound infection among post-operative patient in some secondary health facilities in Imo State.

Materials and Methods
The study was conducted from A The study was conducted from August 2019 to January 2020 in august 2019 to January 2020 in three secondary health facilities randomly selected across the geopolitical zones in Imo State. These are: General Hospital Okigwe, Holy Rosary Hospital Emekuku and General Hospital awo-mamma. The selected Secondary health facilities were considered according to the clientele size, level of education of patients, socioeconomic

status of patients and more especially capacity of health personnel. The criteria for patient to be considered as qualified to participate as part of the study population includes: Age (patients off all age group with the exception of neonates), presence of postsurgical wound infection (only patients with surgical site infections after surgical procedures are considered) and consent to participate (patients are to give informed consent to take part in the study). Convenient sampling was used in this study. All the patients with clinical evidence of sepsis were incorporated throughout the study duration and in aggregate, 180 patients were enrolled. Wound samples were collected from patients during the duration of surgical wound dressing before cleaning of wound with antiseptic solution. Collection of swab specimens was carried out aseptically on the first day when patients presented clinical evidence of infection before the cleaning of the wound with antiseptic. Swabs were collected from surgical site without skin commensals contamination using sterile cotton wool and were transferred to the laboratories at once on Amies transport media. Upon arrival in the laboratory, swabs were immediately cultured on blood agar, MarConkey agar, nutrient agar and fresh blood agar plates. Inoculation of specimens waas done on both differential and enrich media (MacConkey and blood agar) and incubated aerobically at 35^{o} C for 24-48 hours. Preliminary identification of bacteria isolates was done using colony characteristics of organisms such as morphology, haemolysis on blood agar, changes in physical appearance of the differential media and enzyme activities of the organisms and Gram staining. Biochemical test were carried out on the colonies from the nutrient agar.

Data was analysed using the SPSS statistical tool and Microsoft Office Excel 2010. Frequency distribution and two way tables will be used to summarize the data and Chi square test be will be used to determine the association between independent and dependent variables, p-value < 0.05 were considered significant.

Presentation of Data

In this section, the data obtained during the six (6) month period between August 2019 and January 2020, which this study was carried out are presented. The study enrolled a total of 180 respondents who were patients that have clinically suspected post-surgical wound infections. The clinical characteristics of patients are shown in Table 1. Most of the participants were males (51.7%) and of statistical age distribution from 12-80.

Table 1: Socio-demographic characteristics of patients

Variable	Number of sample, n (%)
Age (years)	
12-25	20 (11.1)
26-39	25 (13.9)
40-53	47 (26.1)
54-67	50 (27.8)
68-81	38 (21.1)
Gender	
Male	93 (51.7)
Female	87 (48.3)
Educational level	
None	21 (11.7)
Primary	65 (36.1)
Secondary	62 (34.4)
Tertiary	32 (17.8)
Smoking	
Yes	33 (18.3)
No	147 (81.7)
Alcohol	
Yes	65 (36.1)
No	115 (63.9)

Table 2 shows the clinical and procedure characteristics of patients with post-surgical wound infections. Data obtained from surgical department reveals that patients (41.7%) are from the orthopedic and trauma ward were of the majority. On the type of surgery, majority (78%) of patients were from the emergency surgery. Most (25.6%) of the patients have had surgical debridement and external fixation carried out on them.

Table 2: Clinical procedure

Variable	Number, n (%)
Surgical department	
General surgery	60 (33.3)
Obstetrics-Gynecology	45 (25)
Orthopedic	75 (41.7)
Type of incision	
Emergency	128 (78)
Elective	52 (22)
Type of surgery	
Clean	180 (180)
Type of operation	
Surgical Debridement & external Fixation	46 (25.6)
Caesarian section	29 (16.1)
Laparotomy	35 (19.4)
Open reduction & internal fixation	17 (9.4)
Amputation	20 (11.1)
Surgical debridement	13 (7.2)
Others	20 (11.1)

A total of 252 aerobic bacteria were yielded by the 180 cultures that were positive, and with no anaerobic isolates as shown in Table 3. It was observed that 160 (63.5%) of the isolates were gram negative organisms and were more prevalent than gram positive bacteria 92 (36.5%) of the organisms. Results indicated that *Staphylococcus aureus* 70(27.8%), *Pseudomonas aeruginosa* 50(19.8%), and *Escherichia coli* 42(16.7%) were the three most commonly bacteria isolates.

Table 3: Pathogenic bacteria isolates from surgical department

Organism	Number (n)	% Occurrence
Staphylococcus aureus	70	27.8
Pseudomonas aeruginosa	50	19.8
Klebsiella spp	30	11.9
Escherichia coli	42	16.7
Proteus mirabilis	28	11.1
Coagulase Negative Staphylococci	22	8.7
Pseudomonas spp	10	4
Total	252	100

Table 4 shows the results of the common bacteria isolated from different surgical departments. The rate of bacterial isolation was higher in orthopedic surgery (36.5%) in comparison with either obstetric gynecology (34.5%) or general surgery (29%). The table summarizes the common pathogens isolated from different wards of surgical department. It can be seen that *Staphylococcus aureus* 36/92(39.1%) was the most common pathogen isolates in the orthopedic ward followed by *Pseudomonas aeruginosa* 20/92(21.7%) and *Proteus mirabilis* 10/92(10.9.3%) respectively.

In obstetrics-gynecology, *Pseudomonas aeruginosa* 20/87(23.0%), was the most isolated followed by *Staphylococcus aureus* 18/87(20.7%) and *Escherichia coli* 17/87(19.5%).

In the case of pathogen isolated from general surgery, *Escherichia coli* 18/73(24.7%) was the most common followed by *Staphylococcus aureus* 16/73(21.9%), *Klebsiella spp* 10/73 (13.7%) and *Pseudomonas aeruginosa* 10/73(13.7%).

Table 4: Number of bacterial isolates from postsurgical wound infection in different surgical unit

Organisms	General surgery n (%)	Obstetrics-gynecology n (%)	Orthopedic n (%)
Staphylococcus aureus	16(21.9)	18(20.7)	36(39.1)
P. aureginosa	10(13.7)	20(23)	20(21.7)
Klebsiella spp	10(13.7)	13(14.9)	7(7.6)
Escherichia coli	18(24.7)	17(19.5)	7(7.6)
Proteus mirabilis	8(11)	10(11.5)	10(10.9)
CoNS	7(9.6)	9(10.3)	6(6.5)
Pseudomonas spp	4(5.5)	0(0)	6(6.5)
Total	73 (100)	87 (100)	92 (100)

Coagulase Negative Staphylococci = CoNS

Table 5 depicts the number of pathogenic bacteria isolates from various post-surgical wounds with respect to the type of operation carried out in various wards. Most 60/252 (23.8%) of the isolates were from surgical debridement and external fixation (SD&EF) operations. Of these, the most prevalent bacteria was *Staphylococcus aureus* accounting for 21/60(35.0%) of isolates from SD&EF procedures. It can be seen that *P. aureginosa* was the most common organism isolated from post from post caesarean section (CS) wound representing 10/29(34.5%) of isolates. Remarkably, *E. coli* was the most common isolated from post laparotomy accounting for 16/59(27.1%) followed by *P. aureginosa* 15/59(25.4%).

Table 5: Number of pathogenic bacteria isolates with respect to the type of operation

Organisms	SD & EF n (%)	CS n (%)	Lap n (%)	ORIF n (%)	Amp. n (%)	SD n (%)	Others n (%)
S. aureus	21(35)	7(24.1)	7(11.9)	11(36.7)	4(12.5)	10(52.6)	10(43.5)
P. aureginosa	14(23.3)	10(34.5)	15(25.4)	5(16.7)	5(15.6)	0(0)	1(4.3)
Klebsiella spp	5(8.3)	4(13.8)	8(13.6)	3(10)	4(12.5)	4(21.1)	2(8.7)
Escherichia coli	9(15)	2(6.9)	16(27.1)	2(6.7)	5(15.6)	0(0)	8(34.8)
Proteus mirabilis	7(11.7)	3(10.3)	4(6.8)	3(10)	6(18.8)	4(21.1)	1(4.3)
CoNS	2(3.3)	2(6.9)	7(11.9)	5(16.7)	5(15.6)	1(5.3)	0(0)
Pseudomonas spp	2(3.3)	1(3.4)	2(3.4)	1(3.3)	3(9.4)	0(0)	1(4.3)
Total	60(100)	29(100)	59(100)	30(100)	32(100)	19(100)	23(100)

SD & EF = Surgical debridement and external fixation, CS = caesarean section, Lap = Laparotomy, ORIF = Open reduction & internal fixation, Amp. = Amputation, SD = Surgical debridement

Table 6: Statistical analysis one

Surgery department	Number of Organisms n (%)	p-value (Chi test)
Orthopedic (Orth.) Obstetrics-Gynecology (Obs-Gyn.)	92 (36.5) 87 (34.5)	0.006
Orth. General surgery (GS)	92 (36.5) 73 (29)	0.020
Obs-Gyn. General surgery	87 (34.5) 73 (29)	0.295

The statistical analysis in Table 6 shows the results of the Chi test conducted to determine the difference in the occurrence of bacterial isolates in postsurgical wound infections from various surgical units. The test was conducted separately between two surgery departments each respectively. It can be seen that the differences in the incidence rate of postsurgical wound infections in orthopedic and obstetrics-gynecology was statistically significant (p = 0.006), and the same holds for general surgery (p = 0.020). However, between obstetrics-gynecology and general surgery, the difference was not statistically significant (p = 0.295). Therefore, the analysis has shown that statistical significant difference existed only between orthopedics ward and the others.

Table 7: Statistical analysis two

Type of operation	Number of Organisms n (%)	p-value (Chi test)
Surgical debridement and external fixation (SD & EF) Caesarean section (CS)	60 (23.8) 29 (11.5)	0.675
SD & EF Laparotomy (Lap)	60 (23.8) 59 (23.4)	0.036
SD & EF Open reduction & internal fixation (ORIF)	60 (23.8) 30 (11.9)	0.369
SD & EF Amputation (Amp)	60 (23.8) 32 (12.7)	0.104
SD & EF Surgical debridement (SD)	60 (23.8) 19 (7.5)	0.076
SD & EF Others	60 (23.8) 23 (9.1)	0.192

The analysis in Table 7 is to determine whether there is difference in the incidence rate of pathogenic bacteria isolates from the types of operations. The table shows that the difference between surgical debridement and external fixation (SD & EF) and caesarean section (CS) was not statistically significant (p = 0.675) and the same holds between open reduction & internal fixation (ORIF) (p = 0.369) as well as between others (p = 0192). However still using SD & EF as reference type of operation, statistical significant was only observed between (SD & EF) and Laparotomy (Lap) (p = 0.036) and between surgical debridement (SD) (p = 0.076).

Discussion

The increase in trauma and associated financial burden on patients due to postsurgical wound infection has been a major concern to healthcare professionals. Postsurgical infections are said to be one of the undesirable and possibly very severe cases from surgery (Barbara, 2018). The study of common bacterial isolates in postsurgical wound infection in tertiary health facilities in Imo State using appropriate microbiological method has been carried out.

Incidence rate of postsurgical wound infection among post operative patient in some secondary health facilities in Imo State:

This study has shown the predominance of male cases (51.7%) over female cases (48.3%) in which the sex ratio, male:female was 1.1:1 and this result was similar to findings in Mukagendaneza *et al*. (2019) [17], Hubab *et al*. (2018) [11], Rao and Chakravarthy (2016) [22], Negi *et al*. (2015) [18], Kihla *et al*. (2014) [12], Pathak *et al*. (2014) [20] and Bandaru *et al*. (2012) [5] in which male cases were higher compared with female cases. A number of studies have revealed higher rate of infection in males than females in postsurgical wound infection, and this may be as a result of higher exposure in environmental conditions associated with risk factors (Rao and Chakravarthy, 2016) [22]. Higher incidence of postsurgical wound infection was found among patients within the age of f 40-53 years and above. This finding is similar to the reports by Negi *et al*. (2015) [18] in which patients with age > 50 had more surgical site infection rate than patients who were of age ≤ 30, for Bandaru *et al*. (2012) [5], patients of age more than 50 years were found to account for most postsurgical wound infections, and Kihla *et al*. (2012) documented the highest category of cases to be of age >60. Ageing is a crucial factor in the development of postsurgical wound infection since in aged cases there is low healing rate, low immunity, increased catabolic processes and presence of such illness like diabetes, hypertension, and others (Negi *et al*., 2015, Khan *et al*., 2013) [18].

Frequency of pathogenic bacteria isolates from types of surgery done on different cases with postsurgical wound infections:

The outcomes of the current study were based on surgery cases with postsurgical infection cases, out of which, majority (41.7%) consisted of orthopedics patients followed by general surgery cases (33.3%) and obstetrics-gynecology (25%) respectively. This finding is similar to the result given by Mukagendaneza *et al*. (2019) [17] and Manyahi (2012) [14] that reported most of the incidence of surgical site infections (SSIs) in orthopedics. It was also found that the cases with high rate of infections from the type of surgery were predominantly surgical debridement and external fixation, caesarian section and laparotomy. This result was similar to that reported in the studies conducted by Dessie *et al*. (2016) [7] in Ethiopia and Manyahi (2012) [14] in Tanzania.

The study investigated 252 bacterial isolates of postsurgical wound infections so as to determine their types and antimicrobial susceptibility pattern. Finding reveals that Gram negative organisms were predominant isolates (63.5%) in postsurgical wound infections whereas only two gram positive bacteria were isolated (*Staphylococcus aureus* and *CoNS*). It seems that this observation is in line with the studies conducted by Mukagendaneza *et al*. (2019) [17], Mohammed *et al* (2017) and Dessie *et al*. (2016) [7], Gelaw *et al*. (2014) [9], Kihla *et al* (2014) [12], Etok *et al*. (2012) [8] and Garba *et al*. (2012), and Mahyahi (2012) in Rwanda, Ethiopia, Cameroon, Nigeria (Uyo and Zaria), and Tanzania respectively, but in contrast to the report by Sawdekar *et al*. (2015) [23] and Hubab *et al*. (2018) [11] that gram positive bacteria were predominant. Generally, this observation was in consistent with the finding in Gelaw *et al*. (2014) [9] which also isolated *Staphylococcus aureus* and *CoNS* as the two only gram positive bacteria isolates.

The commonest bacterial isolate in this study was *Staphylococcus aureus* (27.8%). The studies by Mohammed *et al*. (2017), Roy *et al*. (2017), Negi *et al*. (2015) [18], Akinkunmi *et al*. (2014) [2], Pathak *et al*. (2014) [20], Wondemagegn *et al*. (2012) [30], Gelaw *et al*. (2014) [9], van Walraven and Musselman (2013) [29], Mohammed *et al*. (2013) [16], Gibbons *et al*. (2011) [10], Mawalla *et al*. (2011) [15], Sonawane *et al*. (2010) [26], Ussiri *et al*. (2005) [28], Andhoga *et al*. (2002) [4], and Shittu (2002) [25] also reported *Staphylococcus aureus* as the most commonest pathogen bacteria isolate of SSIs. However, the studies by Dessie *et al*. (2016) [7] and Mukagendaneza *et al*. (2019) [17] observed *Escherichia coli* and *Klebsiella spp* as the commonest bacterial isolates respectively.

The fact that *Staphylococcus aureus* is an endogenous source of infection may be the cause of its high incidence rate. The post surgery wound infections with this pathogenic organism may also be as a result of contamination from the environment. For example, surgical instrument contamination, which can easily occur when natural skin barrier is disrupted and thereby causing *Staphylococcus aureus*, a common infection organism on surfaces, to easily enter the wounds.

Generally, the profiles of pathogenic bacteria isolates highly associated with postsurgical wound infections in this study were *Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli, Klebsiella spp, and Proteus mirabilis* and this is similar to previous studies in Nigeria by Mohammed *et al*. (2013) [16] and Adegoke *et al*. (2010) [1], in Pakistan by Hubab *et al*. (2018) [11], in India by Negi *et al*. (2015) [18], in Tanzania by Manyahi (2012) [14], in Ethiopia by Dessie *et al*. (2016) [7], Gelaw *et al*. (2014) [9] and Amare *et al*. (2011) [3], in Vietnamese by Thu *et al*. (2006) [27], and in India by Sikka *et al*. (2012).

Considering number of pathogen isolates from postsurgical wound infection in various surgical departments in this study, *Staphylococcus aureus* was the most common organism isolated in the orthopedic ward while, *Pseudomonas aeruginosa* closely followed by *Staphylococcus aureus* and *Escherichia coli* occurs highest in obstetrics-gynecology unit. The present finding seems to be consistent with other studies who reported *Staphylococcus aureus* as the most occurring pathogens isolated in orthopedics ward (Manyahi, 2012; Markovic *et al*., 2009; Maksimovic *et al*., 2008; Bercion *et al*., 2007) [14]. In this study, *Escherichia coli* was observed to be the most pathogenic organism isolated from general surgery department, Manyahi (2012) [14] reported *Escherichia coli*, *Klebsiella spp* and *Pseudomonas aeruginosa* as the three most frequent bacterial isolate in general surgery ward, while Mukagendaneza *et al*. (2019) [17] and Anvikar *et al*. (1999) observed *Klebsiella spp* as the predominant bacterial isolated. These observations seem to imply that the pathogenic isolates of PSIs depend on the place surgeries are carried out and whether there was skin incision or

gastrointestinal tract opening (Mahyahi, 2012). The difference might be as result of "variation in common nosocomial pathogens inhabitant, difference in policy of infection control and preventions between countries and hospitals" (Mukagendaneza *et al*., 2019) [17].

Conclusion

The study has shown that Gram negative bacteria were predominant from postsurgical wound infections, *Staphylococcus aureus* being most common isolate.

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