Surgical Site Infection after Caesarean Section: Epidemiology, Microbiology, Management and Prevention in a Tertiary Health Facility in Niger Delta Region, Nigeria

Abstract

Background: Surgical site infection despite marked advances in surgical techniques and preventive measures continues to contribute substantially to hospital morbidity, financial burden and mortality.

Aims: This study was designed to measure surgical site infection rate following caesarean section, investigate the risk factors and the pattern of the offending microbes. The paucity of SSI data from authors' center influenced the desire to contribute data to cesarean section-related SSI.

Study design: A case control study

Place and Duration of Study: Niger Delta University Teaching Hospital Bayelsa State Nigeria between May 2018 and March 2020

Methodology: Consenting cases of caesarean procedure-related surgical site infection were recruited as study group and the next non-infected caesarean patients as the control group. Descriptive statistics was done with EPI Info and Instat software. Relative risk (RR) determined association of variables and SSI with p-value <.05

Results: Twenty six (9.4%) of the 276 caesarean section cases had surgical site infection. Unbooked status (RR 2.4, p=0.003), BMI$\geq$30mgm^{-2}(RR 2.2, p=0.02), surgery duration > 60 minutes (RR 5.3, p=0.03), interrupted stitch (RR 3.0, P<0.001), prolonged rupture of fetal membranes (p=0.008), chorioamnionitis (RR 2.68, p=0.002), estimated blood loss>1000ml (p=0.02) were significant risk factors for SSI. SSIs had longer postoperative hospital stay median (IQR) 14.5(10-21) vs.6.0 (5-7), P<.001. Obstructed labor (42.3%) indicated most of SSIs after C-section. Wound discharge (37%), fever (23%) and wound dehiscence 17% were the main clinical features of SSI. The most isolated microorganisms were staphylococcus aureus (22.7%), klebsiella species and Escherichia coli 18.2% each, predominantly susceptible to quinolones and gentamycin and resistant to beta-lactam antibiotics.

Conclusions: Surgical site infection after C-section was still common in Nigeria. The factors were multifactorial and largely modifiable.

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Keywords: Caesarean, surgical site, infection, Risk factors, isolate organisms, hospital acquired, antimicrobial sensitivity

1. Introduction

Infection is the invasion and multiplication of disease-causing organism and the reaction of the host system to the organism and its toxins. When this occurs at or near surgical incision within 30 days of an operative procedure or after one year if an implant is placed it is termed surgical-site infection (SSI).[1-2] Surgical site infection accounts substantially for surgical morbidity, human and financial burden and mortality. It is an index of hospital acquired infection (HAI) of health facilities. It complicates generally a range of 0.1-50.4% of surgeries with the lowest among the industrialized and the highest rates in developing countries.[3] Tumor-related and transplant surgeries have the highest SSI. Caesarean section is one of the global leading surgical procedures performed in obstetrics and gynecology practice. Even in the second-tier health facility over a fifth of delivery were through cesarean section.[4] The procedure involves a midline vertical or transverse suprapubic (Pfannenstiel) skin incision on the anterior abdominal wall to access the uterus and mostly lower segment uterine incision to deliver the fetus, placenta and the membranes. Infection of the surgical site following caesarean delivery increases the maternal morbidity, financial burden and risk of mortality in addition to burden to the care providers. The severity of SSI ranges from superficial incisional skin infection(superficial; involving the skin and subcutaneous tissues) through deep incisional(involving the deeper soft tissues of incision; muscle and fascia) to organ-space infections(involving any part of the anatomy other than the incised body layers above; that is, skin, subcutaneous, fascia and muscle).[2,5]

Epidemiologically surgical site infection patients account for about a third of all septic patients. [6-8] Median time-to-onset of SSI is 17.0 days.[9] The SSI contributes substantially to surgical morbidity and mortality, leads to increased duration of postoperative hospital stay, higher rates of hospital readmission, impaired health outcomes and increased hospital costs.[6]

The surgical patients are exposed to a variety of external nosocomial and host endogenous bacteria, viruses, fungi and parasites. Staphylococcus aureus accounts for 15-20% of hospital acquired SSIs; among this group, methicillin resistant S aureus (MRSA) with its associated multiple antibiotic resistance is increasing globally. Other organisms isolated are gram-negative bacilli, coagulase-negative staphylococcus, enterococcus species and Escherichia coli. [10-11]

The wide variation in individual response to infection and outcome from sepsis is function of the genetic factors.[6] It is equally observed that minimizing the surgical stress response can be beneficial to patient outcome. Some modifiable factors associated with postoperative immunosuppression include minimally invasive surgery and avoidance of hemorrhage, blood transfusion and perioperative bacterial contamination.[6] Apart from more severe wound class, emergency procedures, long operations, the use of non-absorbable sutures, foreign bodies, copious use of subcutaneous electro cautery, excessive blood loss and hypothermia, smoking status, increased patient dependence have all been associated with increased risk of surgical site infection.[6] Other risk factors are advanced age, patient frailty, surgery complexity, increased pre-operative hospital stay (>7days significantly increase SSI) and co-morbidities especially diabetes mellitus and increased body mass index.[9] All measures to prevent the risks of SSI should be in place from the surgical staff, surgical room environment and patient's endogenous skin micro flora. To achieve this are preoperative disinfection, skin preparation of both the patient and surgeons, shaving and care of surgical wears.[6] There is good evidence too that delayed administration of prophylactic antibiotics is associated with a significant increase in SSI.[6] Identified risk factors are therefore biological, suggesting that patients who are less fit, who have a greater in-patient hospital exposure time and or are undergoing longer and more complex surgeries are at an increased risk for SSI.[9]

The incidence of SSI following caesarean section and its risk factors were not previously reported in Bayelsa state. The knowledge of SSI risk factors, their identification in preoperative patient allow optimal preventive measures prior, during and postoperatively for the optimal surgical treatment outcome. This study is more relevant now that there is continuous global rise in surgical procedure, comorbidities and caesarean section as one of the leading surgical procedures.[12]

This study is therefore designed to determine the incidence of surgical site infection among caesarean section cases in this center, investigate the prevailing risk factors and the common isolate organisms.

Comment [A3]: Copious word looks out of context

Comment [A4]: Increased patient dependence on what?

Comment [A5]: Incidence cannot be identified by this study design

2. Materials and Methods

2.1 Study setting: This study was conducted in the Obstetrics and Gynecology Department of Niger Delta University Teaching Hospital (NDUTH) domicile in Okolobiri Bayelsa State in Niger Delta Region of Nigeria. The department comprises of four units driven by ten obstetricians/Gynecologists. NDUTH is a tertiary health institution that offers teaching, research and clinical services to the domicile state and the neighboring states. The study setting was fairly well equipped for surgical treatment with adequate water supply, electricity supply, functioning central sterilizing unit.

2.2 Study design: This was a case control study.

2.3 Timeline: This study took place between May 2018 and March 2020.

2.4 Study population: prospectively recruited participants who had SSI and randomly selected next participants without SSI following cesarean section in the center within the study period; case and control respectively.

Comment [A6]: Case control study collects retrospective data

2.5 Eligibility criteria

2.5.1. Inclusion criteria: All the consenting in-patient caesarean cases complicated by SSI and the next non-SSI cases.

2.5.2. Exclusion criteria: All the referred postoperative cases and those that declined consent to participation were excluded from the study. All outpatient cases of SSI were also excluded from the study.

2.6 Ethical approval: The hospital Research and Ethical Committee (REC) gave approval for the study

2.7 Data management: The predictor variables assessed were the sociodemographic characteristic of the participants; age, marital status, parity, social class, booking status. The social classification of the women was based on the educational attainment of the women and the occupation of their husbands. [13] The husband occupation was classified into professional, middle level and unskilled respectively scored 1, 2 and 3 while the education of the women was scored 0, 1 and 2 respectively for tertiary, secondary and primary levels of education. The aggregate of the two scores was the social class. For the purpose of this study the social class I and II was high class, class III middle class while IV and V formed the lower class. The details of the surgical procedure were type of skin incision (midline subumblical/low transverse(Pfannenstiel), type of skin wound closure: subcuticular continuous or interrupted, type of suture to skin: absorbable (chromic/Polyglactin not removed or non-absorbable nylon which alternate stitches were removed on 7^{th} postoperative day and the rest out on the 8^{th} day, size of suture to skin (0 or 2/0), use of antibiotics; perioperative and postoperative antibiotic, indication for surgery, timing; elective or emergent, premature rupture of membranes and duration. The uterus is repaired with chromic or Polyglactin suture while the fascia is repaired with Polyglactin or nylon suture if it is high class wound. The National Research Council in the USA, classified Surgical Wound into clean, clean-contaminated and contaminated or dirty.[1] The risks of infection for clean and clean-contaminated wounds are low at approximately 1–4 and 3–6 per cent respectively while the risks are substantial for contaminated wounds in a range of 4 to 20 per cent.[6] In clean surgical procedures, the gastrointestinal, gynecologic and respiratory tracts are not entered, Staphylococcus aureus from the exogenous environment or the patient's skin flora is the usual cause of infection. In the other categories of surgical procedures; clean-contaminated, contaminated and dirty/infected, the polymicrobial aerobic and anaerobic flora closely resembling the normal endogenous microflora of the surgically entered or resected organ are the most frequently isolated pathogens. Caesarean section wound is clean-contaminated surgical wound class as the gynecologic tract is entered. Pre-operative team had the traditional surgical hand-washing with soap and water. Patient skin was prepared with cetrimide and methylated spirit. The center practice peritoneal non-closure and a combination of a single dose immediate pre-operative or intraoperative intravenous antibiotic (mostly ceftriaxone 1gm or 2gm) and standard regime of prolonged postoperative antibiotic prophylaxis. As part of the postoperative care, the wound is evaluated for infection on the third, fifth postoperative days, on discharge and the two week postnatal visit. The physician determined and classified the surgical site infection (SSI) as by the Center of Disease Control and Prevention (CDC) into incisional SSIs which can be superficial involving skin and subcutaneous tissues only or deep involving the fascia and muscles in addition or organ/space SSIs that affect the rest of the body in addition to the incised body wall layers. Wound dehiscence is partial or total separation of previously approximated wound edges due to a failure of proper wound healing.[12] The clinically diagnosed cases of SSIs had confirmatory laboratory diagnosis with wound swab or tissue specimens sent for microbiological tests for gram staining and microscopy followed by aerobic culturing in blood or MacConkey agar and anaerobic culturing when indicated in chocolate agar and antimicrobial sensitivity testing as necessary. The isolate organisms and their sensitivity pattern were collated into the EPI Info designed spreadsheet among other variables. The data was analyzed with EPI INFO and Instat statistical packages. Comparative statistics to test for association was done using the Fishers exact with statistical significance set at $P<.05$ or 95% Confidence Interval (CI) exclusion of nullity of one. Relative Risk (RR) value >1.0 was a risk factor for SSI while <1.0 was protective and =1.0 has no effect.

2.8. Main outcome measures: The main outcome variables measured were the incidence of SSI, the identifiable risk factors, the isolate organisms and their antimicrobial susceptibility.

Comment [A7]: Antibiotic prophylaxis cannot be prolonged

3. RESULT

Seven hundred and twenty-four deliveries took place at this center in the studied period with 276 by caesarean section, a CS rate of 276/724(38.1%). Among the 276 caesarean section births, 26 had surgical site infection; a CS SSI rate of 9.4%. All the participants were retroviral seronegative and no case of diabetes mellitus in pregnancy recorded in the period.

Comment [A8]: Caesarean section births- appearing that babies had SSI

Table 1 shows the demographic characteristics of the participants. The study and the control groups were comparable in age (P=0.52), parity (p=0.32), marital status (p=0.58), education (p=1.0) and social status (p=0.96). The mean age of the study and control groups was 31.2±5.6 years and 30.3±5.0 years respectively p=0.52. The corresponding values for their parities were 2.2±2.1 and 1.5±1.6, P=0.20 Unmarried participants were 50% more prone to SSI however, the difference was not significant. In the contrary, the unbooked participants were significantly more than twice more likely to suffer SSI (RR 2.4, p=0.003)

Table 1.Demographic Characteristics of the Participants

Variable	Category	Study group n (%)	Control group n (%)	RR,95% CI	P-value
Age(years):	20-24 25-29 30-34 ≥35	4(15.4) 6(23.1) 8(30.8) 8(30.8)	4(12.5) 10(31.3) 13(40.6) 5(15.6)	-	0.52
Parity:	0 1-2 3-4 ≥5	9(34.6 6(23.1 5(19.2 6(23.1	13(40.6 10(31.2 7(21.9 2(6.3	-	0.32
Social class:	Upper Middle lower	5(19.2) 8(30.8) 13(50.0)	7(21.9) 10(31.2) 15(46.9)	-	0.96
Education:	≤Secondary >Secondary	13(50.0) 13(50.0)	17(53.1) 15(46.9)	0.93	1.00
Marital status:	Unmarried Married	2(7.6) 24(92.4)	1(3.1) 31(96.9)	1.5	0.58
Booking Status:	Unbooked Booked	15(57.7) 11(42.3)	6(18.8) 26(81.2)	2.4, 1.4-4.2,	0.003

The mean time to onset of SSI from the date of surgery was 6.8±3.2 days, majority 20 (76.9%) of the diagnoses were made within the first seven postoperative days and ranged 4-20 days. The median time was 6.0(IQR-5-7) days. Approximately three of every five (57.7%) of the cases were superficial incisional SSI and close to two of the five (38.5%) were deep incisional and only one of the cases was beyond the body wall; organ space SSI and burst abdomen.

Table 2: Clinical Features of SSI

Variable	Category	Frequency	Percentage
Time-to Onset of SSI: Before clinical diagnosis	≤7	20	76.9
	>7	6	23.1
	Mean ± SD: Median(IQR)	6.8±3.2 6.0(5-7)	
Wound class	Organ/Space SSI	1	3.8
	Deep incisional SSI	10	38.5
	Superficial incisional SSI	15	57.7

Table 3 shows the risk factors for SSI in the participants. Surgery duration longer than 60 minutes was significantly more than fivefold more likely to be associated with SSI(RR 5.3,p=0.03) and this risk was directly related to the duration of surgery as the risk rose from insignificant level as the duration increased from 46-60 minutes (RR 5.0,p=0.08). Comorbidities; anemia, coexisting uterine fibroids and hypertensive disorder raised SSI risk by 46%, 30% and 19% respectively. However, none of the observed differences was statistically significant. Obesity significantly more than doubled the risk of SSI after cesarean section (p=0.02). Unlike the frequency of the occurrence of PROM that did not significantly affect the risk of SSI following caesarean delivery, the duration significantly influenced the risk (p<0.01). Twenty one (80.8%) of cases had their primary CS while 5(19.2%) have had at least a previous C-section. The results also showed that pregnancy related complication; chorioamnionitis significantly raised the risk of SSI almost threefold (RR 2.7, P<0.01). Preoperative hospitalization did not influence the occurrence of SSI (p=0.56). On the other hand, the study group had significantly longer postoperative hospital stay (16, 6±10 vs.7, 2±7.6, p<0.001). Preoperative intravenous antibiotic given in the labor ward compared with intraoperative was about twice associated with SSI and the observed difference was statistically significant (RR-2.1, p-0.02). Midline subumblical skin incision compared with Pfannenstiel incision was 60% more likely to be associated with SSI, nonetheless the difference was not significant (RR=1.6, p=0.40).Unlike subcuticular skin closure, the interrupted mattress closure was thrice more associated with SSI and this was statistically significant (RR 3.04, p<0.001). The nylon suture to skin increased the risk of SSI by 78% when compared with chromic which was similar to the polyglactin but the observed difference was not significant (p>0.05).The size of the suture to the skin, either 0 or 2/0 had no influence on the occurrence of SSI (p= 1.00).Similarly, the emergency timing of the surgery though had about 90% increased risk of SSI, nonetheless, it was statistically similar to the planned procedures (p=0.28).Though the risk was similar(p=1.00) between the procedures performed by the resident obstetricians, there was a slight 6.0% increased risk in the cases operated by the consultants.

Table 3. Risk Factors of Surgical Site Infection among the Participants N=58

Risk factor/ Variable	Category	Study Group n=26 (%)	Control Group n=32 (%)	RR, 95% Confidence Interval	P-value
Comorbid State:	Anemia	15(57.7)	13(40.8)	1.46	0.29
	Hypertension	10(38.5)	10(31.3)	1.19	0.59
	BMI(kg/m^2) ≥30	19(73.1)	13(40.6)	2.2, 1.1-4.4	0.02
	Coexisting fibroids	4(15.4)	3(9.4)	1.3	.69
Pregnancy complications	Chorioamnionitis	7(26.9)	0	2.68, 1.9-3.8	.002
	PROM	12(46.2)	11(34.4)	1.3	.42

	Duration PROM(Hours): Mean ±SD	38.7±26.5	12.9±12.0	-	0.008
	Median ,IQR	24.1, 19.6-72.0	8.5, 7.6-12		
Preoperative PCV (%)	<30	6	7	1.04	1.0
	Mean ± SD (%)	33.2±4.1	32.8±4.3	-	0.72
Postoperative PCV(%)	<30	15	10	1.8	0.06
	Mean ± SD (%)	27.8±4.9	29.8±4.8		0.13
	Transfused	11	7	1.6	0.15
	Number units transfused	27	18		
Cadre of Surgeon	Consultant Obstetrician	7(26.9)	8(25.)	1.06	1.0
	Trainee Obstetrician	19(73.1)	24(75.0)		
Length of hospitalization Before surgery (Days):	Mean ± SD	1.2±3.7	0.8±1.1	-	0.56
EBL (mls)	>1000	9(34.6)	3(9.4)	2.03, 1.2-3.3	0.02
Surgery duration(minutes)	30-45	1(3.8)	9(28.1)	Ref	
	46-60	7(26.9)	7(21.7)	5.0, 0.72-34.5	0.08
	>60	18(69.2)	16(49.8)	5.3, 0.80-34.9	0.03
	Mean ± SD Median(IQR)	74.3±22.1, 70.5(58-87)	66.1±38.1, 62(44-71)	-	0.33
Surgical details: Indication	CPD/Obstructed labor Abnormal lie/presentation Severe preeclampsia Prev CS Others(BOH,UVP, APH,etc)	11(42.3) 3(11.5) 4(15.4) 8(30.8) 2(7.7)	6(18.8) 6(18.8) 3(9.4) 8(25.0) 9(28.2)	-	0.15
Duration Postoperative Hospital stay(days)	Mean ± SD Median(IQR)	16.6±10.0 14.5(10-21)	7.2±7.6 6.0(5-7)	- -	<.001
Timing preoperative iv antibiotic	In labor ward	9(37.5)	3(10.0)	2.1, 1.2-3.5	0.02
	Intraoperative	15(62.5)	27(90.0)		
Type skin incision	Midline subumblical	4(15.4)	2(6.3)	1.6	0.40
	Pfannenstiel	22(84.6)	30(93.8)		
Type skin closure	Interrupted	16(61.5)	4(12.5)	3.04, 1.7-5.4	<.001
	Subcuticular	10(38.5)	28(87.5)		
Type suture to skin	Nylon	16(61.5)	8(25.0)	1.78	0.22
	Polyglactin (Vicryl)	7(26.9)	19(59.4)	0.72	0.67
	Chromic	3(11.5)	5(15.6)	ref	
Size suture to skin	2/0	21(80.8)	26(81.2)	0.98	1.0
	0	5(19.2)	6(18.8)		

Timing of surgery:	Emergency	24(92.3)	26(81.3)	1.92	0.28
	Elective	2(7.7)	6(18.8)		

Wound discharge (37%) was the most common presenting symptom of SSI in this data. Seventeen of the 24 wound discharges (70.8%) were non-offensive sero-purulent discharge and 7(29.2%) were mal odorous. There was fever in 23% cases making it the second leading symptom (Figure 1). Greenish yellow discoloration of wound dressing occurred in 13% of the cases while wound breakdown/dehiscence occurred in 17% of the cases. It is important to note that some of the patients had more than one of the clinical features at the diagnosis of wound infection.

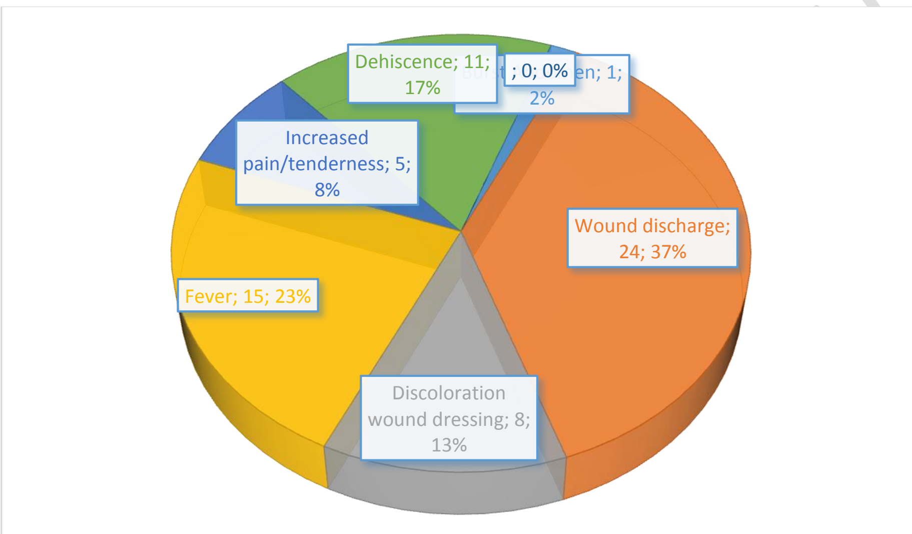

Figure 1: Clinical Presentation of Surgical Site Infection

Figure 2 shows the isolate microorganisms from the surgical sites of the participants. Twenty two 22(84.6%) of the cases had wound culture test while four (15.4%) did not do the test. Among those who had the culture test, Escherichia coli 4(18.2%), klebsiella species 4(18.2%) and staphylococcus aureus 5(22.7%) were the leading isolates. Pseudomonas species, staphylococcus epidermidis, streptococcus species, candida species constituted 4.5% each while the sterile culture was 22.7%. The gram positive to gram negative ratio was 1:1.3

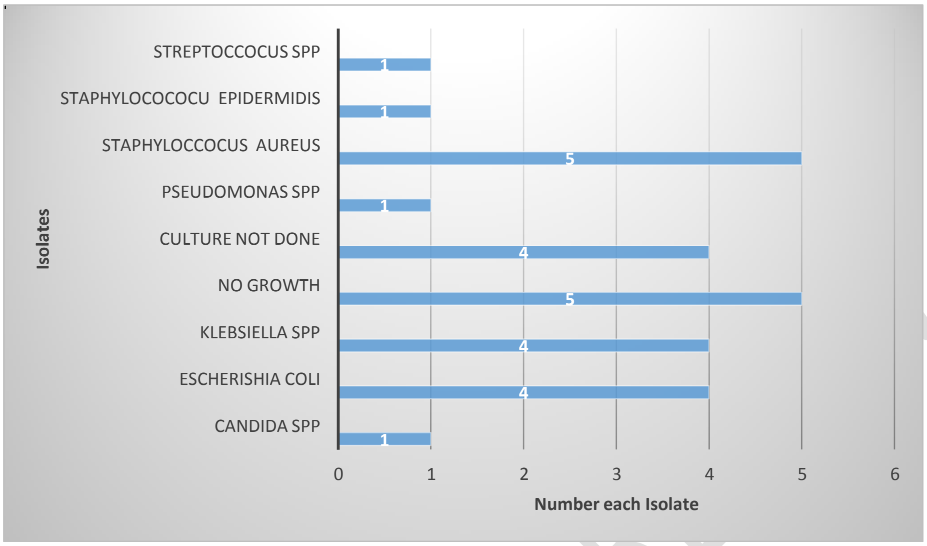

Figure 1: Isolate Microbes from the Participants

Table 4 shows the pattern of the isolate microbes and the antimicrobial sensitivity profile. The isolates showed multidrug resistance. Only imipenem (100.0%), ciprofloxacin (60.0%), ofloxacin (60.0%) and gentamycin (37.5%) were active against the isolates. With the exception of cefuroxime (20.0%) sensitivity, there was over 90% resistance to cephalosporin, amoxicillin-clavulanic acid and erythromycin. The isolated staphylococcus spp was sensitive to ofloxacin (60.0%), gentamycin (20.0%) and imipenem (100.0%) and resistant to all the other tested antibiotics including the third generation cephalosporins .Staph epidermidis was sensitive to only ofloxacin and gentamycin. Half (50.0%) of the E. coli was simultaneously sensitive to ofloxacin, gentamycin and ciprofloxacin. Similarly 75% of the klebsiella species isolates were sensitive to ciprofloxacin, ofloxacin and gentamycin only and resistant to all the other tested antibiotics. The pseudomonas spp was resistant to all the tested antibiotics; third generation cephalosporins, quinolones, amoxicillin-clavulanic acid and gentamycin. Streptococcus spp was sensitive to ciprofloxacin, gentamycin, third generation cephalosporin and amoxicillin-clavulanic acid but resistant to ofloxacin and cefixime.

Comment [A9]: Imipenem +Cilastatin, but not alone

Table 4: Isolate Microbes Antimicrobial Sensitivity Profile

Antimicrobial Agent	Number of Isolate Microorganisms Sensitive(S)						Total Sensitive Isolates (%)
	Escherichia coli	Klebsiella spp	Pseudomonas aerogenosa	Staphylococcus Aureus	Staphyloccus epidermidis	Streptococcus spp	
Number Cases	4	4	1	5	1	1	16
Augmentin	R1,R2,R3	R1,R2,R3,R4	R	R1,R2,R4,R5	R	S	1/14(7.1)
Ceftriaxone	R1,	R1,R2,		R1,R2,R5	R		0/7(0.0)
Ceftazidime	R1,R2,	R1,R3,R4	R	R1,R2,R3	R	S	1/11(9.1
Cefuroxime	R1,S2,	R1,R3,R4	R	R1,R2	R	S	2/10(20.0)
Cefixime	R1,R2,	R3,R4				R	0/5(0.0)

Chloremphenicol	S4						1/1(100.0)
Ciprofloxacin	R1,S2,S3,R4	S2,S3,S4	R	R3		S	6/10(60.0)
Nitrofurantin	-R4	R2	R				0/3(0.0)
Ofloxacin	R1,S2,S3	R1,S2,S3,S4	R	S1,R2,S3,R4, S5	S	R	9/15(60.0)
Gentamycin	R1,S2,S3,R4	R1,S2,S3,R4	R	R1,R2,R3,R4, R5	S	S	6/16(37.5)
Erythromycin	R4	R1		R1,R2,R3,R4	R		0/7(0)
Imipenem	-	S2		S3			2/2(100.0)
Amoxycillin	S4						1/1(100.0)
Cloxacillin	R4			R3			0/2(0.0)
Cefotaxime		R1					0/1(0.0)
Levofloxacin	S4						1/1(100.0)
Rifampicin	R4						0/1(0.0)
Total Sensitive Agents/Tests	7/15 agents	4/12 agents,	0/7	2/10	2/7	5/7	30/107(28.04) tests
	10/28 tests	9/29 tests	-	4/29	2/7	5/7	

R=Resistance, S= Sensitive, Augmentin = amoxicillin-clavulanic acid

All the SSIs had daily or twice daily wound cleaning and dressing with extended postoperative hospital stay ranging 7-48 days and 10-31 days respectively for those that had subcuticular and interrupted mattress skin closure. They also had extended antibiotic use based on the isolate organisms and their sensitivity profile. Twelve (46.2%) of the study group required and had secondary closure of the wound while 11(42.3%) were transfused with at the least two units of blood during the management of SSI. Only 2 (7.7%) of the cases were readmitted for SSI management after being discharged home while 24(92.3%) were diagnosed before discharge.

Table 5: Interventions Given to Participants

Intervention	Frequency	%
Secondary closure	12	46.2
Post-diagnosis blood transfusion	11	42.3
Readmitted	2	7.1
Long hospital stay	23	82.1
Wound cleaning and redressing	All	100

4. Discussions

This case control study was conducted to measure the incidence of caesarean section related surgical site infection, investigate the risk factors and the pattern of the offending microbes and their antimicrobial susceptibility in a tertiary referral health facility in Bayelsa state in South-south Nigeria.

The incidence of surgical site infection following caesarean section from this study was 9.4%. This was comparable to the findings from other studies,[5,14-15] higher than other reports,[7, 16-18] and lower than 11.0% - 15.6% in other reports.[5,19-23] Variation in patients characteristics, institutional theater policies and practices, surgical procedure and study design may account for the wide range of incidences of SSIs across the studies.[3,22] Although there exist some inherent endogenous SSI risk factors in each surgical patient, this high incidence could be attributable to some exogenous factors relating to poor quality preventive measures. The main clinical features were wound discharge (37%), fever (23%) and wound dehiscence 17%. The presence of any of these within 30 days of caesarean section procedure with the involvement of the skin and subcutaneous tissues or deeper; the fascia and anterior abdominal muscles incised or the deeper body parts manipulated during the procedure defines CS-related SSI.[24] This is further confirmed with the isolation of microorganisms from aseptically collected fluid from the site.

We found multifactorial risk factors for our recorded SSIs. These factors operate either preoperative, intraoperative or postoperative. Preoperatively, unbooked status was associated with increased risk of SSI following caesarean section in this study. This corroborates another report.[18] Most of the obstructed labor cases were referred cases with long labor duration, prolonged rupture of fetal membranes and possible multiple unsterilized vaginal examination all associated with increased risk of SSI. The majority (92.3%) of the SSI followed emergency cesarean section and about doubled the risk from the elective procedures .This finding was similar to other reports from other parts of the world.[19-20,25] The risk of SSI was more than doubled following cesarean delivery in obese women. This was consistent with other reports.[15,23] Obesity does not raise the risk of SSI by only posing surgical difficulties due to the anatomic adipose panniculus and the attendant longer surgical duration but together with its increased risk of insulin resistance and baseline blood sugar. In addition, it is associated with vascular insufficiency, altered immune mediators and nutritional deficiencies.[26] Similarly, we report an increased risk of SSI following caesarean section associated with prolonged rupture of fetal membranes corroborating other reports.[15-18,20,23] The rupture of fetal membranes before delivery increases the risk of ascending infection especially the longer the duration. This encourages ascending infection of the uterine contents including chorioamnionitis and the endometrial lining thereby facilitating easy spread to surgical site. Intact fetal membranes prevent infection from the lower genital tract during gestation and its breach results in ascending infection and its multiple adverse feto-maternal effects including SSI if the delivery is by C-section.

Another preoperative operating factor we found was that all the cases complicated by chorioamnionitis were significantly associated with post caesarean SSI. This finding corroborated another report.[5] The offending microbes in chorioamnionitis are easily inoculated in the surgical site as the neonate and other products of conception are evacuated through the caesarean surgical window. In the event of inadequate antibiotic prophylaxis and or prolonged procedure SSI is easily established.

Intraoperative, the duration of the surgical procedure longer than 60 minutes significantly influenced the likelihood of SSI in caesarean section more than fivefold. Long surgery duration as a risk factor for SSI has been reported by other workers.[14-15, 23, 27] The longer the duration of CS procedure the more the tissue desiccation and the exposure to the environmental factors raising the risk of SSI. A linear relationship of the likelihood of SSI and the duration of the surgical procedure as noted in this study has been previously reported by other workers.[27] In the event of the use of immediate preoperative or intraoperative intravenous antibiotic prophylaxis, the reduction of tissue concentration as a procedure prolongs has been postulated as another possible reason for increased risk of SSI in long procedures.[27] This indicates a repeat of intraoperative antibiotic in prolonged procedure that extends beyond the half-life of the used antibiotic. Possible factors that influence the duration of surgical procedure are patient characteristics, preoperative planning, surgeon skill and fatigue, support staff experience and efficiency, access to equipment and intra-operative teaching.[27-28] All these factors are modifiable risk factors for SSI.

Interrupted stitch to skin tripled the risk of SSI following caesarean section consistent with another report in the literature.[20] Unlike in the subcuticular skin closure with only one entry from the external skin surface and one exit puncture across the surgical wound, the interrupted skin closure involves multiple skin –wound-skin punctures with the needle and the suture materials that can increase the risk of inoculation of the microbial agents and SSI. The subsets were similar in preoperative packed cell volume but there was an insignificant reduction in the postoperative values of the cases. Poor hemoglobin concentration means poor tissue perfusion and oxygenation with consequent poor wound healing and impaired resistance to infection.

Decision for skin incision is mostly made intraoperative. Midline subumblical vertical skin incision increased the risk for SSI by 60% though this did not reach the statistically significant level and this was supported by the findings by other workers reporting significant risk of SSI in vertical incision. [5, 20, 29] Unlike the Pfannenstiel transverse suprapubic skin incision through tissues with better blood supply, the midline incision passes through less perfused tissue. It is evident from the literature that caesarean deliveries performed through a transverse skin incision though longer in incision-to-delivery intervals compared to midline vertical skin incision, overall, the median operative time for the transverse incision is shorter by 3 and 4 minutes for primary and repeat cesarean deliveries respectively.[30-31] Secondly the caesarean section performed through midline vertical skin incision was associated with more postpartum transfusion an indication of more blood loss and increased risk for wound breakdown and infection.[30] Postoperative, inadequate replacement of blood loss increases the risk of SSI.
The most frequently isolated microorganisms were staphylococcus spp (22.7%) followed by klebsiella spp and Escherichia coli 18.2% each. Staphylococcus aureus was the most common offending SSI isolate microorganism reported in other parts of Nigeria.[7, 14, 32] The gram positive to gram negative ratio was 1:1.3 In the southwestern part of the country ratios of 1:2.3 and 4:1 were reported.[7] The observed differences can be ascribed to the diversity in the composition of microbe population and antimicrobial policies among centers and regions.[7] Staphylococcus species SSI results from the patients exogenous skin flora, operating team nasal flora, operating theatre environment and surgical instrument contamination. Quality patient skin preparation, surgical environment like positive pressure theatre and instrument sterilization will markedly reduce SSI from this organism. This is the most implicated bacterium in superficial incisional SSI which was the most at 57.7% in this study comparable to another report.[22]

The isolate microbes were multidrug resistant consistent with other reports. [18, 32] There was moderate susceptibility to quinolones and gentamycin and multiple resistance to the beta lactamase inhibitors. The difference in the drug susceptibility across the centers may be a reflection of difference in drug regime. Multidrug resistance as recorded in this study can be ascribed to inadequate and inappropriate use of postoperative antimicrobial agents. The cephalosporins were the most used postoperative antimicrobial agents in this center. Robust antibiotic policy and guideline based on local susceptibility profile will prevent or reduce the multidrug resistance and SSI. This will ensure proper use of the agents thereby positively impacting on the treatment of SSI.

Comment [A10]: Is due to irrational use of antibiotics and not due to post-operative use of AMA

Extended hospital admission and readmission, Cleaning and dressing, more antibiotic therapy, blood transfusion and reoperation to repair the surgical wound were the interventions. As the part of the intervention 42% of the participants required reoperation and 82% had prolonged hospitalization because of the required further management. This corroborated other reports. [14,33] Consequently, there was associated rise in hospital cost from the long hospital stay, more investigations and treatment together with the resultant physical and emotional stress to the victims, their families and more work for care providers and increased hospital consumables and overall medical bill.

Evidence from this data, SSI preventive measures should include proven potent intraoperative intravenous prophylactive antibiotic. It is evident, that the practice of preoperative prophylactic antibiotics at least 5–10 minutes before creating the skin incision to ensure adequate tissue concentration and repeat dose if the duration of the procedure exceeds the half-life of the antimicrobial agent(s) reduced the risk of SSI.[6,34] Corroborating this was the evidence that preoperative antibiotic latest two hours before surgical incision was more protective of SSI than if it were given earlier or later.[35] Short preoperative hospital admission, short duration of surgical procedure, prevention of obstetric complications like prolonged PROM, prolonged obstructed labor, prolonged labor, chorioamnionitis reduced the likelihood of SSI. These have been previously supported. [5,36] Others are the use of transverse suprapubic skin incision and subcuticular skin closure. Most importantly, regular and frequent staff education on prevention of hospital acquired infection and departmental HAI auditing.

This report was from an institution based data that is not generalizable to the general population. A larger sample size will further improve the evidence from this study. The main strength of this study was derived from its prospective data and case control design.

5.Conclusion

Surgical site infection following caesarean section is common. It is associated with multifactorial causes largely modifiable with strict adherence to quality surgical guidelines. We proffer designing, regular review and strict adherence to surgical wound prevention protocol, use of SSI prevention checklist across the various points of interface with the cesarean section patients and regular surgical units auditing of surgical site infection.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial.
Conflict of interest: None declared.

Comment [A11]: Proper

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