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Incidence and risk factors associated with surgical site infection following cesarian section at Kibungo Referral Hospital, Rwanda – A prospective cohort study

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ABSTRACT

INTRODUCTION: Cesarian section (CS) is lifesaving both for the mother and the baby. Worldwide, there has been an increase in the incidence of CS. However, complications may arise postoperatively for both mother and newborn.

Our aim was to determine the incidence rate of post-CS surgical site infection (SSI), identify factors associated with SSI, and identify the most frequent microorganisms associated with the presence of post-CS SSI.

METHODS: This is a prospective cohort study conducted at KRH, including all CS, performed from February to April 2020. Patient's demographics, operative management, and outcomes were analyzed.

RESULTS: A total of 201 patients aged between 15 to 47 years were operated on and 3.48% developed SSI. 90% were from Ngoma district, 47% had secondary education followed by 36% with primary education. The majority (97%) had no comorbidities. Povidone and chlorhexidine combined was the most commonly used disinfectant. 53% were emergencies and 92% of CS were performed by general practitioners. The average duration of operation was between 30 to 45minutes. Showering prior to operation (RR=0.39) at 95% CI [0.005-0.29], not shaving 30 minutes prior to incision (RR: 25.5) at 95% CI [3.5-18.7] and use of both povidone and chlorhexidine for skin preparation (RR= 0.15) at 95% CI [0.1-1.6] are associated with reduced risk of developing SSI. Obstructed labor/dystocia ((RR=4.55) at 95%, CI [1.6-45.4]) increases the infection risk. Staphylococcus aureus was the most frequently isolated microorganism in post-CS SSI patients.

CONCLUSION: Active hospital infection services and adherence to evidence-based guidelines for SSI prevention measures would reduce the post-CS SSI incidence rate and improve patient care.

Keywords: Cesarian section, Incidence, Outcome, Microorganisms, Surgical Site Infection

INTRODUCTION

A review of the literature highlights that surgical site infections are a common major complication after caesarian sections worldwide and are mainly responsible for increased maternal morbidity and

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mortality, dissatisfaction of the patient and family, longer hospital stay, and higher treatment cost [1,2]. The infection can come from the break of skin normal flora, spillage from the gastrointestinal system, or others.

The incidence of post-CS SSI varies from high income to low and middle-income settings. In developed country, SSI results in morbidity between 3% to 16% and death 0.3% to 0.8% [3]. Compared to low-income and Middle-income settings, incidence can go up to 25% [4,5,6]. In Rwanda, it was more slightly lower at 4.9% compared to other countries [2]. This wide variation is due to advanced hospital infection control services and good implementation of evidence-based guidelines for SSI prevention measures [7].

The occurrence of SSI depends on the complex interaction of such as the pre-morbid health condition of the mother, nutritional status, age of the mother, the presence of prolonged premature rupture of the membrane, and prolonged duration of CS more than an hour or surgical technique used [3,5,8,9].

Staphylococcus aureus, Escherichia coli, Klebsiella pneumonia, and pseudomonas aeruginosa are the most common isolates of post-CS SSI. However, *staphylococci*, being a major component of the skin microbiome, remain the most common microorganism responsible for post-CS SSI [2,5,6,9,10]. Moreover, the microbiology patterns in organ/space occupying infections for post-CS peritonitis are polymicrobial and are dominated by *E. coli* (25%) and *Klebsiella pneumonia* (21%) [11].

METHODS

Study design: A prospective cohort study. The study was conducted at Kibungo Referral Hospital, one of the new three newly upgraded hospitals to tertiary referral hospital level in Rwanda, located in the Eastern Province. It originally serves a catchment area of approximately 400,000 population and has a capacity of 312 beds. There are 3 operating suites and the gynecology and obstetrics ward have 73 beds. An estimated 2500 operations are performed annually. The most common operation is the cesarian section (72%).

Participants: The study included all women aged 15 years and above who gave birth by caesarian section, both elective and emergency, at Kibungo Referral Hospital from February to April 2020. Pregnant women in labor first consult at the health center where they receive prenatal care. When the pregnancy is at high risk or has indications for operation, the patients are transferred to the tertiary hospital, where assessment is made for spontaneous vaginal delivery versus caesarian section. After the operation, the patient is followed up postoperatively and discharged on day 3 or 4 postoperatively with an appointment for follow up in outpatient consultation several days later.

All pregnant women aged 15 years and above who delivered by cesarean section at KRH from January to March 2020 were enrolled, and all data were analyzed.

This study's primary objective was to determine the incidence rate of post-CS SSI, identify associated risk factors, as well as to characterize the most frequently involved microorganisms.

Data sources: Data were collected using a pre-established questionnaire to record patient demographics, clinical presentation and comorbidities, perioperative data. Follow up at 30 days post-operation was done using phone calls and registration records at post-operative scheduled hospital visits.

Quantitative variables: Variables were collected on patient's demographics, operative management, and the patient's outcome. We defined SSI as any infection occurring at the operated site within 30 days post-operation, as well as infection that involved the skin, subcutaneous soft tissue, any deep organ space. We considered "superficial infection" in all cases with infection in the subcutaneous tissue and above the fascia/; and "deep infection" as representing endometritis or intraperitoneal abscess.

The following were considered signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat.

Data management and statistical analysis: The questionnaire (data-collection tool) was explicitly designed for this study. The collected data was entered into a password protected Excel database and analyzed using SPSS version 21. Descriptive statistics were calculated and presented as frequencies and percentages. Univariate analysis was performed to determine the association between SSI and the other studied variables.

Ethical approval: No physical, social, emotional, legal and/or financial risks were identified.

Hospital ethical approval from the Kibungo Referral Hospital department of Maternity was obtained (No: KBG11/2020).

Personal data was not used in the analysis. Each patient was assigned a unique study identifier number. A password-protected study identifier number linking with the personal identifier (name, hospital ID) were kept separately by the principal investigator (PI). Only the researcher and the research team had access to the study data and information.

An informed consent form was obtained from the patient or any other legally recognized attendant at the time of recruitment. Participation in the study was by choice and the patient had the right to withdraw from the study at any time during the study period. Funding &Sponsors: No funding has been sought or gained for this project.

There were no incentives offered to patients whose data were used in this study.

RESULTS

We enrolled 201 patients who underwent caesarean section at Kibungo referral hospital aged 15 to 47 with a mean of 28 years. Eighty percent were married and 14% were single. The majority of the study participants had no underlying comorbidities (97%), while only 3% had chronic conditions (hypertension, hepatitis, or diabetes mellitus). Fifty three percent (53%) of performed operations were emergency and 47% elective. Repeat caesarean sections (41%), obstructed labour or dystocia (24%) and foetal distress (18%) were the most common indications for operation. Povidone-iodine and chlorhexidine combined was the most common disinfectant used (81%), whereas povidone-iodine alone was used to clean the operation site in 19%. The duration of operation was between 30 to 45minutes in 62% of the operated patients, followed by 46 to 60minutes in 36%, and just 2% lasted more than 60minutes. Most of the operations were performed by general practitioners (92%) versus 8% by obstetrician-gynecologists (Appendix 2, page 44 and 45).

The incidence of post-CS SSI was 3.5%, the most common being deep infection with 57%, followed by superficial at 43%. The mean days of hospital stay were 4 with a range of 2 to 15 days (Table 1).

Obstructed labor/dystocia ((RR=4.55) at 95% CI [1.6-45.4]) increases the infection risk and showering prior to operation ((RR=0.39) at 95% CI [0.005-0.29]) is associated with reduced risk of developing SSI while shaving 30 minutes prior to incision, the result shows that women who shaved are at 25.5 times risk of developing post-CS SSI (RR:25.5) at 95% CI [3.5-18.7] (Appendix 1, page 43).

Staphylococcus aureus represents the most common isolated microorganism of post-CS SSI at 57.1%, followed by *Escherichia coli* with 28.6% and *Klebsiella spp* with 14.3%.

DISCUSSION

Surgical infection remains the most challenging morbidity post caesarian section. This study found the Post-CS SSI incidence rate of 3.5%, which falls within the worldwide range of 3% to 15% (Soule B.

Table 1: Incidence of post-CS SSI and other operative outcomes of the study participants

Variable		Observation (N)	Percentage (%)
Complications			
	Surgical site Infection	7	3.5
	Post-partum Hemorrhage	4	2
	Anemia	3	1.5
	Pneumonia	3	1.5
	None	184	91.5
Category of surgical site infection			
	Superficial	3	43
	Deep	2	57
Unplanned Re-operation	Yes	9	4
Length of hospital stay (Mean, range) in days			4 (2-15)

M., 2018). With reference to other published series in low- and middle-income settings, it remains low. Alfouzan et al. in 2019 found an incidence rate of 1.7% to 2.95% respectively between 2014 and 2016 in a study conducted in Kuwait, whereas Mpogoro and colleagues in 2014 found an incidence rate of 16.2% in their study conducted at Bugando medical centre, Tanzania [10,12]. This low incidence is likely due to good improvement in the practice of preventive measures of post-CS SSI. Among analyzed variables, showering prior to operation, shaving 30minutes prior to incision, and Skin preparation were the identified key predictors of post-CS SSI, similar to other published studies [13,14]. These factors were significantly associated with the occurrence of post-CS SSI compared to other factors considered in this study (urgency of operation, indication, operation time, occupation, comorbidities, level of education of the woman and age).

The timing of shaving affects the wound infection rate. Shaving patients before surgery increases the risk of surgical site infections. The World Health Organization (WHO) has warned and urged health workers to avoid shaving surgical sites with a razor blade. When needed, especially if it interferes with the surgery, the global health body recommends using electrical clippers [15]. When shaving was done immediately before surgery, the infection rate was 3.1%. Shaving 24 hours or more before surgery raised the infection rate to more than 20% [16].

The use of skin preparation solutions combining Povidone and Chlorhexidine was found to reduce the risk of occurrence of post-CS SSI. as compared to other published series, Ngai, et al.2015 in their study on skin preparation for prevention of SSI after C/S in hospital of US found that there is no significant difference in the use of either combined or single-skin preparation solution to reduce post-CS SSI; and Tetsuya Kawakita & Helain J. Landy, 2018 in their study conducted at MedStar Washington Hospital Center found that there were few cases of post-CS SSI where chlorhexidine skin preparation was used [17,18]. There is variability in research findings, but the combination of povidone and chlorhexidine solutions and other prevention measures seem to reduce the risk of occurrence of post-CS SSI. Mihretu.M et al.2019 found that pregnancy-induced anemia, chorioamnionitis, midline skin incision, and post-operative hemoglobin less than 11 g/dl are the only factors associated with post-CS SSI. In contrast, Cheng. K. et al., in their study on risk factors for surgical site infections in a teaching hospital, showed that comorbidity of diabetes and cancer contribute to the occurrence of post-CS SSI, which are different from our findings [19,20].

Obstructed labor/dystocia was also significantly associated with infection [24]. This is similar to other published series [25]. Prolonged labor and multiple cervical examinations are well-known and significant variables associated with post-cesarean infection [26]

The most common microbial patterns in post-CS SSI are polymicrobial and due to gram-negative infections. In this study, most of the specimens isolated were monomicrobial and *Staphylococcus aureus* were the most isolates. One possible reason is that majority of our surgical site infections were superficial. This is supported by the study conducted by Shekhar P. et al. They found that, in 269 patients who develop SSI, 45.3% of them were related to Staphylococcus Aureus with a significant impact on their healing process [21]. This is different from the study conducted at the University teaching hospital of Kigali, Rwanda, which found that *Klebsiella spp* were the most isolated pathogens (55%) [22]. The prior exposure to antibiotics before transfer to the hospital may also explain the monomicrobial patterns and impacted the ability to detect the microorganism. Prior studies have shown that 63.5% of patients receive antibiotics at the district hospital prior to transfer to a referral hospital [23]. However, in organ/space occupying SSI, the pattern is polymicrobial gram-negative, as Kenneth et al.2018 found in their study on post CS peritonitis at the University Teaching Hospital of Kigali, Rwanda [11].

CONCLUSION

Usage of Skin preparation solution efficiently, not shaving 24hrs before CS, and showering one hour before CS were found to be highly associated with post-CS SSI when much caution is not taken, especially to women undergoing CS at the hospital. To maintain proper hygiene and adherence to available infection prevention measures reduces the incidence of SSI in post-CS patients.

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Appendix 1: Association between the occurrence of post-CS SSI, demographic and clinical characteristics of participants

		Surgical site infection				
Factors	**Variables**	**Yes N (%)**	**No N (%)**	**RR**	**95% CI**	**P-value**
Age group						
	Below 20	1 (14.3)	22 (100)	1.0 (Ref)		
	20-30	2 (28.5)	96 (54)	0.46	0.4-5.3	0.53
	31 and Above	4 (57.2)	76 (36)	1.16	0.12-10.9	0.89
Level of Education						
	Primary & below	5 (79)	74 (38.1)	4.054	0.8-21.4	0.97
	Secondary & above	2 (1.6)	120 (98.4)	1.0 (Ref)		
Occupation						
	Farmer	5 (71.4)	114 (58.7)	1.75	0.3-9.2	0.5
	None Farmers	2 (28.6)	80 (41.2)	1.0 (Ref)		
Comorbidities	With Comorbidity	0 (0)	5 (2.4)	1.0 (Ref)		
	Without Comorbidity	7 (0)	188 (96.4)	0.57	0.1-3	0.5
Urgency						
	Emergency	5 (71.4)	101 (52)	2.3	0.44-12.2	0.32
	Elective	2 (28.5)	93 (48)	1.0 (Ref)		
Indication of C/S	Obstructed labor/Dystocia					
		5 (71.4)	44 (22.7)	4.55	1.6-45.4	0.012
	Other Complications	2 (28.6)	150 (77.3)	1.0 (Ref)		
Operation period						
	Day	4 (57.1)	107 (55.2)	1.1	0.24-4.9	0.92
	Night	3 (42.9)	87 (44.8)	1.0 (Ref)		
Skin preparation						
	Povidone	3 (42.9)	11 (5.6)	1.0 (Ref)		
	Both	1 (14.3)	24 (12.4)	0.15	0.1-1.6	0.002
	Chlorhexidine	3 (42.9)	159 (81.9)	0.69	0.1-0.4	0.12
Shaving prior to incision						
	Yes	5 (71.4)	191 (98.5)	25.5	3.4-18.7	0.001
	No	2 (28.5)	3 (1.5)	1.0 (Ref)		
Showering 30 min prior to operation						
	Yes	3 (42.9)	193 (99.5)	0.39	<0.01-0.46	<0.001
	No	4 (57)	1 (0.5)	1.0 (Ref)		
Duration period	<= to 45 min	3 (42.3)	121 (62.4)	1.0 (Ref)		
	>45 min	4 (57.1)	73 (37.6)	2.21	0.5-10.1	0.3
Operator	GP	7 (100)	177 (91.2)	>1	0.01-0.1	0.99
	GYN/OBST	0 (0)	17 (8.8)	1.0 (Ref)		

Ref: Reference group

Appendix 2: Patients' demographic and clinical characteristics

Variable		N	Percentage (%)
Age (in years)			
	Below 20	15	8
	20-30	107	53
	31-40	75	37
	41 and above	4	2
Mean age, range			28 (15,47)
Residence			
	In-zone	180	90
	Out of zone	21	10
Level of education			
	Primary	79	39.3
	Secondary	94	47
	University	28	14
Occupation			
	Farmer	119	59
	Gov/private employee	65	32
	Student	4	1
	None	13	6
Marital status			
	Married	161	80
	Single	29	14
	Divorced	6	3
	Widow	5	3
Comorbidities			
	Hypertension	3	1.5
	Hepatitis	2	1
	Diabetes mellitus	1	0.5
	None	195	97
Hospital stay prior to surgery			
	Less than 24 hours	126	62
	Between 24-48 hours	74	37
	More than 48 hours	1	1
Showering before surgery		196	98

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Shaving before surgery		196	98
Type of prophylactic antibiotic	Ceftriaxone	200	99
	Ampicillin	1	1
Urgency of CS	Emergency	106	53
	Elective	95	47
Indication for CS			
	Repeat CS	82	41
	Obstructed labor/Dystocia	49	24
	Fetal distress	37	18
	Breech presentation	10	5
	Multiple pregnancies	7	3
	Macrosomia	7	3
	Antepartum hemorrhage	5	3
	Patient wish	3	2
	Eclampsia	1	1
Disinfectant used for skin preparation			
	Chlorhexidine and povidone-iodine solutions	162	81
	Chlorhexidine alone	25	12
	Povidone alone	14	7
Operative period			
	Day	111	55
	Night	90	45
Duration of operation			
	30 to 45minutes	124	62
	46 to 60 Minutes	73	36
	Above 60 Minutes	4	2
Qualification of the operator			
	General practitioner	184	92
	Obstetrician-gynecologist	17	8
	Below 45 Minutes	124	62