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Original Research Article

Risk factors associated with post cesarean surgical site wound infection in Bangabandhu Sheikh Mujib medical university, Bangladesh

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ABSTRACT

Background: Caesarean section is one of the most commonly performed surgical procedures in hospitals. Surgical site infections are a common complication after a caesarean section (C-section) and mainly responsible for increased maternal mortality and morbidity, the dissatisfaction of patients, longer hospital stays as well as higher treatment costs.
Methods: This prospective cohort was conducted at Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh included 400 women (247 emergency CS, 153 elective CS) from September 2019 to August 2020. Data were collected through consent, medical record reviews, and questionnaires. SSI risk factors were assessed, and wound examinations were conducted before discharge. STATA 14.0 was used for analysis. Participants were educated about SSI symptoms and monitored for 30 days post-operation.
Results: Nulliparous individuals were more common in the emergency CS group (61.5% vs. 32% in Elective CS). Ruptured membranes were higher in emergency CS (71.7% vs. 2.6% in elective CS). Prophylactic antibiotic usage differed significantly (88.7% in emergency CS vs. 3.9% in elective CS). Post-discharge wound infections were more prevalent in emergency CS (10.53% vs. 2.61% in elective CS). No significant differences were found in other parameters. High-risk factors included BMI >30 and operation time ≥45 min.
Conclusion: SSI rates may be underestimated with limited hospital observation. Prolonged operation times (>38 min) and high BMI (>30) significantly increased SSI risk. Identifying high-risk subgroups and administering antibiotics accordingly can help prevent SSI and reduce unnecessary antibiotic use.

Keywords: Caesarean, Delivery, Surgical, Infection

INTRODUCTION

The definition of caesarean section by the world health organization (WHO) entails the delivery of a fetus, placenta, and membranes through incisions in both the abdominal and uterine walls after the 20th week of pregnancy.[1] Surgical site infection (SSI) is characterized by infections occurring at or near surgical incisions within 30 days post-operation or within a year if implants are involved. Wound infections following caesarean delivery are categorized as superficial, deep, or organ-related based on tissue or organ involvement.[1,2] Within Western nations, Italy takes the lead in the number of annual caesarean sections (CSs) performed. Over the past two decades, the country's mean proportion of CSs has surged from 11-12% in the early 1980s to 35.8% in 2002.[3] Yet, this trend is not exclusive to Italy. According to the 2004 caesarean section-clinical guideline from the National collaborating centre for women's and children's health, the UK observed an increase in CS rates from 9% to 21% between 1980 and 2001. Key clinical reasons for CS have remained

consistent: fetal dystocia (22%), labor progress failure (20%), previous CS (14%), podalic presentation (11%), and more recently, maternal request (7%).[4] Surgical site infections (SSI) represent the most frequent postoperative complications, contributing to $3.2 billion in hospital costs per annum, and accounting for 20% of unplanned readmissions following patient discharge.[5,6] The application of antiseptic chlorhexidine gluconate in surgical wound irrigation plays a vital role in SSI prevention, contributing to improved evidence-based guidelines and surveillance systems, crucial for healthcare providers in curbing postoperative wound infections.[7] SSI ranks among the leading causes of morbidity and mortality in women undergoing caesarean sections, with reported rates ranging from 3% to 15%.[6,8] Alarming SSI rates following CS have been reported in various lower and middle-income countries, such as Nigeria (16.2%), Kenya (19%), Tanzania (10.9%), and Vietnam (9.7%).[9,10] In North America, caesarean delivery rates have been on the rise. In Canada, caesarean deliveries constituted 20% of births in 1988, a figure that increased to 26% in 2012.[11,12] Risk factors for SSI encompass extreme maternal weight (underweight or obese), prolonged labor, extended surgery duration, multiple procedures, manual placenta removal, young maternal age, preoperative maternal condition, procedure-related blood loss, and absence of antibiotic prophylaxis.[13-15] SSI can substantially disrupt the postpartum phase for both mother and newborn, hindering recovery, caregiving, and home reintegration. In Canada, though no national surgical site infection surveillance for caesarean deliveries exists, the US National Healthcare Safety Network reported a mean rate of 0.16% in 2014.[16] An Australian study spanning 2002 to 2013, encompassing 81 healthcare facilities, displayed a 2.05% rate, which decreased over the study period.[17] Variability exists in surgical site infection rates up to hospital discharge following caesarean delivery, ranging from 0.16% to 3.2%.[16,18,19] While rates increase with post-discharge surveillance, this practice is resource-intensive and not universally adopted.[19] The present study's objectives are twofold: to document the authentic incidence of post-caesarean SSI, as per the US centers for disease control and prevention (CDC) definition, and to pinpoint independent infection risk factors.

METHODS

The study was conducted at Bangabandhu Sheikh Mujib medical university (BSMMU), Dhaka, Bangladesh, spanning September 2019 to August 2020. Using a 30-day hospital-based prospective cohort approach, women who underwent cesarean delivery (CD) within the first month of data collection were followed. The study included women who fulfilled specific criteria such as willingness to participate, a permanent address, and mental fitness for accurate reporting. Participants lacking post-discharge contact information were excluded. The sampling method involved including all CDs during the initial data collection phase until reaching the predetermined sample size (convenience sampling). A total of 400 participants were selected for the present study via a consecutive sampling method, with 247 emergency caesarean section cases and 153 elective caesarean section cases. Data collection involved obtaining consent from women delivering by CD at BSMMU, reviewing medical records for surgical site infection risk factors, and using a comprehensive questionnaire and chart review to gather information on maternal and procedural aspects. The study employed a comprehensive approach, encompassing data collection through interviews, observations of CS procedures, and wound examinations before discharge. Data analysis was performed using STATA 14.0. Throughout the study, participants were educated about SSI symptoms and were encouraged to report infections within 30 days post-operation. A questionnaire captured wound healing progress, with efforts made to maintain participant engagement and data completeness. Ultimately, the study enrolled 400 women without any dropouts, ensuring a comprehensive dataset for investigating risk factors associated with post caesarean surgical site wound infection.

RESULTS

A higher percentage of nulliparous individuals were observed in the emergency CS group (61.5%) compared to the elective CS group (32%), with a p value of less than 0.01. Regarding membrane status, 28.3% of the Emergency CS group had intact membranes, while 71.7% had ruptured membranes; in contrast, the Elective CS group showed 97.4% intact membranes and 2.6% ruptured membranes. No significant difference was found in the number of women on current immunosuppressive or anti-viral treatment. Antibiotic treatment before CS was received by 8.1% in the Emergency CS group and 3.3% in the Elective CS group (p=0.66). A significant disparity in receiving prophylactic antibiotics in relation to CS was noted, with 88.7% in Emergency CS group and 3.9% in Elective CS group (p<0.001). Similarly, differences were observed in the mean number of post-operative days spent in the maternity ward (5.1 days in Emergency CS vs. 4.6 days in Elective CS, p=0.01). Noteworthy differences emerged in the number of women diagnosed with SSI before hospital discharge (1.62% in Emergency CS vs. 1.31% in Elective CS, p=0.8045) and after hospital discharge (10.53% in Emergency CS vs. 2.61% in Elective CS, p=0.0035). Other parameters, such as the presence of women with temperature >38°C post-operation and the prevalence of specific preoperative infections, were also evaluated but did not exhibit statistically significant differences between the two groups.

The mean age was slightly higher in the Elective CS group, with 31.8 in the emergency CS group and 33.4 in the elective CS group. On the other hand, mean BMI was slightly higher in the emergency CS group, with 29.5 mean BMI in the emergency CS group, and 28.1 in the elective CS group. In the emergency CS group, the mean time of CS from rupture of membrane was 19.4.

Table 1: Pre-operative and postoperative characteristics of study people (n=400).

Characteristics		Emergency CS (N=247)		Elective CS (N=153)		P value
		Frequency	%	Frequency	%	
Nulliparous		152	61.5	49	32	
No. of women with membranes	Intact membranes	70	28.3	149	97.4	< 0.01
	Ruptured membranes	177	71.7	4	2.6	
No. of women on current immunosuppressive treatment		0	0	2	1.3	0.0728
No. of women on current anti-viral treatment		1	0.4	0	0	0.4340
Women receiving antibiotic treatment before the CS		20	8.1	5	3.3	0.66
Women receiving prophylactic antibiotics in relation to CS		219	88.7	6	3.9	<0.001
Women with bacterial vaginosis confirmed pre-op.		1	0.4	1	0.7	1
Women with vaginal Streptococcus-B confirmed pre-op.		8	3.2	1	0.7	1
No. of women with temperature >38 C post-op.		16	6.5	5	3.3	0.1647
Mean number of post-op. days in the maternity ward		5.1	-	4.6	-	0.01
No. of women having SSI diagnosed before hospital discharge		4	1.62	2	1.31	0.8045
No. of women having SSI diagnosed after hospital discharge		26	10.53	4	2.61	0.0035

Table 2: Available data regarding showering practices pre-operation (n=322).

Showering practices	Shortly before, N (%)	Same day, N (%)	Evening before, N (%)
	23 (7.14)	80 (24.84)	219 (68.01)
Home (N=218)	5 (2.293)	54 (24.77)	159 (72.94)
Ward (N=104)	18 (17.307)	26 (25)	60 (57.69)

Table 3: Available data regarding shaving practices of patient's pre-operation (n=389).

Shaving practices	Shortly before, N (%)	Same day, N (%)	Evening before, N (%)
	311 (79.95)	8 (2.06)	70 (17.99)
Clipper (N=1)	0 (0)	0 (0)	1 (100)
Cream (N=2)	0 (0)	0 (0)	2 (100)
Disposable Razor (N=380)	312 (82.11)	8 (2.11)	60 (15.79)
Other (N=6)	0 (0)	0 (0)	6 (100)

Exact data regarding showers was only available for 322 patients. The participants are stratified into three categories based on their timing of showering: "Shortly Before", "Same Day" and "Evening Before." Within the entire cohort, 7.14% of participants showered "Shortly Before" 24.84% opted for "Same Day" and the majority, comprising 68.01%, practiced showering "Evening Before". Further analysis is delineated based on the location of showering: at home (N=218) and within the ward (N=104). Among those who showered at home, 2.293% preferred "Shortly Before," 24.77% selected "Same Day" and the predominant choice of 72.94% was "Evening Before". In the ward subgroup, showering practices displayed variation, with 17.307% choosing "Shortly Before", 25% opting for "Same Day" and 57.69% favoring "Evening Before".

Exact data regarding shaving practice was only available for 389 patients. Within the cohort, a substantial majority of 79.95% of participants engaged in shaving "Shortly Before" a minor proportion of 2.06% chose "Same Day" and 17.99% preferred "Evening Before". The analysis extends to various methods of shaving, including "Clipper" (N=1), "Cream" (N=2), "Disposable Razor" (N=380) and "Other" (N=6). For those employing a "Disposable Razor" 82.11% shaved "Shortly Before" 2.11% chose "Same Day" and 15.79% favored "Evening Before". Notably, individuals using "Clipper", "Cream" and "Other" methods all uniformly chose the "Evening Before" option.

The participants are divided into categories based on two key parameters. In terms of "Indications for CS" the data reveals a breakdown of the reasons leading to the CS procedure. Fetal Indication constitutes the most prevalent

indication, accounting for 30% of cases, followed closely by previous CS at 27%. Maternal Indication and Podalic Presentation are reported at 25% and 11% respectively, while Twin Birth and Maternal Request each contribute to 6% and 1% of the cases. Shifting to the "Type of Incision" the data showcases the distribution of incision methods utilized during the CS. Pfannenstiel incision is overwhelmingly prominent, constituting 96% of cases, while Stark incision accounts for 1%. Notably, a subset of 12 cases (3%) is categorized as "Missing" for this parameter.

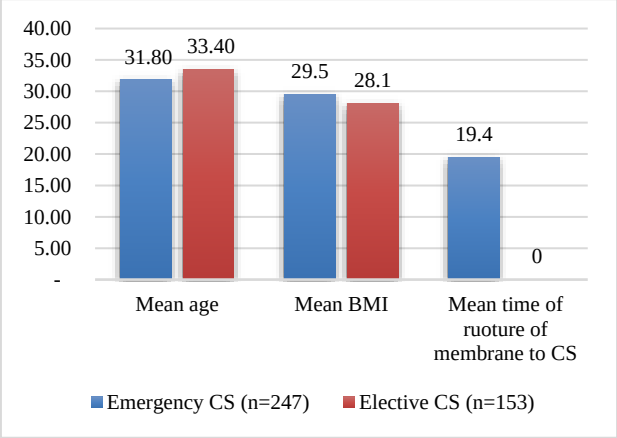

Figure 1: Mean pre-operative characteristics of study people (n=400).

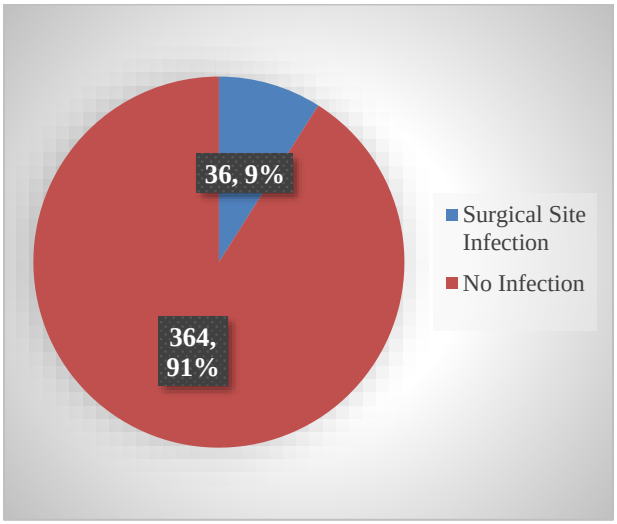

Figure 2: Incidence of surgical site infection among the participants.

Among the total participants of the study, 9% had surgical site infection, while 91% had no SSI. For the "Abnormal Amniotic Fluid" category, 5.60% of the wound infection group (N=36) had this risk factor, whereas 10.8% of the no infection group (N=364) exhibited the same risk factor. Similar trends are observed for "Positive Vaginal Swab" with 10.00% in the infection group versus 15.6% in the no infection group, and for "Labor before CS" with 25.00% and 30.5% respectively.

Table 4: Type on Incision, and Indication of CS among study subjects (n=400).

Parameters		N	%
Indications for CS	Fetal indication	120	30
	previous CS	108	27
	Maternal indication	100	25
	Podalic presentation	44	11
	Twin birth	24	6
	Maternal request	4	1
Type of Incision	Pfannenstiel	384	96
	Stark	4	1
	Missing	12	3

The occurrence of an "Emergency Caesarean Section" was found in 55.00% of the infection group and 52.8% of the no infection group. "Shower Evening Before Operation" was reported for 56.30% in the infection group and 68.7% in the no infection group. In the category of "Shaving Evening before the operation" 15.00% of the infection group and 17.8% of the no infection group displayed this risk factor. Additionally, the "Time Between Membrane rupture and Intervention" shows a median value of 743.5 in the infection group and 306.5 in the no infection group, with a statistically significant p value of 0.04.

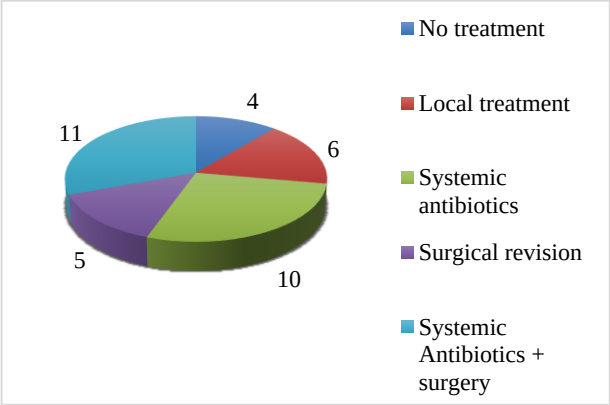

Figure 3: No. of study people according to the treatment of post-caesarean SSI (n=36).

Among the 36 SSI cases, 4 received no treatment post operation, 11 received systemic antibiotics along with surgery, 10 received only systemic antibiotics, 6 received local treatment, and 5 received surgical revision. Operation time and patient weight are considered 2 major risk factors. The current study group was divided into quartiles according to operation time, and within each quartile, risk of infection was calculated.

The cut off time between the fourth and other quartiles was 45 min. Within the BMI ≤30 category, 11 individuals (30.5%) had an operation time of <45 min, while 5 individuals (13.9%) had an operation time of ≥45 min. In contrast, within the BMI >30 category, 9 individuals (25.1%) had an operation time of <45 min, and 11 individuals (30.5%) had an operation time of ≥45 min.

Table 5: Types of risk factors presents in wound infection group and no infection group (n=400).

Risk factors	SSI group (N=36)	SSI group (%)	No infection group (N=364)	No infection group (%)	P value
Abnormal amniotic fluid	2/32	5.60	40/336	10.8	NS
Positive vaginal swab	2/18	10.00	39/228	15.6	NS
Labor before CS	9/36	25.00	111/364	30.5	NS
Emergency caesarean section	20/36	55.00	191/361	52.8	NS
Shower evening before operation	16/29	56.30	210/298	68.7	NS
Shaving evening before the operation	5/36	15.00	63/355	17.8	NS
Time between membrane rupture and intervention (median and range)	743.5 (164-1440)		306.5 (5-1816)		0.04

Table 6: A cross-tabulation of the two risk factors (BMI >30 and operation time ≥45 min) and SSI, demonstrating a high-risk group of 36 women.

Risk Factor	BMI ≤30		BMI >30	
	N	%	N	%
Operation time <45 min	11	30.5	9	25.1
Operation time ≥45 min	5	13.9	11	30.5

DISCUSSION

The findings from our study reveal a post-caesarean surgical site infection rate of 9% within a 30-day observational period based on the CDC standard. Furthermore, an investigation conducted by Hana Lijaemiro, Semarya Berhe Lemlem et al at Addis Ababa University College of Health Sciences, Department of Midwifery, Ethiopia, identified a 15.1% incidence of post-caesarean SSI.[20]

This emphasizes the significance of post-discharge infection surveillance to promptly assess and enhance caesarean delivery services, especially considering the decreasing inpatient stay duration. It should be noted that the 15.1% rate might be underestimated due to a considerable number of lost participants. Comparatively, this rate is notably higher than the reported rates from various studies conducted in different locations, with incidence rates ranging from 0.5% to 10.9%.[21-29] The observed variation in rates could be attributed to disparities in SSI definitions, distribution of risk factors, study timelines, socioeconomic status, and healthcare systems. Regarding our study's validity, we believe the SSI incidence reported here to be accurate due to the complete follow-up response (100%) and adherence to CDC criteria for a 30-day observation period. Stricter diagnostic criteria were applied for classifying SSI as superficial or profound, with only two participating obstetricians involved in the classification procedure. In comparison, other studies, including the Libyan study, may have adopted more specific diagnostic criteria, such as considering healing progress and the presence of specific bacteria alongside CDC criteria. This divergence might contribute to the substantial difference in post-CD SSI incidence rates between our study and Libya's.[24] Our findings also uncovered discrepancies between recommended guidelines and actual practices concerning SSI prevention and caesarean section procedures. Divergences in SSI prophylaxis practices were noted, partially influenced by current hospital protocols. For instance, preoperative showering, a common practice (82%), was generally conducted the night before the operation without antiseptic, contrary to international recommendations. Similarly, shaving practices differed, with the majority (97.25%) of women shaved using a disposable razor, which aligns with the hospital protocol but contrasts with CDC guidelines advising against shaving or recommending clippers. Moreover, while almost all cases adhered to iodine-povidone skin preparation (98.8%), the hospital protocol omitted specific mentions of skin preparation. In line with the high incidence of SSI in the Ethoplan study (15.1%), a noticeable discrepancy was found when compared to previous Ethiopian studies, which reported lower incidence rates, such as 6.8%, 11%, and 11.7%.[27,30,31] Possible reasons for this variance include differences in study design, location, and sample size. Within the emergency CS group, a substantial percentage (88.7%) received prophylactic antibiotics related to CS, while a smaller proportion (8.1%) received other antibiotic treatment before the procedure. Variability in the use of prophylactic antibiotics was also observed in elective CS across different obstetric departments.[32] Studies by Bagratee et al and Ruiz et al showed mixed results regarding the effectiveness of prophylactic antibiotics in reducing SSI rates for elective CS.[33,34] Few studies distinguish between elective and emergency caesareans or adhere to CDC criteria. Notably, the Norwegian 'Breakthrough Project' indicated lower wound infection rates (2.2% and 2.7%) for women with regional and general anesthesia, respectively.[35] Consistent with earlier reports, Ehrenkranz et al. and Nielsen et al reported infection rates of 1.1% and 1.6%, respectively, while Couto et al. and Tran et al. demonstrated higher rates (9.6% and 9.8%, respectively) with a 30-day follow-up period post-hospital discharge.[36-39] Additionally, the

incomplete documentation of indications for CS complicated the evaluation of intervention appropriateness. Only a minority of cases aligned with published indications, while maternal requests accounted for a small proportion (0.9%) of cases. Our study identified operating time ≥45 min and BMI >30 as independent risk factors for post-caesarean SSI. Although the link between increasing BMI and postoperative infection is well-documented, the impact of longer operations, regardless of peri-operative blood loss, on SSI risk is a novel finding.[40,41] Consequently, we recommend antibiotic administration for women with significant risk factors, regardless of the CS being elective or emergency, considering the potential consequences of SSI and the long-standing debate surrounding antibiotic use. Moreover, the lack of standardized reporting of CS indications in clinical documentation highlights the necessity for organizational and training interventions to guide healthcare providers in making evidence-based decisions regarding CS.

CONCLUSION

In conclusion, our study underscores the importance of post-discharge infection surveillance and adherence to guideline recommendations in optimizing CD services and preventing SSI. The identified risk factors offer valuable insights for targeted interventions and improved patient outcomes.

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