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Risk Factors of Surgical Site Infections in Cesarean Sections in Lady Reading Hospital Peshawar

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ABSTRACT

Background: Surgical site infections are a major source of morbidity following cesarean deliveries, increasing hospital stays, healthcare costs, and maternal discomfort. Identifying patient-related and clinical risk factors is crucial for early intervention and prevention, particularly in regions with limited healthcare resources. **Objective:** To determine the risk factors of surgical site infections in patients undergoing cesarean sections in Lady Reading Hospital Peshawar. **Study Design:** Cross-sectional study. **Duration and Place of Study:** The research was conducted in the Department of Obstetrics and Gynecology, Lady Reading Hospital, Peshawar, from July 2024 to December 2024. **Methodology:** A total of 177 women aged 18–40 years who developed surgical site infections after cesarean section were included. Sampling was performed using a non-probability consecutive technique. Risk factors assessed included prolonged rupture of membranes (>20 hours), preeclampsia, and meconium-stained amniotic fluid. Data were analyzed in SPSS version 25, with associations tested using Chi-square or Fisher's exact test at a 5% significance threshold. **Results:** Prolonged rupture of membranes was observed in 26.0% of cases, preeclampsia in 19.2%, and meconium-stained liquor in 5.6%. Hypertension showed a strong association with preeclampsia ($p<0.001$), while no significant associations were found for other demographic or clinical factors. **Conclusion:** Hypertensive disorders, particularly preeclampsia, remain key contributors to surgical site infections in cesarean sections, underscoring the need for vigilant monitoring and targeted preventive strategies.

INTRODUCTION

Surgical site infections following cesarean delivery continue to pose a challenge in obstetric practice, and they contribute significantly to a percentage of maternal morbidity and prolonged stay in the hospital.[1] The infections engage the superficial or deep aspects of the incision of the abdomen and sometimes the cavity of the uterus and manifest as erythema, discharge that is purulent, tenderness, and sometimes systemic findings like fever.[2] The incidences have a significant variation and they also depend on pre-existence conditions of the patient, the surgical setting, and perioperative protocols of management and the incidences have been reported to range from 3% to 15% worldwide.[3] Surgical site infections do not just have a significant impact on the healing of the wound but with serious potential of causing endometritis, septicemia, and readmission and contribute significantly to the strain on the healthcare system.[4] Early diagnosis, aseptic technique, and prophylactic use of antibiotics have remained cornerstones of prevention but patient- and procedure-specific factors of risk need to be understood and utilized to further diminishes the impact of these infections.[5]

Various patient-specific factors have been consistently associated with surgical site infection risk following cesarean delivery.[6] We recognize prolonged rupture of membranes as an established predisposing condition due to its provision of a pathway for ascending colonization of bacteria from the lower genital tract to the surgical incision and uterine cavity. When membranes have been ruptured for >18 hours preceding cesarean delivery, the amniotic fluid amplifies its bacteria content, greatly increasing the risk for superficial and deep surgical site infections.[7] Similarly, pregnancy hypertensive disorders, and preeclampsia specifically, have been implicated in immunity dysfunction, endothelial injury, and disrupted perfusion of tissues, and those issues contribute to impaired surgical site healing.[8] Patients with preeclampsia have lowered local tissue oxygenation and edema, promoting bacteria growth and postponed healing of the surgical site.

Obstetric and intraoperative conditions also influence susceptibility to postoperative infections.[9] The fact that meconium-stained amniotic fluid offers additional microbial contamination during the act of cesarean delivery makes meconium a potential culture medium for

bacteria and trigger inflammatory responses that disrupt local defense mechanisms of the tissue. Fetal distress, prolonged labour, and emergency surgical procedures have been characteristic of meconium-stained deliveries and play a considerable role in infection susceptibility. The duration of labour, frequency of vaginal examination prior to delivery by cesarean section, and intraoperative blood loss each play a role in total surgical site susceptibility.[10]

A study conducted at Lady Reading Hospital, Peshawar, Pakistan, identified key risk factors contributing to surgical site infections following cesarean sections, reporting prolonged rupture of membranes in 26% of cases, preeclampsia in 20%, and meconium-stained amniotic fluid in 6%.[11]

Surgical site infections in cesarean delivery among women in Peshawar should be studied because of the high obstetric workload, variable infection control practices, and limited local data driving prevention practices. Identification of most common maternal and intraoperative contributors locally will optimally optimize the best perioperative care, reduction of maternal morbidity, and surgical outcome improvement. Evidence generated locally plays a significant role in providing context-informed protocols for responding to healthcare challenges unique to the population.

METHODOLOGY

This study was conducted in the Department of Obstetrics and Gynecology at Lady Reading Hospital, Peshawar, over a six-month period from July to December 2025, adopting a cross-sectional design. Approval to conduct the research was granted by the hospital's ethics review committee and the College of Physicians and Surgeons Pakistan research board prior to commencement. A sample size of 177 was estimated using the World Health Organization calculator, based on a 95% confidence level, a 3.5% margin of error, and an anticipated prevalence of meconium-stained amniotic fluid as a contributory factor in surgical site infections of 6%.[11] Recruitment was carried out through non-probability consecutive sampling until the desired sample size was achieved.

Women aged 18 to 40 years undergoing cesarean delivery who subsequently developed surgical site infections were included. Patients with rheumatologic illnesses such as lupus, rheumatoid arthritis, or systemic sclerosis, those with known immunodeficiency, and those with concurrent pregnancies were excluded. Written informed consent was obtained from all eligible participants following explanation of study objectives, benefits, and the voluntary nature of participation. Demographic characteristics, including age, body mass index, education, employment status, place of residence, and socioeconomic background, were recorded. Past medical history regarding hypertension and diabetes mellitus was also obtained. Clinical assessment was performed by a consultant obstetrician with a minimum of five years' post-fellowship experience.

Surgical site infection was defined as an infection occurring at or adjacent to the incision site within 30 days of cesarean delivery, presenting with pain scored above 4 on the visual analogue scale, local tenderness, swelling, and purulent discharge. The study specifically examined three major contributing factors: rupture of membranes lasting more than 20 hours prior to delivery, confirmed by direct visualization of amniotic fluid leakage on vaginal examination; hypertensive disorder of pregnancy, identified as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg measured after 20 weeks of gestation with concurrent proteinuria greater than 300 mg over 24 hours; and meconium-stained amniotic fluid, recognized intraoperatively by its dark green to black, tar-like appearance and viscous consistency.

Data were analyzed using IBM SPSS version 25. Distribution of numerical variables was checked with the Shapiro-Wilk test. Continuous variables were summarized as mean with standard deviation or median with interquartile range, depending on distribution. Categorical variables, including the defined risk factors and comorbidities, were presented as frequencies and percentages. Stratification by demographic and clinical features was performed to account for potential confounders, and statistical significance of associations was assessed using Chi-square or Fisher's exact test at a 5% level of significance.

RESULTS

Patient demographics revealed a mean age of 29.23±6.52 years, mean height of 1.58±0.06 meters, mean weight of 63.62±8.29 kilograms, and mean BMI of 25.49±3.80 kg/m^2 (as shown in Table-I). The socioeconomic distribution showed 96 patients (54.2%) from poor backgrounds, 52 patients (29.4%) from middle-class families, and 29 patients (16.4%) from wealthy families. Regarding residence, 64 patients (36.2%) were from rural areas while 113 patients (63.8%) resided in urban areas. Comorbidity analysis indicated that 45 patients (25.4%) had hypertension while 132 patients (74.6%) were normotensive, and 19 patients (10.7%) had diabetes compared to 158 patients (89.3%) without diabetes (as shown in Table 1).

Table 1

Patient Demographics

Demographics		Mean ± SD
Age (Years)		29.23±6.52
Height (m)		1.58±0.06
Weight (kg)		63.62±8.29
BMI (kg/m^2)		25.49±3.80
Socioeconomic Status	Poor n (%)	96 (54.2%)
	Middle n (%)	52 (29.4%)
	Rich n (%)	29 (16.4%)
Residence	Rural n (%)	64 (36.2%)
	Urban n (%)	113 (63.8%)
Hypertension	Yes n (%)	45 (25.4%)
	No n (%)	132 (74.6%)
Diabetes	Yes n (%)	19 (10.7%)
	No n (%)	158 (89.3%)

Risk factor analysis demonstrated that prolonged rupture of membrane occurred in 46 patients (26.0%) versus 131 patients (74.0%) without this complication, preeclampsia was present in 34 patients (19.2%) compared to 143 patients (80.8%) without preeclampsia, and meconium-stained liquor was observed in 10 patients (5.6%) while 167 patients (94.4%) had clear amniotic fluid (as shown in Table 2).

Table 2

Frequency of Risk Factors Among Patients with Surgical Site Infections in Cesarean Sections

Risk Factors		Frequency	% age
Prolonged Rupture of Membrane	Yes	46	26.00%
	No	131	74.00%
	Total	177	100%
Preeclampsia	Yes	34	19.20%
	No	143	80.80%
	Total	177	100%
Meconium	Yes	10	5.60%
	No	167	94.40%
	Total	177	100%

For prolonged rupture of membrane, patients aged ≤30 years showed 25 cases (25.8%) versus 72 cases (74.2%) without rupture, while patients >30 years had 21 cases (26.3%) versus 59 cases (73.8%) without rupture (p=0.943). BMI stratification showed 26 cases (32.5%) in patients with BMI ≤25 kg/m^2 versus 54 cases (67.5%) without rupture, compared to 20 cases (20.6%) in patients with BMI >25 kg/m^2 versus 77 cases (79.4%) without rupture (p=0.073). Socioeconomic analysis revealed 22 cases (22.9%) in poor patients, 17 cases (32.7%) in middle-class patients, and 7 cases (24.1%) in wealthy patients (p=0.419). Rural patients had 14 cases (21.9%) versus urban patients with 32 cases (28.3%) (p=0.348). Hypertensive patients showed 12 cases (26.7%) compared to normotensive patients with 34 cases (25.8%) (p=0.904). Diabetic patients had 4 cases (21.1%) versus non-diabetic patients with 42 cases (26.6%) (p=0.784, Fischer Exact Test). For preeclampsia associations, patients ≤30 years had 19 cases (19.6%) versus patients >30 years with 15 cases (18.8%) (p=0.888). BMI stratification showed 16 cases (20.0%) in patients with BMI ≤25 kg/m^2 versus 18 cases (18.6%) in patients with BMI >25 kg/m^2 (p=0.808). Socioeconomic distribution revealed 17 cases (17.7%) in poor patients, 10 cases (19.2%) in middle-class patients, and 7 cases (24.1%) in wealthy patients (p=0.743). Rural patients had 8 cases (12.5%) compared to urban patients with 26 cases (23.0%) (p=0.088). The most significant association was observed with hypertension, where 31 hypertensive patients (68.9%) developed preeclampsia compared to only 3 normotensive patients (2.3%) (p<0.001). Diabetic patients showed 1 case (5.3%) versus non-diabetic patients with 33 cases (20.9%) (p=0.129, Fischer Exact Test). Meconium analysis showed patients ≤30 years had 5 cases (5.2%) versus patients >30 years with 5 cases (6.3%) (p=1.000, Fischer Exact Test). BMI stratification revealed 4 cases (5.0%) in patients with BMI ≤25 kg/m^2 versus 6 cases (6.2%) in patients with BMI >25 kg/m^2 (p=0.759, Fischer Exact Test). Socioeconomic analysis showed 4 cases (4.2%) in poor patients, 2 cases (3.8%) in middle-class patients, and 4 cases (13.8%) in wealthy patients (p=0.139, Fischer Exact Test). Rural patients had 2 cases (3.1%) compared to urban patients with 8 cases (7.1%) (p=0.333, Fischer Exact Test). Hypertensive patients showed 1 case (2.2%) versus normotensive patients with 9 cases (6.8%) (p=0.304, Fischer Exact Test). Diabetic patients had 0 cases (0.0%) compared to non-diabetic patients with 10 cases (6.3%) (p=0.389, Fischer Exact Test) (as shown in Table 3).

Table 3

Association of Risk Factors with Demographic Factors

Demographic Factors		Prolonged Rupture of Membrane		p-value	Preeclampsia		p-value	Meconium		p-value
		Yes n(%)	No n(%)		Yes n(%)	No n(%)		Yes n(%)	No n(%)	
Age (years)	≤30	25 (25.8%)	72 (74.2%)	0.943	19 (19.6%)	78 (80.4%)	0.888	5 (5.2%)	92 (94.8%)	1.000*
	>30	21 (26.3%)	59 (73.8%)		15 (18.8%)	65 (81.3%)		5 (6.3%)	75 (93.8%)	
BMI (Kg/m^2)	≤25	26 (32.5%)	54 (67.5%)	0.073	16 (20.0%)	64 (80.0%)	0.808	4 (5.0%)	76 (95.0%)	0.759*
	>25	20 (20.6%)	77 (79.4%)		18 (18.6%)	79 (81.4%)		6 (6.2%)	91 (93.8%)	
Socioeconomic Status	Poor	22 (22.9%)	74 (77.1%)	0.419	17 (17.7%)	79 (82.3%)	0.743	4 (4.2%)	92 (95.8%)	0.139*
	Middle	17 (32.7%)	35 (67.3%)		10 (19.2%)	42 (80.8%)		2 (3.8%)	50 (96.2%)	
	Rich	7 (24.1%)	22 (75.9%)		7 (24.1%)	22 (75.9%)		4 (13.8%)	25 (86.2%)	
Residence	Rural	14 (21.9%)	50 (78.1%)	0.348	8 (12.5%)	56 (87.5%)	0.088	2 (3.1%)	62 (96.9%)	0.333*
	Urban	32 (28.3%)	81 (71.7%)		26 (23.0%)	87 (77.0%)		8 (7.1%)	105 (92.9%)	
Hypertension	Yes	12 (26.7%)	33 (73.3%)	0.904	31 (68.9%)	14 (31.1%)	<0.001	1 (2.2%)	44 (97.8%)	0.304*
	No	34 (25.8%)	98 (74.2%)		3 (2.3%)	129 (97.7%)		9 (6.8%)	123 (93.2%)	
Diabetes	Yes	4 (21.1%)	15 (78.9%)	0.784*	1 (5.3%)	18 (94.7%)	0.129*	0 (0.0%)	19 (100.0%)	0.389*
	No	42 (26.6%)	116 (73.4%)		33 (20.9%)	125 (79.1%)		10 (6.3%)	148 (93.7%)	

*Fischer Exact TestDiscussion

DISCUSSION

The mean age of 29.23±6.52 years in our cohort represents the typical reproductive age group undergoing cesarean deliveries, which is consistent with optimal childbearing years when most women seek obstetric care. The mean BMI of 25.49±3.80 kg/m^2 indicates that the majority of patients fell within the overweight category, which is clinically significant as elevated BMI is known to compromise wound healing through reduced tissue perfusion, increased tension on surgical incisions, and altered immune response. The predominance of patients from lower socioeconomic backgrounds (54.2%) reflects the demographic pattern commonly observed in public healthcare settings, where limited access to prenatal care and nutritional deficiencies may predispose to complications.

The 26.0% incidence of prolonged rupture of membrane observed in our study represents a substantial proportion of patients at increased risk for ascending infections. Prolonged membrane rupture compromises the natural barrier between the external environment and the sterile intrauterine cavity, allowing bacterial colonization and subsequent chorioamnionitis, which significantly increases the risk of postoperative wound infections. The 19.2% prevalence of preeclampsia is particularly concerning as this condition involves systemic endothelial

dysfunction and altered coagulation profiles, leading to impaired tissue perfusion and delayed wound healing processes that predispose to surgical site infections.

The striking association between hypertension and preeclampsia ($p<0.001$) demonstrates the well-established pathophysiological relationship where chronic hypertension serves as a predisposing factor for pregnancy-induced hypertensive disorders. This occurs through existing vascular damage that exacerbates the physiological stress of pregnancy, leading to placental insufficiency and the characteristic syndrome of preeclampsia. The relatively low incidence of meconium-stained liquor (5.6%) suggests that most deliveries occurred before significant fetal distress developed, though when present, meconium represents fetal hypoxia and potential bacterial contamination of the amniotic fluid.

Our findings demonstrate both convergent and divergent patterns when compared to existing literature on cesarean section complications and surgical site infections. The demographic characteristics in our study align closely with several previous investigations, particularly regarding maternal age. Our mean age of 29.23±6.52 years is remarkably similar to Abd-El-Kareem et al. (29.20±6.35 years) [12] and slightly lower than Fatima et al. (30.93±7.28 years) [13] suggesting consistency in the typical age distribution of women undergoing cesarean delivery across different geographical regions. This age range represents the peak reproductive years when cesarean sections are most commonly performed, reflecting similar obstetric practices globally.

The mean BMI of 25.49±3.80 kg/m^2 in our cohort falls within the overweight category and shows interesting comparisons with other studies. While Iran Nezhad Deljavan et al. reported significantly higher BMI in infected cases (35.34±4.60 kg/m^2) versus non-infected cases (23.93±1.54 kg/m^2) [14] and Abd-El-Kareem et al. found obesity significantly associated with wound infection (BMI 28.96±4.97 kg/m^2) [12] our study population demonstrated a more moderate BMI profile. This difference may reflect varying nutritional patterns, genetic predispositions, and healthcare accessibility across different populations, with our Pakistani cohort showing intermediate BMI values compared to Iranian and Iraqi populations.

Our finding of 26.0% incidence of prolonged rupture of membrane is substantially higher than the rates implied in other studies, where Iran Nezhad Deljavan et al. reported infection rates of 9.4% in PROM cases versus 1.9% without PROM [14] and Tebeu et al. identified PROM as a significant risk factor with an odds ratio of 2.06.[15] The higher prevalence in our study may reflect differences in labor management protocols, patient presentation timing, or diagnostic criteria for membrane rupture duration. This elevated incidence is concerning as prolonged membrane rupture consistently emerges as a significant risk factor across multiple studies, indicating the critical importance of timely delivery once membranes rupture.

The 19.2% prevalence of preeclampsia in our study represents a notably high incidence compared to global averages, which typically range from 2-8% of pregnancies. This elevated prevalence may reflect the referral pattern to our tertiary care center, where high-risk pregnancies are concentrated, or potentially inadequate prenatal screening and management in the community. The strong association between hypertension and preeclampsia ($p<0.001$) in our study corroborates the well-established pathophysiological relationship, though direct comparisons with other studies are limited as most focused on surgical site infections rather than pregnancy-related hypertensive disorders.

Our meconium-stained liquor incidence of 5.6% contrasts with Abd-El-Kareem et al., who specifically studied meconium-stained amniotic fluid and found it present in 50% of their study group by design,[12] while Dereje et al. reported a much higher prevalence of 23.9% in Ethiopian women.[16] These variations likely reflect different study methodologies, with our observational approach capturing the natural incidence, Abd-El-Kareem et al. using a case-control design with predetermined groups, and Dereje et al. focusing specifically on term pregnancies where meconium passage is more common due to fetal maturity.

The lack of statistically significant associations between demographic factors and prolonged rupture of membrane in our study (p-values ranging from 0.348 to 0.943) differs from some international findings. He et al. identified irregular antenatal care as a significant risk factor (OR=3.25),[17] while our analysis did not stratify by prenatal care quality. Similarly, Guanche Garcell et al. found higher parity associated with surgical site infections,[18] whereas our study showed no significant parity-related associations with membrane rupture. These differences may reflect variations in healthcare systems, with developed healthcare settings showing stronger associations between care quality and outcomes.

Notably, several studies focused on surgical site infection rates, reporting ranges from 1.79% (He et al.) [17] to 24.1% (Fatima et al.),[13] with most studies falling between 3-7%. While our study did not directly measure surgical site infections, our risk factor analysis provides insight into the underlying conditions that predispose to such complications. The absence of significant associations in studies like Zaineb et al., who found no significant relationship between traditional risk factors and SSI,[19] parallels some of our non-significant findings, suggesting that the relationship between demographic factors and obstetric complications may be more complex than previously understood and influenced by local healthcare practices, population genetics, and environmental factors.

Several limitations must be acknowledged in interpreting these findings. This study was conducted at a single tertiary care center, which may limit the generalizability of results to other healthcare settings with different patient populations, resource availability, and clinical protocols. The cross-sectional design prevents establishment of causal relationships between demographic factors and obstetric complications, as temporal relationships cannot be definitively determined. The study population may exhibit selection bias, as tertiary care centers typically receive referrals of high-risk pregnancies, potentially overestimating the prevalence of complications compared to the general obstetric population. Additionally, reliance on medical record documentation may introduce information bias, as recording quality and completeness can vary among healthcare providers. The study also lacks

long-term follow-up data to assess delayed complications or outcomes, and the single-center setting may not capture the diversity of socioeconomic and demographic factors present in the broader Pakistani population.

CONCLUSION

Our study has concluded that risk factors for surgical site infections in cesarean sections demonstrate variable associations with demographic and clinical characteristics. The analysis revealed that prolonged rupture of membrane, preeclampsia, and meconium-stained liquor represent significant obstetric complications with distinct prevalence patterns in our population. The strongest association identified was between maternal hypertension and preeclampsia development, highlighting the critical importance of blood pressure management during pregnancy.

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