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Predictors and Bacteriological Profile of Surgical Site Infection Following Cesarean Section: A Comprehensive Review

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Abstract: ***Background: Surgical site infection (SSI) is one of the most common complications following cesarean section (CS) and remains a significant cause of maternal morbidity worldwide. The global rise in cesarean delivery rates has proportionally increased the burden of postoperative wound infections, particularly in low- and middle-income countries. Objective: To review the predictors and bacteriological profile of surgical site infections following cesarean section, with emphasis on antimicrobial resistance patterns and clinical implications. Methods: A narrative review of published literature, international guidelines, and observational studies was conducted to synthesize evidence on epidemiology, risk factors, microbial spectrum, and antimicrobial susceptibility patterns associated with post-cesarean SSIs. Results: The incidence of SSI following cesarean delivery ranges from 3–15% in high-income countries and up to 25% in resource-limited settings. Major predictors include maternal obesity, anemia, diabetes mellitus, prolonged rupture of membranes, emergency cesarean delivery, prolonged operative time, and inappropriate antibiotic prophylaxis. The bacteriological profile commonly includes Gram-positive cocci, Gram-negative bacilli, and anaerobic organisms, with increasing prevalence of multidrug-resistant strains such as MRSA and extended-spectrum beta-lactamase (ESBL)-producing Enterobacterales. Conclusion: Post-cesarean SSI is multifactorial and largely preventable. Early identification of high-risk patients, adherence to infection prevention protocols, and regular microbiological surveillance are essential for reducing maternal morbidity.***

Keywords: Cesarean section, Surgical site infection, Predictors, Bacteriological profile, Antimicrobial resistance, Maternal morbidity

1. Introduction

Cesarean section (CS) is among the most frequently performed surgical procedures in obstetrics. Although often lifesaving for both mother and fetus, it is associated with higher postoperative morbidity compared to vaginal delivery. Surgical site infection (SSI) remains one of the most significant postoperative complications.

The Centers for Disease Control and Prevention defines SSI as an infection occurring within 30 days of a surgical procedure involving the incision, deep soft tissues, or organ spaces manipulated during surgery (1). The World Health Organization recognizes SSI as one of the most common healthcare-associated infections globally and a key indicator of surgical quality (2).

With increasing global cesarean delivery rates, particularly in urban and tertiary healthcare settings, the absolute number of women at risk of postoperative infections has risen. Post-cesarean SSI contributes to prolonged hospital stay, increased healthcare expenditure, delayed maternal recovery, impaired breastfeeding, and, in severe cases, systemic sepsis.

Epidemiology

The incidence of post-cesarean SSI varies widely:

- 3–15% in high-income countries (3)
- 15–25% or higher in low- and middle-income countries (4)

Cesarean section is classified as a clean-contaminated procedure because it involves controlled entry into the genital tract, which harbors endogenous microbial flora (5). Underreporting may occur, especially in settings without structured post-discharge surveillance systems, as many infections manifest after hospital discharge.

Pathophysiology

The development of SSI involves the interaction between microbial contamination and host susceptibility.

Host-Related Factors

Pregnancy is associated with immunological adaptation characterized by relative suppression of cell-mediated immunity (6). Other physiological changes include:

- Dilutional anemia
- Tissue edema
- Hormonal influences on collagen synthesis and wound healing

These changes may compromise immune defense and delay wound repair.

Surgical Factors

- Tissue trauma and devitalization
- Hematoma or seroma formation
- Prolonged operative duration
- Suboptimal aseptic technique

Increased operative time is associated with greater tissue exposure and risk of contamination.

Predictors of Surgical Site Infection

SSI following cesarean section is multifactorial. Predictors can be grouped into maternal, obstetric, intraoperative, and postoperative categories.

1) Maternal Risk Factors

a) **Obesity:** Maternal obesity (BMI ≥30 kg/m²) is consistently reported as a strong independent predictor of SSI (7). Increased adipose tissue thickness reduces tissue perfusion and oxygenation.

b) **Anemia:** Preoperative anemia impairs oxygen delivery to tissues, which is essential for effective wound healing.

c) **Diabetes Mellitus:** Both pregestational and gestational diabetes increase infection risk due to impaired leukocyte function and delayed collagen deposition (8).

Other Maternal Factors:

- Hypertensive disorders
- Malnutrition
- Immunosuppressive conditions

2) Obstetric Risk Factors

- Prolonged rupture of membranes (>12 hours) (9)
- Prolonged labor
- Multiple vaginal examinations
- Meconium-stained liquor
- Emergency cesarean section

Emergency procedures carry a higher risk of infection due to limited preparation time and increased contamination.

3) Intraoperative Risk Factors

- Operative duration exceeding 60 minutes (10)
- Excessive blood loss
- Improper timing of antibiotic prophylaxis
- Inadequate hemostasis

Prophylactic antibiotics administered within 30–60 minutes before incision significantly reduce SSI incidence (11).

4) Postoperative Risk Factors

- Poor wound care
- Hyperglycemia
- Hematoma or seroma formation
- Prolonged hospitalization
- Delayed ambulation

Early detection and appropriate wound management are critical in preventing progression.

Bacteriological Profile

The bacteriological spectrum of post-cesarean SSI reflects endogenous genital tract flora and hospital-acquired pathogens. Infections are frequently polymicrobial.

Gram-Positive Organisms

The most commonly isolated Gram-positive organism is *Staphylococcus aureus*, including methicillin-resistant strains (MRSA). Streptococcus species and Enterococcus species are also frequently reported, particularly in superficial incisional infections.

Gram-Negative Organisms

Gram-negative bacilli are increasingly identified in post-cesarean SSIs, especially in tertiary care settings. Frequently reported organisms include *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Proteus* species. These organisms are often associated with deeper or more severe infections.

Anaerobic Organisms

Anaerobic bacteria such as *Bacteroides* species and other obligate anaerobes may be isolated, particularly in polymicrobial infections and cases associated with prolonged labor or membrane rupture.

Antimicrobial Resistance Patterns

The emergence of multidrug-resistant organisms has complicated management of SSIs. Increasing resistance has been observed to commonly used antibiotics such as ampicillin and early-generation cephalosporins (12).

Major resistance concerns include:

- Methicillin-resistant Staphylococcus aureus (MRSA)
- ESBL-producing Gram-negative bacilli
- Increasing fluoroquinolone resistance
- Emerging carbapenem resistance

These trends highlight the importance of institution-specific antibiograms and antimicrobial stewardship programs to guide empirical therapy.

2. Clinical Implications

Understanding predictors and local bacteriological trends enables:

- Risk stratification of patients
- Optimization of perioperative management
- Rational empirical antibiotic selection
- Targeted infection control strategies

Routine culture and sensitivity testing remain essential for appropriate definitive therapy.

Prevention Strategies

Preoperative Measures

- Correction of anemia
- Glycemic control
- Appropriate skin antisepsis
- Timely administration of prophylactic antibiotics

Intraoperative Measures

- Strict adherence to aseptic technique
- Gentle tissue handling
- Adequate hemostasis
- Proper wound closure technique

Implementation of WHO surgical safety recommendations has been shown to reduce postoperative infection rates (2).

Postoperative Measures

- Standardized wound care protocols
- Early mobilization
- Monitoring blood glucose levels
- Patient education regarding wound hygiene
- Active surveillance systems

3. Discussion

Surgical site infection following cesarean section remains a substantial contributor to maternal morbidity worldwide. Obesity, diabetes, prolonged rupture of membranes, emergency surgery, and prolonged operative duration consistently emerge as major predictors.

The bacteriological profile varies by region and healthcare setting but generally includes Gram-positive cocci, Gram-negative bacilli, and anaerobic organisms. The increasing prevalence of multidrug-resistant strains underscores the need for rational antibiotic use and continuous microbiological surveillance.

Effective prevention requires a multifaceted approach addressing patient optimization, surgical technique, antibiotic stewardship, and postoperative monitoring.

4. Conclusion

Post-cesarean surgical site infection is a multifactorial and largely preventable complication. Identification of high-risk patients and understanding local bacteriological patterns are critical for effective management. Strengthening infection control measures, optimizing perioperative care, and implementing antimicrobial stewardship programs will significantly reduce maternal morbidity associated with cesarean delivery.

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