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Original Research Paper

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MICROBIAL PROFILE AND ANTIBIOTIC RESISTANCE PATTERN OF SURGICAL SITE INFECTIONS FOLLOWING LOWER SEGMENT CAESAREAN SECTION IN WESTERN RAJASTHAN

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ABSTRACT

Background: Surgical site infection (SSI) following caesarean section is an important cause of maternal morbidity. Because the microbial spectrum and antimicrobial resistance patterns vary geographically, local surveillance is essential for selecting effective empirical therapy. **Methods:** This hospital-based cross-sectional observational study was conducted from April 2024 to March 2026 in the Department of Microbiology, Dr. S. N. Medical College and Associated Group of Hospitals, Jodhpur. A total of 550 deep-wound specimens from women aged 18–45 years with clinically suspected SSI within 30 days after lower segment caesarean section were processed by standard aerobic culture. Isolates were identified by conventional microbiological methods. Antimicrobial susceptibility testing was performed by the Kirby–Bauer disc-diffusion method and interpreted according to applicable CLSI criteria. Methicillin resistance was detected using the cefoxitin-disc method. **Results:** Significant bacterial growth was obtained from 276 of 550 specimens (50.2%). Gram-positive cocci accounted for 193 (69.9%) isolates and Gram-negative bacilli for 83 (30.1%). Coagulase-negative staphylococci (CoNS) were the most frequent isolates (116; 42.0%), followed by Staphylococcus aureus (61; 22.1%), Escherichia coli (33; 12.0%), Klebsiella pneumoniae (33; 12.0%), Enterococcus species (16; 5.8%), Pseudomonas aeruginosa (11; 4.0%) and Citrobacter species (6; 2.2%). Methicillin resistance was detected in 35/61 (57.4%) S. aureus isolates and 71/116 (61.2%) CoNS isolates. All tested Gram-positive isolates were susceptible to vancomycin and linezolid. Overall, 236/276 (85.5%) isolates were multidrug resistant. **Conclusion:** Post-caesarean SSI in this setting was predominantly caused by staphylococci and was associated with a high burden of methicillin resistance and multidrug resistance. Culture-guided treatment, periodic institutional antibiograms, antimicrobial stewardship and strict infection-prevention practices are required.

KEYWORDS : Surgical site infection; Caesarean section; Microbial profile; Antimicrobial resistance; MRSA; CoNS; Multidrug resistance.

INTRODUCTION

Surgical site infection is one of the most frequent healthcare-associated infections and remains a major preventable cause of postoperative morbidity, prolonged hospitalization, readmission and increased healthcare expenditure. [1,2,3]

The burden is disproportionately high in low- and middle-income countries, where limitations in infection-prevention infrastructure, overcrowding and inappropriate antimicrobial use contribute to higher infection rates. [2,4,5]

Caesarean section is among the most commonly performed major surgical procedures worldwide, and its increasing frequency has enlarged the population of women exposed to postoperative infectious complications. [6,7]

Post-caesarean SSI can delay maternal recovery, interfere with breastfeeding and mother–infant bonding, and may progress to wound dehiscence, pelvic infection, sepsis and death. Reported rates vary widely across institutions because of differences in patient characteristics, surveillance methods and perioperative practices. [8,9,10,11]

The causative organisms originate from maternal skin, genital and gastrointestinal flora as well as the hospital environment. Staphylococci, Enterobacterales and non-fermenting Gram-negative bacilli are commonly implicated, but their relative frequency and resistance patterns are institution specific. [12,13,14,15]

The increasing prevalence of methicillin-resistant staphylococci and multidrug-resistant Gram-negative bacilli complicates empirical treatment and emphasizes the need for culture-based therapy and regularly updated local antibiograms. [16,17,18,19,20]

Contemporary data from the semi-arid zone of western Rajasthan are limited. Therefore, this study was undertaken to determine the microbial profile and antimicrobial resistance pattern of SSI following lower segment caesarean section at a tertiary-care centre in Jodhpur.

MATERIALS AND METHODS

Study design and setting: A hospital-based, cross-sectional, observational study was conducted in the Department of Microbiology, Dr. S. N. Medical College and Associated Group of Hospitals, Jodhpur, Rajasthan, from April 2024 to March 2026.

Study population: Women aged 18–45 years with clinically suspected SSI occurring within 30 days after lower segment caesarean section were enrolled by consecutive non-probability sampling. Cases with an appropriate deep-wound specimen and written informed consent were included. Unlabelled, leaking, dried, contaminated, delayed, duplicate or otherwise unsuitable specimens, and patients without consent, were excluded.

Sample size: The minimum calculated sample size was 196 using $n = Z^2pq/d^2$, with an anticipated prevalence of 15%, 95% confidence level and 5% absolute precision. During the study period, 550 eligible patients were included.

Specimen collection and processing: After removal of the

dressing, superficial exudate and surrounding contamination were cleaned with sterile normal saline. Aspirated pus from the depth of the wound was preferred; when aspiration was not feasible, two deep-wound swabs were collected before antimicrobial therapy whenever possible. One swab was used for direct Gram staining and the other for aerobic culture.

Culture and identification: Specimens were inoculated onto blood agar and MacConkey agar and incubated aerobically at 35–37°C for 18–24 hours. Isolates were identified using colony morphology, Gram reaction and standard biochemical tests. Conventional tests included catalase and coagulase tests for staphylococci and appropriate oxidase, indole, methyl-red, citrate, urease, triple-sugar-iron and motility tests for Gram-negative bacilli.

Antimicrobial susceptibility testing: A 0.5 McFarland inoculum was tested by the Kirby–Bauer disc-diffusion method on Mueller–Hinton agar. Inhibition-zone diameters were measured and interpreted according to applicable CLSI criteria. Methicillin resistance in staphylococci was detected using the cefoxitin-disc method. Quality-control procedures were performed using appropriate reference strains. 17,18

Data analysis: Data were entered into the study master chart and summarized using frequencies and percentages. Multidrug resistance was reported according to the operational definition used in the thesis.

Ethical considerations: The study was conducted after approval by the Institutional Ethics Committee. Written informed consent was obtained from all participants, and confidentiality was maintained.

RESULTS

Among 550 clinically suspected post-LSCS SSI specimens, 276 (50.2%) yielded significant bacterial growth and 274 (49.8%) showed no aerobic growth. Gram-positive organisms predominated, accounting for 193 (69.9%) isolates, whereas 83 (30.1%) were Gram-negative.

Table 1. Culture positivity among surgical site infection samples (N=550)

Culture result	Number of samples	Percentage (%)
Culture-positive	276	50.2
No growth	274	49.8
Total	550	100.0

Table 2. Distribution of isolates by Gram reaction (n=276)

Gram reaction	Number of isolates	Percentage (%)
Gram-positive cocci	193	69.9
Gram-negative bacilli	83	30.1
Total	276	100.0

Table 3. Distribution of bacterial isolates among culture-positive samples (n=276)

Organism	Number of isolates	Percentage (%)
Coagulase-negative Staphylococcus (CoNS)	116	42.0
Staphylococcus aureus	61	22.1
Klebsiella pneumoniae	33	12.0
Escherichia coli	33	12.0
Enterococcus species	16	5.8
Pseudomonas aeruginosa	11	4.0
Citrobacter species	6	2.2
Total	276	100.0

CoNS constituted the largest group of isolates, followed by S. aureus. Among Gram-negative organisms, E. coli and K. pneumoniae occurred with equal frequency. This distribution demonstrated a clear predominance of staphylococcal pathogens in post-caesarean wound infection.

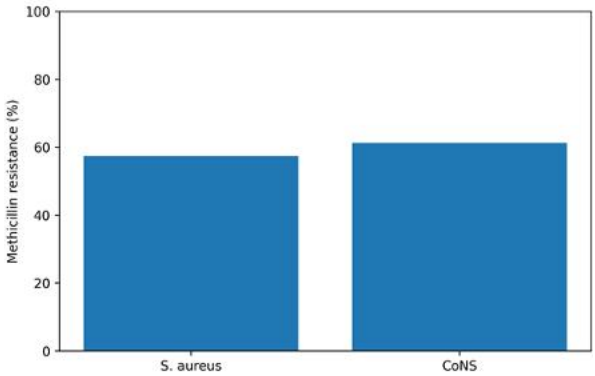

Figure 1. Distribution of bacterial isolates among culture-positive samples (n=276)

Table 4. Methicillin resistance among staphylococcal isolates

Organism	Tested (n)	Methicillin-resistant n (%)	Methicillin-sensitive n (%)
Staphylococcus aureus	61	35 (57.4)	26 (42.6)
Coagulase-negative Staphylococcus	116	71 (61.2)	45 (38.8)

Methicillin resistance was common in both S. aureus and CoNS. All tested Gram-positive isolates remained susceptible to vancomycin and linezolid. The detailed organism-wise antibiograms were retained in the thesis; the present manuscript highlights the resistance findings most relevant to clinical decision-making.

Table 5. Overall burden of multidrug resistance among bacterial isolates (N=276)

Susceptibility result	Number	Percentage (%)
Multidrug-resistant (MDR)	236	85.5
Non-MDR	40	14.5
Total isolates	276	100.0

Overall, 236 of 276 isolates (85.5%) fulfilled the study definition of multidrug resistance, indicating a substantial resistance burden among post-LSCS SSI pathogens.

DISCUSSION

The culture-positivity rate in the present study was 50.2%, demonstrating that approximately half of clinically suspected post-caesarean SSIs yielded an aerobic bacterial pathogen. Differences in culture positivity between studies may reflect prior antibiotic exposure, specimen quality, case definitions, patient characteristics and laboratory methods. [9,10,11,12]

Gram-positive cocci predominated, with CoNS and S. aureus together accounting for nearly two-thirds of all isolates. Staphylococci are common colonizers of skin and can gain access to the operative wound during surgery or postoperative wound care. CoNS, although often regarded as commensals, may be clinically relevant when isolated from appropriately collected deep-wound specimens in a compatible clinical setting. [13,14,16]

E. coli and K. pneumoniae were the leading Gram-negative isolates. Enteric and genital-tract flora may contaminate the surgical field during caesarean delivery, while hospital environmental exposure can contribute to infection by resistant Gram-negative bacilli, including Pseudomonas species. Similar mixed Gram-positive and Gram-negative profiles have been reported in Indian and international studies. [9,10,12,13,14,15,21,19]

Methicillin resistance was detected in 57.4% of S. aureus and 61.2% of CoNS isolates. This high prevalence restricts the

utility of many beta-lactam agents for empirical treatment and supports the need for laboratory confirmation of susceptibility. The preserved activity of vancomycin and linezolid against the tested Gram-positive isolates is reassuring, but these agents should be reserved for appropriate indications and used under antimicrobial-stewardship oversight. [17,18,20]

The overall MDR rate of 85.5% is clinically important. High antimicrobial consumption, empirical broad-spectrum treatment, delayed culture sampling and cross-transmission within healthcare settings may contribute to selection and persistence of resistant organisms. Institution-specific antibiograms and surveillance systems are essential for translating laboratory data into rational empirical treatment policies. [17,18,19,20]

Prevention remains central to reducing post-caesarean SSI. Evidence-based perioperative measures include appropriate antimicrobial prophylaxis, adherence to aseptic technique, optimization of modifiable maternal risk factors, standardized wound care and surveillance with feedback to clinical teams. [1,4,22,23,24,25,26,27,28,29]

The present study provides contemporary microbiological and resistance data from a tertiary-care centre in western Rajasthan. Its findings support early collection of appropriate deep-wound specimens, culture-guided de-escalation and periodic review of institutional prophylaxis and treatment protocols.

These findings should also be interpreted alongside the broader evidence on SSI epidemiology, microbiological surveillance, perioperative prevention and antimicrobial stewardship. 30

CONCLUSION

Post-LSCS surgical site infections in this tertiary-care setting were predominantly caused by Gram-positive cocci, particularly CoNS and S. aureus. More than half of the staphylococcal isolates were methicillin resistant, and the overall burden of multidrug resistance was high. Vancomycin and linezolid retained activity against the tested Gram-positive isolates. Routine microbiological evaluation, culture-guided antimicrobial therapy, periodic local antibiograms, antimicrobial stewardship and rigorous infection-prevention measures are necessary to reduce maternal morbidity and limit further emergence of resistance.

LIMITATIONS

The study was conducted at a single tertiary-care centre and included only clinically suspected post-LSCS SSI cases; therefore, the findings may not be generalizable to all obstetric settings. Anaerobic bacteria and fungi were not evaluated routinely, and molecular characterization of resistance determinants was not performed. Prior antimicrobial exposure may have reduced culture yield. The study focused primarily on microbiological findings and did not provide a denominator-based incidence of SSI among all caesarean deliveries.

RECOMMENDATIONS

Appropriate deep-wound specimens should be collected before antimicrobial therapy whenever feasible. Empirical treatment protocols should be based on periodically updated institutional antibiograms and revised in collaboration with microbiology, obstetrics, infection-control and antimicrobial-stewardship teams. Compliance with surgical prophylaxis, hand hygiene, aseptic wound care and SSI surveillance should be audited regularly.

DECLARATIONS

Ethical approval

Ethical approval was obtained from the Institutional Ethics Committee, Dr. Sampurnanand Medical College, Jodhpur, Rajasthan, India (Certificate Reference No. SNMC/IEC/2026/Plan/1308; dated 01 May 2026). Written informed consent was obtained from all participants, and participant confidentiality was maintained throughout the study.

Informed consent

Written informed consent was obtained from all eligible participants.

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Conflict of interest

The authors declare no conflict of interest.

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Author Contributions

Dr Prinka Choudhary: investigation, data collection, laboratory work and initial drafting. Dr Richa Bareth: manuscript preparation, review, editing and correspondence. Dr R. S. Parihar: conception, supervision and critical revision. Dr Mukesh: methodology support, interpretation and critical review. Dr Mukesh Sharma: critical review of the manuscript and approval of the final version.

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