



ISSN:

2542-2758 (Print) 2542-2804 (Online)

ARTICLE INFO:

Received date: August 10, 2025

Accepted date: December 14, 2025

Published date: December 31, 2025

KEYWORDS:

Anaerobic bacteria, *Bacteroides fragilis*, Drug Resistance, Microbial, Drug Sensitivity Tests, Surgical Wound Infection

CORRESPONDING AUTHOR:

Bijoylakshmi Dewasy (PhD Scholar)

Assistant Professor

Department of Microbiology pattern,
Birat Medical College Teaching Hospital
Budhiganga-2, Morang, Nepal

Email: dewasy1983@gmail.com

ORCID ID: 0000-0002-0115-4701

Access the article online



DOI: 10.62065/bjhs732

CITATION:

Dewasy BL, Tuladhar R, Singh RK, Singh PR, Pokharel HP, Singh A. Anaerobic Bacteria from Surgical Site Infections and Its Antibiotic Susceptibility Pattern in Eastern Nepal: A Prospective Study. 2025; 10 (3): 97-103.

COPYRIGHT:

© Authors retain copyright and grant the journal right of first publication with the work simultaneously licensed under Creative Commons Attribution License CC - BY 4.0 which allows others to share the work with an acknowledgment of the work's authorship and initial publication in this journal.



Anaerobic Bacteria from Surgical Site Infections and Its Antibiotic Susceptibility Pattern in Eastern Nepal: A Prospective Study

Bijoylakshmi Dewasy^{1,2*}, Reshma Tuladhar¹, Randhir Kumar Singh², Praveer Raj Singh³, Hanoon P Pokharel⁴, Anjana Singh¹

¹ Central Department of Microbiology, Kirtipur, Tribhuvan University, Kathmandu, Nepal

² Department of Microbiology, Birat Medical College Teaching Hospital, Biratnagar, Morang, Nepal

³ Department of Surgery, Kathmandu Model Hospital, Kathmandu, Nepal

⁴ Department of Obstetric and Gynaecology, Birat Medical College & Teaching Hospital, Tankisinwari-2, Morang, Nepal

ABSTRACT

Introduction: Surgical site infections (SSIs) remain a major cause of postoperative morbidity, with anaerobic bacteria increasingly recognized as significant pathogens. Understanding their prevalence, associated risk factors, and antibiotic susceptibility is critical to inform effective empirical therapy and optimize patient outcomes.

Objectives: To isolate and identify anaerobic bacteria from SSIs and assess their antibiotic susceptibility patterns during phase II.

Methodology: A prospective analytical cross-sectional study was conducted at Birat Medical College Teaching Hospital, Morang, Nepal, from April 2023 to December 2023. The study included 641 patients in phase I and 701 patients in phase II. Clinical specimens were collected and processed for anaerobic bacterial isolation. Antibiotic susceptibility testing was performed following CLSI guidelines. Host factors, infection sites, and laboratory parameters were analyzed for associations with anaerobic culture-positive SSIs.

Results: The overall prevalence of SSIs was 12.3%, with 5.7% caused by anaerobic bacteria. The most common anaerobic pathogen was *Bacteroides fragilis* (35%), followed by *Peptoniphilus asaccharolyticus* (27.5%), *Bacteroides thetaiotamicron* (22%), and *Clostridium perfringens* (15%). Nearly 50% of the anaerobic isolates exhibited resistance to metronidazole and tetracycline. Significant associations were observed between comorbidities and infection sites in anaerobic culture-positive cases.

Conclusion: This study highlights the growing antimicrobial resistance among anaerobic pathogens and need for updated antibiotic prophylaxis strategies to improve the management of SSIs. *B. fragilis* was the predominant anaerobic pathogen, and notable resistance to key antibiotics was observed. The study also identified significant associations between comorbidities, infection sites and anaerobic infections.

Introduction

Surgical site infections (SSIs) are common postoperative complications that occur at or near the surgical incision, particularly when prosthetic materials are implanted during surgery.¹ These infections often arise from the patient's own normal flora. Surgical wounds are generally classified as clean, clean-contaminated, contaminated, or dirty, based on the degree of microbial contamination.² Both aerobic and anaerobic bacteria can be responsible for SSIs.³

Preoperative optimization plays a critical role in preventing SSIs. Strategies may include controlling diabetes, enhancing immune function, addressing malnutrition and obesity, optimizing skin condition, improving vascular health, promoting smoking cessation, and adjusting immunosuppressive medications.⁴ Additionally, hematological parameters such as white blood cell (WBC) count, C-reactive protein (CRP), and erythrocyte sedimentation rate (ESR) are increasingly utilized for early detection and assessment of SSIs.^{5,6}

The emergence of antibiotic resistance due to the overuse of antibiotics has significantly influenced the incidence and management of SSIs.⁶ Among anaerobic pathogens, commonly implicated bacteria include *B. fragilis*, *Prevotella* spp., *Porphyromonas* spp., *Fusobacterium* spp., *Peptoniphilus* spp., and *Clostridium* spp. Understanding the distribution of these pathogens, their resistance patterns, and associated clinical factors is essential for guiding empirical therapy and improving surgical outcomes.

This study aims to compare the rate and patterns of anaerobic bacteria in SSIs during phases I and II, focusing on pathogen identification and antibiotic susceptibility to support evidence-based antimicrobial management.

Methodology

A hospital-based analytical cross-sectional study was conducted at Birat Medical College Teaching Hospital (BMCTH), Morang, Nepal. Phase I (October 2021–December 2022) included 641 surgical patients out of 5,487. Phase II (April 2023–December 2023) enrolled 701 patients out of 7,239 to assess anaerobic bacterial profiles and resistance patterns. Patients with SSIs admitted to general surgery, orthopedics, obstetrics, and gynecology wards were included. Ethical approval was obtained from the Nepal Health Research Council (NHRC; Ref. No. NHRC 234/2020 & 160/2023), and written informed consent was obtained from adults (≥18 years) or guardians for minors.

The Phase II sample size was calculated using Cochran's formula, assuming 38% prevalence.⁷

$$\begin{aligned} \text{Sample size (n)} &= \frac{z^2 \times P \times Q}{d^2} \\ &= \frac{1.96^2 \times 0.38 \times 0.62}{0.038^2} \\ &= 627 \end{aligned}$$

Inclusion criteria were patients of any age and sex with SSIs per CDC guidelines; patients from ICU, with blood/urine/sputum samples, or incomplete records were excluded. Preoperative, intraoperative, and postoperative antibiotic administration followed WHO guidelines (2016), with patient risk factors and hematological and renal parameters collected from operative records.⁸

Sample collection and microbiology: Pus, tissue, and body fluids were aseptically collected and transported in anaerobic vials. Samples were inoculated into Robertson's cooked meat broth and incubated overnight, then sub cultured on blood agar, Brucella blood agar, and Bacteroides bile esculin agar for 48–72

hours in anaerobic jars with AnaeroGas Packs, indicators, and palladium catalysts.⁹ Metronidazole discs (5 µg) were used to selectively isolate anaerobic bacteria, and aerotolerance tests distinguished obligate from facultative anaerobes. Obligate anaerobes were confirmed by susceptibility to colistin (10 µg), kanamycin (1,000 µg), and metronidazole (5 µg) discs.¹⁰ Bacterial identification employed conventional methods and the Vitek 2 Compact System (BioMérieux), with *Bacteroides fragilis* ATCC 25285 as the control.^{11,12}

Antibiotic susceptibility: Agar dilution determined minimal inhibitory concentrations (MICs) for cefoxitin, tetracycline, piperacillin/tazobactam, clindamycin, imipenem, and metronidazole according to CLSI guidelines.¹² MIC ranges were: metronidazole 0.125–64 µg/mL; imipenem and clindamycin 0.125–16 µg/mL; piperacillin/tazobactam 0.125–128 µg/mL; cefoxitin 2–64 µg/mL; tetracycline 2–16 µg/mL.

Data analysis: Data were entered in MS Excel and analyzed using SPSS v29. Frequencies, percentages, and odds ratios from logistic regression assessed associations between anaerobic culture positivity and socio-demographic, clinical, hematological, and renal parameters. A p-value <0.05 was considered statistically significant.

Results

Among the 701 operated patients in Phase II, the overall SSI rate was 86 (12.3%), with 40 cases (5.71%) confirmed as anaerobic SSIs. Clinical samples were predominantly obtained from pus 22 (55%), followed by body fluids 12 (30%) and tissues 6 (15%).

Analysis of socio-demographic and clinical factors showed that age, gender, hospital unit, wound category and urgency of surgery were not significantly associated with anaerobic culture-positive SSIs. However, the presence of comorbidities and the anatomical site of infection were significantly associated with anaerobic SSIs ($p < 0.05$) (Table 1).

Table 1: Association of anaerobic culture result with socio-demographic and clinical characteristics of the study population in Phase II

Host factors	Anaerobic culture positive			
		N (%)	Odds ratio (95% CI)	p-value
Age group (years)	0-10	6(15)	0.25 (0.01- 4.73)	0.355
	11-20	3(7.5)	1 (0.05- 18.92)	1
	21-30	16(40)	0.67 (0.09- 5.13)	0.697
	31-40	2(5)	2 (0.08- 51.6)	0.676
	41-50	5(12.5)	0.5 (0.03- 7.99)	0.624
	51-60	3(7.5)	1 (0.05- 18.92)	1
	61-70	3(7.5)	2 (0.05- 18.92)	1
	71-80	2(5)	2 (0.08- 51.6)	0.676
Gender	Male	19(47.5)	2.48 (0.59- 10.4)	0.215
	Female	21(52.5)	2.13 (0.45- 10.1)	0.339
Units	General Surgery	19(47.5)	2.18 (0.19- 25.02)	0.531
	Gynaecology	4(10)	5.33 (0.53- 54.03)	0.157
	Orthopaedic	17(42.5)	2.91 (0.6- 14.18)	0.186
Comorbidities	Diabetes mellitus	4(10)	0.33 (0.16- 0.71)	0.004
	Large number of visitors	4(10)	0.44 (0.22- 0.89)	0.023
	Increasing age	2(5)	0.36 (0.17- 0.74)	0.005
	Smoking/alcohol	7(17.5)	0.43 (0.21- 0.91)	0.028
	Weak immune system	11(27.5)	0.26 (0.11- 0.64)	0.003
	Obesity	6(15)	0.42 (0.2- 0.87)	0.02
	Malnutrition	1(2.5)	0.34 (0.17- 0.71)	0.004
	Prolong hospitalization	3(7.5)	0.42 (0.21- 0.86)	0.017
No comorbidities	2(5)	-	-	
Wound category	Clean	16(40)	0.26 (0.1- 0.7)	0.008
	Clean contaminated	7(17.5)	0.57 (0.28- 1.16)	0.122
	Contaminated	18(45)	0.83 (0.36- 1.93)	0.67
Urgency of Surgery	Elective	31(77.5)	2.78 (0.3- 25.86)	0.368
	Emergency	9(22.5)	1.44 (0.29- 7.14)	0.657
Observe of SSIs (days)	1 to 7	8(20)	2.33 (0.34- 15.8)	0.385
	8 to 14	18(45)	1.7 (0.42- 6.88)	0.457
	15 to 21	9(22.5)	0.7 (0.12- 4.03)	0.688
	21 to 30	5(12.5)	1.5 (0.14- 16.32)	0.739
Site of infections	Necrotising fasciitis	6(15)	0.36 (0.17- 0.77)	0.009
	Cellulitis	8(20)	0.23 (0.09- 0.56)	0.001
	Perforative Peritonitis	2(5)	0.19 (0.08- 0.45)	<0.001
	Appendicular abscess	5(12.5)	0.21 (0.09- 0.5)	<0.001
	Periodontal abscess	4(10)	0.2 (0.08- 0.48)	<.001
	Liver abscess	1(2.5)	0.18(0.08- 0.43)	<0.001
	Pancreatic abscess	8(20)	0.23 (0.09- 0.56)	0.001
	Perianal abscess	1(2.5)	0.18 (0.08- 0.43)	<0.001
	Intraabdominal abscess	3(7.5)	0.19 (0.08- 0.46)	<0.001
	Caesarean abscess	2(5)	0.19 (0.08- 0.45)	<0.001

Logistic regression analysis of hematological and renal parameters revealed that total leukocyte count (TLC) was significantly associated with anaerobic SSIs ($p = 0.003$), while neutrophil percentage, ESR, CRP, albumin, random blood sugar, uric acid, sodium, potassium, and creatinine showed no significant association (Table 2).

Table 2: Haematological and renal function tests of SSIs patients in Phase II

Parameters	Haematological risk factors		
	Anaerobic culture positive blood sample n(%)	Odds ratio (95% CI)	p-value
TLC (WBCs/ul)		0.05 (0.01- 0.37)	0.003
Normal	21 (52.5)		
Increased	19 (47.5)		
Neutrophils (%)		0.33 (0.03- 3.2)	0.341
Normal	4 (10)		
Increased	36 (90)		
ESR (mm/hr)		1.96 (0.48- 7.99)	0.346
Normal	23 (57.5)		
Increased	17 (42.5)		
CRP (mg/L)		0.48 (0.09- 2.49)	0.383
<12	10(25)		
>12	30 (75)		
Albumin (g/dL)		1.27 (0.3- 5.46)	0.748
1-4	27 (67.5)		
>4	13 (32.5)		
Random blood sugar (mg/dl)		1.96 (0.42- 9)	0.78
1-100	27 (67.5)		
>100	13 (32.5)		
Uric acid (mmol/L)		1.44 (0.3- 6.87)	0.644
Normal	16 (40)		
Increased	24 (60)		
Sodium (mmol/L)		3.75 (0.21- 66.77)	0.368
Normal	38 (95)		
Increased	2 (5)		
Potassium (mmol/L)		2.8 (0.16- 49.11)	0.481
Normal	38 (95)		
Increased	2 (5)		
Creatinine (g/dl)		3.75 (0.51- 27.5)	0.194
Normal	32 (80%)		
Increased	8 (20%)		

Out of 40 (5.71%) anaerobic bacterial isolates the *B. fragilis* 14 (35%) was the most prevalent followed by *B.*

thetaiotamicron 9 (22%), *Cl. perfringens* 6 (15%) and *P. asaccharolyticus* 11 (27.5%) in SSIs (Figure 1).

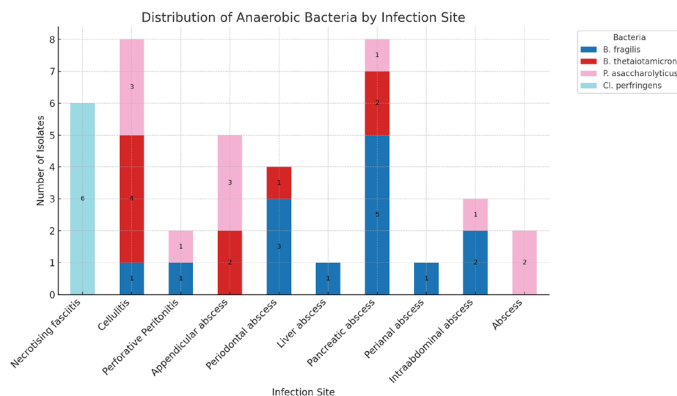


Figure 1: Anaerobic bacteria isolated from various SSIs in Phase II (n=40)

Antibiotic susceptibility patterns revealed high resistance rates among the isolates. *B. fragilis* was highly resistant to metronidazole 11 (78.6%), followed by tetracycline 9 (64.3%), clindamycin 7 (50%) and imipenem 5 (35.7%). Similarly, *B. thetaiotamicron* was resistant to tetracycline 5 (55.6%) and metronidazole 3 (33.3%). *P. asaccharolyticus* was resistant to metronidazole (36.4%), clindamycin (36.4%) and tetracycline (36.4%) respectively. *Cl. perfringens* was resistant to metronidazole (33.3%), clindamycin (33.3%), ceftioxin (33.3%) and tetracycline (33.3%) respectively. All isolated anaerobic bacteria were sensitive to ceftioxin (82.5%) (Table 3).

Table 3: Antibiotic susceptibility pattern of anaerobic bacteria in Phase II

Bacterial species	Antibiotics	MIC Range (µg/mL)	MIC50	MIC90	% Susceptible	% Resistant
Bacteroides fragilis (N=14)	Metronidazole	0.125 to 64	32	64	21.4% (3/14)	78.6%(11/14)
	Imipenem	0.125 to 16	2	16	64.3% (9/14)	35.7% (5/14)
	Clindamycin	0.25 to 16	5	16	50.0% (7/14)	50.0% (7/14)
	Piperacillin/tazobactam	0.125 to 128	8	128	71.4% (10/14)	28.6% (4/14)
	Cefoxitin	2 to 64	8	32	85.7% (12/14)	14.3% (2/14)
	Tetracycline	2 to 16	8	16	35.7% (5/14)	64.3% (9/14)
Bacteroides thetaiotamicron ((N=9)	Metronidazole	0.125 to 64	2	64	66.7% (6/9)	33.3%(3/9)
	Imipenem	0.125 to 16	1	16	77.8% (7/9)	22.2%(2/9)
	Clindamycin	0.25 to 16	1	16	66.7% (6/9)	33.3%(3/9)
	Piperacillin/tazobactam	0.125 to 128	4	128	77.8% (7/9)	22.2%(2/9)
	Cefoxitin	2 to 64	8	64	88.9% (8/9)	11.1%(1/9)
	Tetracycline	2 to 16	8	16	44.4% (4/9)	55.6%(5/9)
Peptoniphilus asaccharolyticus(N=11)	Metronidazole	0.125 to 64	2	64	63.6% (7/11)	36.4%(4/11)
	Imipenem	0.125 to 16	1	16	72.7% (8/11)	27.3%(3/11)
	Clindamycin	0.25 to 16	1	16	63.6% (7/11)	36.4%(4/11)
	Piperacillin/tazobactam	0.125 to 128	4	128	81.8% (9/11)	18.2%(2/11)
	Cefoxitin	2 to 64	8	64	81.8%(9/11)	18.2%(2/11)
	Tetracycline	2 to 16	8	16	63.6%(7/11)	36.4%(4/11)
Clostridium perfringens(N=6)	Metronidazole	0.125 to 64	32	64	66.7% (4/6)	33.33%(2/6)
	Imipenem	0.125 to 16	2	16	83.3% (5/6)	16.7%(1/6)
	Clindamycin	0.25 to 16	5	16	66.7% (4/6)	33.3%(2/6)
	Piperacillin/tazobactam	0.125 to 128	8	128	83.3%(5/6)	16.7%(1/6)
	Cefoxitin	2 to 64	8	32	66.7% (4/6)	33.3%(2/6)
	Tetracycline	2 to 16	8	16	66.7% (4/6)	33.3%(2/6)

Discussion

In the present phase II, SSIs decreased markedly to 12.3%, with anaerobic SSIs at 5.7%, representing a 36.2% overall reduction and a 3.8% decline in anaerobic SSIs. These values are comparable to reports from the United States (4.7%) and Thailand (2.5%).⁹ The proportion of postoperative wound specimens declined to 47.5% in phase II, along with an 18.1% reduction in pus specimens, underscoring the value of sustained SSIs surveillance in infection prevention programs.¹⁴

Age and gender distribution in phase II showed more cases in females. Age group 21-30 showed high SSIs likely due to obstetric procedures. Demographic factor did not show significant associations with anaerobic culture positivity as showed by earlier studies.¹⁵ Contaminated wounds predominated in phase II (45%), while no dirty wounds were reported. As noted previously, wound class may not reliably predict SSIs because classification depends on intraoperative judgment and patient-specific factors.¹⁵ Length of hospital stay also did not correlate with SSIs, possibly reflecting improvements in perioperative care.¹⁶ SSIs were more common in elective than emergency

surgeries, comparable to findings by Cheng et al. (2015).¹⁵

Infection site showed a significant association with anaerobic culture positivity. In phase II, cellulitis and pancreatic abscesses were common, whereas phase I predominantly yielded cellulitis and necrotizing fasciitis. Variations likely reflect differences in contamination risk across anatomical locations: colorectal wounds carry high microbial loads; orthopedic and cardiac implants favor biofilms; abdominal wounds heal slowly; and extremity wounds are environmentally exposed.^{1,17}

Among hematological markers, only WBC count showed a significant association with anaerobic SSIs in this phases. This aligns with Muna and Al-Hameed (2022), who reported elevated WBCs in bacterial infections,¹⁸ although CRP remained non-specific.¹⁹

Bacteroides spp. were the most frequent isolates in phase II (35%), consistent with phase I (31.2%) and higher than reported by Singh et al. (19.1%) and Shenoy et al. (20.9%).^{13,20} Other isolates included *B. thetaiotamicron* (22.5%), *Cl. perfringens* (16%), and *P. asaccharolyticus* (27.5%). Variability across studies likely reflects geographic and clinical differences.

Metronidazole resistance (50%) was slightly lower than phase I (54.1%) but higher than the 7–31% reported by Sood et al. (2021).¹⁶ The highest resistance occurred in *B. fragilis* (78.6%). In this Phase II study Imipenem resistance reached (27.5%), significantly higher than the reports by Sood et al. (2021) and Young et al(2014).^{16,21} Clindamycin resistance (40%) increased from phase I and comparable to global trends of rising resistance.¹⁶ Piperacillin–tazobactam resistance (22.5%) also increased compared to phase I, whereas ceftioxin resistance (17.5%) remained lower than previous reports.¹⁶ Tetracycline resistance was greatest in *B. fragilis* (64.3%), with moderate increases in other species across phases.

Clinically important anaerobic bacteria were isolated which represents. The reduction in anaerobic isolates and resistant strains following changes in surgical prophylaxis in phase II highlights the importance of continued anaerobic bacteriology surveillance to guide SSIs management and antimicrobial Stewardship.

Conclusion

This phase II study confirms *Bacteroides fragilis* as the leading anaerobic pathogen associated with surgical site infections, consistent with our phase I findings. Comorbidities, infection site, and elevated WBC counts were significantly associated with anaerobic culture-positive SSIs, underscoring their clinical relevance. The antibiotic susceptibility pattern highlights the need for informed empirical therapy, as resistance among anaerobes continues to evolve. Strengthening anaerobic diagnostics and integrating resistance data into local treatment guidelines will be essential to improving clinical outcomes.

Recommendations

Routine surveillance of anaerobic pathogens should be conducted at regular intervals preferably every five years and include multicenter data to better capture regional resistance trends. Standardization of antibiotic panels for anaerobic testing is strongly recommended to ensure comparability across laboratories. Based on our findings, ceftioxin and piperacillin tazobactam demonstrated the most favorable susceptibility profiles and may be considered first-line empiric options for anaerobic infections. Conversely, antibiotics such as clindamycin, tetracycline, and metronidazole should be used judiciously and guided strictly by susceptibility results.

Limitations

Only phenotypic methods were used for identification and antibiotic susceptibility testing. Incorporation of molecular approaches such as resistance gene detection would have provided more precise insights into the underlying mechanisms of antimicrobial resistance and strengthened the study's conclusions.

Acknowledgment

We gratefully acknowledge the Central Department of Microbiology, Tribhuvan University, and Birat Medical College Teaching Hospital, Biratnagar, for providing essential laboratory

facilities. We also extend our sincere thanks to the Research Endowment Fund (REF-2078), Tribhuvan University, for financial support.

Conflict of Interest

The authors declare no conflict of interest.

Financial Disclosure

This study was funded by the Research Endowment Fund (REF-2078), Tribhuvan University.

References

1. Chopra H, Islam MA, Sharun K, Emran TB, Al-Tawfiq JA, Dhama K, et al. Recent advances in the treatment of biofilms-induced surgical site infections. *Int J Surg*. 2023;109:65-7. DOI: [10.1097/JS9.000000000000036](https://doi.org/10.1097/JS9.000000000000036) PMID: 36799798 PMCID: PMC10389243
2. Scolaro JA, Agel J, Marmor M, Dumpe J, Karam M, Kellam J, et al. Adaptation of the CDC surgical wound classification system for orthopaedic trauma surgery. *J Orthop Trauma*. 2022;36(5):219-23. DOI: [10.1097/BOT.0000000000002269](https://doi.org/10.1097/BOT.0000000000002269) PMID: 35588171
3. Akhi MT, Ghotaslou R, Beheshtirouy S, Asgharzadeh M, Pirzadeh T, Asghari B, et al. Antibiotic susceptibility pattern of aerobic and anaerobic bacteria isolated from surgical site infections. *Jundishapur J Microbiol*. 2015;8(7):e20309. DOI: [10.5812/jjm.20309v2](https://doi.org/10.5812/jjm.20309v2)
4. Sigurdardottir M, Sigurdsson MI, Vias RD, Olafsson Y, Gunnarsdottir I, Sigurdsson EL, et al. Preoperative optimization reduces superficial SSIs after arthroplasty. *Acta Orthop*. 2024;95:392. DOI: [10.2340/17453674.2024.41012](https://doi.org/10.2340/17453674.2024.41012) PMID: 39016247 PMCID: PMC11253708
5. Karakaya TK, Keskin DD. Hematological and inflammatory parameters predicting SSIs after cesarean delivery. *Mid Blac Sea J Health Sci*. 2024;10(1):71-80. DOI: [10.19127/mbsjohs.1405504](https://doi.org/10.19127/mbsjohs.1405504)
6. Onyegbule O, Akujobi C, Ezebialu I, Nduka A, Anahalu I, Okolie V, et al. Determinants of post-caesarean wound infection. *Br J Med Med Res*. 2014;5(6):767-74. DOI: [10.9734/BJMMR/2015/10297](https://doi.org/10.9734/BJMMR/2015/10297) PMID: 26020728
7. Mekhla, Borle FR. Determinants of superficial SSIs in abdominal surgeries. *J Family Med Prim Care*. 2019;8(7):2258-63. DOI: [10.4103/jfmpc.jfmpc_419_19](https://doi.org/10.4103/jfmpc.jfmpc_419_19) PMID: 31463239 PMCID: PMC6691442
8. World Health Organization. WHO Global Guidelines for the Prevention of Surgical Site Infections. Geneva: WHO; 2016.

9. Chukwuma ST, Balogun OS, Oduyebo OO, Oshun PO, Osuagwu CS, Rotimi VO, et al. Prevalence of anaerobic bacteria in SSIs. *J West Afr Coll Surg.* 2024;14(3):166-73. DOI: [10.4103/jwas.jwas_91_23](https://doi.org/10.4103/jwas.jwas_91_23) PMID: 38562385 PMCID: PMC10980329
10. Nema S, Brahmachari S, Vishnu TN, Biswas D. Anaerobic pyogenic infections: a two-year study. *J Family Med Prim Care.* 2021;10(7):2512-7. DOI: [10.4103/jfmprc.jfmprc_2368_20](https://doi.org/10.4103/jfmprc.jfmprc_2368_20) PMID: 34568128 PMCID: PMC8415683
11. Mohod SV, Gedam DS, Rajan AL, Khadse RK, John R, Rajan A, et al. Automated profiling of MDR pathogens. *Cureus.* 2025;17(6):e85778. DOI: [10.7759/cureus.85778](https://doi.org/10.7759/cureus.85778)
12. Clinical and Laboratory Standards Institute (CLSI). *Methods for Antimicrobial Susceptibility Testing of Anaerobic Bacteria.* CLSI document M11-A9. Wayne (PA): CLSI; 2018.
13. Singh C, Sood A, Bala K, Tandup C, Ray P, Angrup A, et al. Anaerobic infections in surgical units. *Iran J Microbiol.* 2021;13(3):274-81. DOI: [10.18502/ijm.v13i3.6387](https://doi.org/10.18502/ijm.v13i3.6387)
14. Duran A, Gülay H, Terzi MC. Risk factors for SSIs. *Surg Sci.* 2024;15(2):64-80. DOI: [10.4236/ss.2024.152008](https://doi.org/10.4236/ss.2024.152008) PMID: 40291884; PMCID: PMC12019035
15. Cheng K, Li J, Kong Q, Wang C, Ye N, Xia G. Risk factors for SSIs: a prospective study. *Patient Prefer Adherence.* 2015;9:1171-7. DOI: [10.2147/PPA.S86153](https://doi.org/10.2147/PPA.S86153) PMID: 26316722 PMCID: PMC4542557
16. Sood A, Ray P, Angrup A. Antimicrobial resistance in anaerobic isolates. *JAC Antimicrob Resist.* 2021;3(3):dlab044. DOI: [10.1093/jacamr/dlab044](https://doi.org/10.1093/jacamr/dlab044) PMID: 34223113 PMCID: PMC8210138
17. Young PY, Khadaroo RG. Surgical site infections. *Surg Clin North Am.* 2014;94(6):1245-64. DOI: [10.1016/j.suc.2014.08.008](https://doi.org/10.1016/j.suc.2014.08.008) PMID: 25440122
18. Muna AM, Alhameed RA. CRP and WBC as markers in orofacial infections. *J Oral Maxillofac Surg.* 2022;80(4):530-6. DOI: [10.1016/j.joms.2021.08.158](https://doi.org/10.1016/j.joms.2021.08.158) PMID: 34571045
19. Liu J, Xu X, Lv X, Shen G. SSI and platelet count association. *J Int Med Res.* 2022;50(1):03000605211068689. DOI: [10.1177/03000605211068689](https://doi.org/10.1177/03000605211068689) PMID: 35098779 PMCID: PMC8801652
20. Ananth-Shenoy P, Vishwanath S, Targain R, Shetty S, Sunil-Rodrigues G, Mukhopadhyay C, et al. Anaerobic infections in surgical wards. *Iran J Microbiol.* 2016;8(3):181-6. PMID: 27928485; PMCID: PMC5139921
21. Reissier S, Penven M, Guérin F, Cattoir V. Trends in antimicrobial resistance among anaerobic isolates. *Microorganisms.* 2023;11(6):1474. DOI: [10.3390/microorganisms11061474](https://doi.org/10.3390/microorganisms11061474) PMID: 37374976 PMCID: PMC10302625