International Journal of Research in Medical Sciences
Verma S et al. Int J Res Med Sci. 2025 Mar;13(3):1094-1099
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20250672

Original Research Article

Bacterial analysis of high vaginal swabs from women of reproductive age at a tertiary hospital in Lucknow

Sneha Verma[1], Sarah Hassan[1]*, Priyanka Shukla[1], Ayesha Ahmad[2], Riya Nag[3]

[1]Department of Microbiology, Era's Lucknow Medical and Hospital, Lucknow, Uttar Pradesh, India
[2]Department of Obstetrics and Gynecology, Era's Lucknow Medical College and Hospital, Lucknow, Uttar Pradesh, India
[3]Department of Medical Biochemistry, Era's Lucknow Medical College and Hospital, Lucknow, Uttar Pradesh, India

Received: 21 November 2024
Revised: 20 December 2024
Accepted: 19 February 2025

***Correspondence:**
Dr. Sarah Hassan,
E-mail: drsarahabid@gmail.com

ABSTRACT

Background: Vaginal infections are prevalent among women, often caused by disruptions in the vaginal microbiota, leading to symptoms like abnormal discharge, itching, and discomfort. Bacterial vaginosis (BV) is a common condition characterized by a shift from *Lactobacillus* dominance to anaerobic bacteria overgrowth, affecting reproductive-age women significantly. Understanding the microbial ecology and antibiotic susceptibility of vaginal pathogens is crucial for effective management. The study aims to identify bacterial profiles and antibiotic susceptibility patterns from high vaginal swabs. Objectives include determining prevalent pathogenic bacteria and analyzing their antibiotic susceptibility.
Methods: A cross-sectional study at Era's Lucknow Medical College and Hospital over six months analyzed 73 high vaginal swabs from gynecological clinic attendees. Data collection covered demographics, clinical symptoms, and antibiotic history. Laboratory methods included Gram staining, culture on selective media, biochemical tests, and antibiotic susceptibility testing using the Kirby-Bauer disc diffusion method per CLSI guidelines.
Results: In this study at Era's Lucknow Medical College and Hospital, 73 high vaginal swab samples were cultured, with 37 (50.7%) testing positive for various pathogens. *Escherichia coli* was the predominant organism (57%), followed by *Enterococcus* species (22%), *Klebsiella pneumoniae* (13%), *Staphylococcus aureus* (5%), and *Pseudomonas aeruginosa* (3%). Antibiotic susceptibility testing revealed high effectiveness against Gram-negative bacteria, particularly for imipenem, meropenem, and colistin, with rates exceeding 80%.
Conclusions: *Escherichia coli* was found to be the most common cause of abnormal vaginal discharge in women of the reproductive age group.

Keywords: Antibiotic sensitivity, Bacterial vaginosis, Escherichia coli, High vaginal swab, Reproductive-age women

INTRODUCTION

A variety of bacteria are present in the vagina, which is a complicated system.[1] During several life phases, including birth, puberty, and menopause, this unique ecosystem experiences substantial changes.[2] Females' small urethra and physical and physiological closeness to the anal canal make them more vulnerable to vaginal and urinary tract infections.[3] The vaginal microbiota, identified over 150 years ago, is a complex environment hosting numerous microbial species.[4] The proliferation of naturally existing bacteria in the vagina can result in vaginitis and excessive urination. By establishing an acidic environment, generating compounds such as bacteriocin and hydrogen peroxide, and contending for mannose receptors on epithelial cells, the typical vaginal flora preserves the vaginal environment.[5]

Among young, sexually active women between the ages of 26 and 35, vaginal infections are especially prevalent. Early sexual activity, low socioeconomic position, and poor cleanliness are the primary risk factors for symptomatic vaginal infections. The pH stays ≤4.5 in vaginal candidiasis but rises in bacterial vaginosis. Vaginal discharge can be caused by physiological, infectious (such as trichomoniasis, candidiasis, and bacterial vaginosis), and non-infectious causes (such as foreign substances, cervical ectopy, and genital tract cancer).[6] Itching, burning, irritation, pain, and irregular discharge are signs of vaginal infections.[7]

Among the many organisms carried by women of reproductive age are *Escherichia coli* (*E. coli*), *Candida*, *Listeria*, and Group B *Streptococci* (GBS). Life-threatening newborn illnesses including sepsis, meningitis, and necrotizing enterocolitis can result from preterm delivery and extremely low birth weight babies, which are closely linked to *E. coli*. Problems may arise if *E. coli* infiltrates the chorioamnion or amniotic fluid when it is passing through the birth canal or prior to delivery.[8] GBS colonization is a significant risk factor for chorioamnionitis, preterm labor, and low birth weight.[9] Aerobic vaginitis, characterized by disturbed microflora and increased pH, causes symptoms like yellowish discharge and dyspareunia.[10] Bacterial vaginosis can be diagnosed using clinical criteria or laboratory scoring systems.[11]

When a woman of reproductive age has an acidic vaginal pH (≤4.5), the vagina is often protected from common pathogenic diseases. Lactic acid is produced by the commensal bacteria *Lactobacillus* in the vagina to maintain this acidic pH. *Gardnerella vaginalis*, *Mobiluncus*, and *Lactobacillus* proportions are graded using standard tables called Nugent's grading method. High Nugent scores are linked to a higher risk of STDs, preterm delivery, and negative perinatal outcomes include pelvic inflammatory disease, chorioamnionitis, postpartum endometritis, repeat abortion, and post-abortal sepsis. The chance of an early birth is doubled in pregnant women with bacterial vaginosis.[12]

Neisseria gonorrhea, Chlamydia trachomatis, Trichomonas vaginalis, and GBS (*Streptococcus agalactiae*) are common causes of vaginal discharge, while gram-negative rods including *E. coli, Klebsiella, Proteus, Acinetobacter, and Pseudomonas spp.* are other sources of transmission.[13] Although it's a common issue, vaginal discharge is frequently ignored. Simple tests, including wet mount and Gram stain, are inexpensive and widely regarded as the gold standard for diagnosis, and they may readily identify these infections.[14]

The kind of epithelium present and other aspects of the microenvironment determine which infections can affect the vagina, ectocervix, and endocervix. *Candida* species, *Trichomonas vaginalis*, and *Gardnerella vaginalis* can infect the squamous epithelium of the vagina and ectocervix.[15,16]

Antibiotics are crucial for treating bacterial infections but face challenges due to increasing antibiotic resistance, exacerbated by factors like over-the-counter availability, incomplete therapy, and low-quality antibiotics.[17,18] Given the lack of extensive research in Lucknow, this study aimed to understand the current trends in sensitivity patterns of common bacterial isolates from high vaginal swabs.

METHODS

The present study was a cross-sectional study. This study was carried out in the department of microbiology in collaboration with the department of obstetrics and gynecology at Era's Lucknow Medical College and Hospital, Lucknow. Institutional ethical committee approval was obtained. Ethical number- No. ECR/717/Inst./U.P./2015/RR-21. Informed consent was taken. Study period was from September 2022- September 2024.

Study population and patient selection

The study population consisted of 73 patients attending the gynaecological outpatient (OPD) and inpatient (IPD) departments at Era's Lucknow Medical College and Hospital, Lucknow. Patients were selected based on their attendance at these departments, and detailed information including age, sex, and clinical history was recorded. Additionally, histories of antibiotic intake were documented to ensure eligibility for inclusion in the study.

Inclusion criteria

High vaginal swab samples were collected from patients exhibiting symptoms indicative of genital tract infection, ensuring targeted sampling for microbial analysis.

Exclusion criteria

Patients currently taking antibiotics and unmarried women were excluded from the study to maintain consistency in the evaluation of untreated infections and to focus on the reproductive-age group most vulnerable to gynecological infections.

Data collection and statistical analysis

Data collection involved obtaining informed written consent from patients at the gynecological OPD and IPD of Era's Lucknow Medical College and Hospital. Information recorded included patient demographics (name, age, sex, marital status, pregnancy status), details on methods of contraception, and specifics of vaginal discharge (color, consistency). Associated symptoms like itching, vaginal discomfort, and pelvic pain were also noted. Statistical analysis was conducted using MS Office Excel and SPSS 17 for Windows.

RESULTS

In the present study a total of 73 high vaginal swab specimens were referred for bacteriological culture of patients reporting different wards of Era's Lucknow Medical College and Hospital.

The demographic data shows that the majority of participants were in the 20-25 years (35.6%) and 26-30 years (27.4%) age groups, indicating higher prevalence in younger reproductive-age women. The proportion decreased in older groups, with 31-35 years (11.0%), 36-40 years (9.6%), and 41-45 years (16.4%). This trend suggests that vaginal infections may be more common in younger women, possibly due to hormonal, lifestyle, or healthcare-seeking factors (Table 1).

Table 1: Age group distribution of participants.

Age group (years)	Number of participants	Percentage
20-25	26	35.6
26-30	20	27.4
31-35	8	11.0
36-40	7	9.6
41-45	12	16.4

Table 2: Identification of microorganisms in high vaginal swabs.

Microorganisms	Species	Frequency	Percentage
Gram positive	*Staphylococcus aureus*	2	5
	Enterococcus species	8	22
Gram negative	*Escherichia coli*	21	57
	Klebsiella pneumoniae	5	13
	Pseudomonas aeruginosa	1	3
Fungal (yeast)	*Candida spp.*	1	3

Out of the 73 samples of high vaginal swab, 37 samples were positive out of which 21 were *E. coli*, 8 were *Enterococcus*, 5 *Klebsiella*, 2 *Staphylococcus*, and 1 *Pseudomonas* was isolated from the high vaginal swab samples (Table 2).

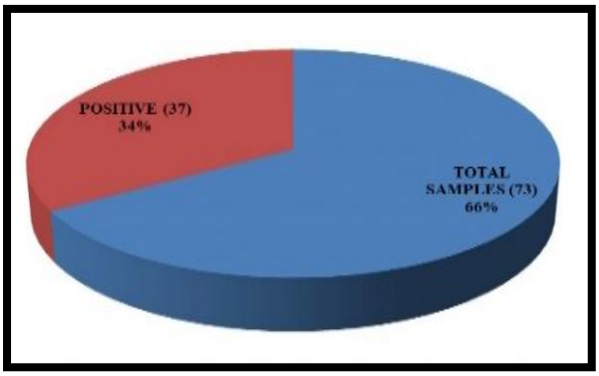

Figure 1: The pie chart shows percentage distribution of positive sample.

The positive samples among the 73 high vaginal swab specimens referred for bacteriological culture. Out of these, 34% (37 samples) were found to be positive for bacterial growth, while the remaining 66% (73 samples) showed no bacterial growth. This indicates that a significant portion of the specimens tested positive, highlighting the prevalence of bacterial infections in the sampled population. This emphasizes the need for careful screening and appropriate treatment for patients presenting with suspected infections (Figure 1).

Table 3: Sensitivity of Gram positive organism (*Staphylococcus aureus*).

Antibiotics	Sensitivity
Cefoxitin	0
Ciprofloxacin	1
Doxycycline	2
Erythromycin	1
Gentamicin	2
Linezolid	2
Clindamycin	2
Vancomycin	2
Amikacin	2
Levofloxacin	1
Teicoplanin	2
Tetracyclin	2

The sensitivity pattern of *Staphylococcus aureus*, a gram-positive organism, against various antibiotics. The results show that the bacterium exhibits high sensitivity to several antibiotics, with full sensitivity (2) observed for doxycycline, gentamicin, linezolid, clindamycin, vancomycin, amikacin, teicoplanin, and tetracycline. moderate sensitivity (1) was noted for ciprofloxacin, erythromycin, and levofloxacin, while cefoxitin shows no sensitivity (0). These findings indicate that *Staphylococcus aureus* is most effectively treated with antibiotics like vancomycin, linezolid, and amikacin, while cefoxitin is ineffective in this case. This highlights the importance of selecting appropriate antibiotics based on sensitivity testing to ensure effective treatment of infections caused by this organism (Table 3).

The antibiotic sensitivity of Enterococcus species to various drugs

Enterococcus demonstrated the highest sensitivity to linezolid, vancomycin, and teicoplanin, with 100% effectiveness (8/8). doxycycline, chloramphenicol, and high-level gentamicin also showed high sensitivity, with 75% of the samples responding to these antibiotics. Ampicillin and amoxiclav display moderate sensitivity (62.5%), while ciprofloxacin and levofloxacin have lower efficacy, with 37.5% and 37% sensitivity, respectively. Pristinomycin has the least effectiveness, with only 25% sensitivity. These results suggest that linezolid, vancomycin, and teicoplanin were the most effective antibiotics for treating infections caused by *Enterococcus* species, whereas ciprofloxacin, levofloxacin, and pristinomycin were less reliable (Table 4).

Table 4: Sensitivity of *Enterococcus* species.

Antibiotics	Sensitivity (%)
Ampicillin	5 (62.5)
Chloramphenicol	6 (75)
Ciprofloxacin	3 (37.5)
Doxycycline	6 (75)
Linezolid	8 (100)
Vancomycin	8 (100)
Teicoplanin	8 (100)
Amoxciclave	5 (62.5)
Levofloxacin	3 (37)
High levelGentamicin	6 (75)
Pristinomycin	2 (25)

The sensitivity pattern of gram-negative bacteria to various antibiotics. Imipenem, meropenem, colistin, and doripenem showed the highest effectiveness, with 100% sensitivity, indicating these antibiotics are highly effective against gram-negative infections. Tigecycline (96.2%), amikacin (92.5%), doxycycline (85.1%), cefoperazone + sulbactam (85.1%), gentamicin, and netilmicin (81.4%) also showed strong sensitivity, making them suitable options for treating infections caused by gram-negative bacteria.

On the other hand, moderate effectiveness was observed for piperacillin and tazobactam (81.4%), tobramycin sulfate (77.7%), cefepime hydrochloride (66.6%), cefoperazone (70.3%), and ceftriaxone (62.9%). Antibiotics such as ciprofloxacin, levofloxacin, and amoxiclav exhibit the lowest sensitivity at 51.8%, suggesting that they are less reliable for treating these infections. This data helps guide clinicians in selecting appropriate antibiotics for effective management of gram-negative bacterial infections (Table 5).

Table 5: Sensitivity pattern of Gram negative bacteria.

Antibiotics (n=27)	Sensitivity	Percentage
Imipenem	27	100
Meropenem	27	100
Piperacillin and tazobactum	22	81.4
Cefepime hydrochloride	18	66.6
Ciprofloxacin	14	51.8
Gentamicin	22	81.4
Doxycycline	23	85.1
Amikacin	25	92.5
Netilmicin	22	81.4
Levofloxacin	14	51.8
Tigecycline	26	96.2
Tobramycin sulfate	21	77.7
Colistin	27	100
Cefoperazone+sulbactum	23	85.1
Amoxiclave	14	51.8
Ceftriaxone	17	62.9
Doripenem	27	100
Cefoperazone	19	70.3

DISCUSSION

In our study, 73 HVS samples were collected, and 37 (34%) were found to be positive for pathogenic bacterial growth. The predominant bacterial isolate was *Escherichia coli*, accounting for 57% of the positive samples. This contrasts with the study by Kumar et al, where the overall positivity for pathogenic aerobic microbes was 27%, and *Candida spp*. accounted for 7.3%.[19] The lower rate of positivity in our study may be due to differences in the population studied or sample collection methods.

Regarding *Candida spp*., only one isolate (3%) was detected in our study, showing complete sensitivity to antifungal agents such as fluconazole, itraconazole, voriconazole, and amphotericin B, with no resistance observed. In contrast, Siti et al reported a higher recovery rate of *Candida spp*. (17.2%) from pregnant women, with *C. albicans* being the most common species.[20] The predominance of non-albicans *Candida* in our geographical area could support the empirical use of antifungal therapy for patients presenting with vaginal discharge, as highlighted in their study.

Group B *Streptococcus* (GBS) was not prevalent in our results, with only *Staphylococcus aureus* (5%) and *Enterococcus* (22%) identified among the Gram-positive bacteria. All GBS isolates in other studies, such as Yancey et al, were highly sensitive to Penicillin, which aligns with the findings in our study, where the Gram-positive organisms were most sensitive to vancomycin and linezolid.[21]

Among *Enterococcus spp.*, 7% of the isolates showed resistance to betalactam antibiotics and high-level resistance to aminoglycosides, although all were sensitive to vancomycin and linezolid, similar to other studies reporting high vancomycin sensitivity. Our study aligns with Cherian et al findings, confirming that linezolid and vancomycin are effective options for treating *Enterococcus* infections.[22]

Klebsiella spp., representing 13% of the isolates in our study, showed sensitivity to all antibiotics except for *Ampicillin*, with a small percentage (4.5%) resistant to all antibiotics, which is in agreement with previous findings that indicate *Klebsiella* resistance to beta-lactams and some aminoglycosides.

E. coli exhibited a low multi-drug resistance rate (1.2%) in our study, compared to other reports by Soni et al where resistance to quinolones, beta-lactams, and aminoglycosides was more widespread.[23] This emphasizes the relative sensitivity of *E. coli* in our population and highlights the importance of antibiotic stewardship to prevent further resistance.

Lastly, *Acinetobacter spp*. isolates, although rare in our study (2%), were fully resistant to all tested drugs, consistent with literature that describes *Acinetobacter baumannii* as a multi-drug-resistant organism, often associated with nosocomial or iatrogenic infections, particularly following invasive procedures such as D and C, as was the case in our study.

Overall, our findings reinforce the importance of early bacterial culture and sensitivity testing in managing vaginal infections, as multi-drug-resistant strains are emerging, though their prevalence in our population remains relatively low. The empirical use of antifungals, especially for *Candida spp*., is supported by our results, while the high sensitivity of vancomycin and linezolid suggests these as first-line treatments for Gram-positive infections, including *Enterococcus*. However, the emergence of multi-drug resistance, though limited, highlights the need for ongoing surveillance.

This study is limited by its small sample size, single-center design, and exclusion of unmarried women and those on antibiotics, which may introduce selection bias. Conventional culture methods may have missed certain pathogens, and the cross-sectional approach prevents tracking changes over time.

CONCLUSION

In conclusion, this study identified *Escherichia coli* as the predominant organism in vaginal infections, followed by *Enterococcus* and *Klebsiella*. The bacterial isolates showed high sensitivity to antibiotics like vancomycin and linezolid for gram-positive bacteria, while imipenem, meropenem, and colistin were most effective for Gram-negative bacteria. The findings highlight the need for targeted antibiotic therapy based on culture and sensitivity results to manage vaginal infections effectively.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Larsen B, Monif GR. Understanding the bacterial f lora of the female genital tract. Clin Infect Dis. 2001;32(4):e69-77.
2. Romero R, Hassan SS, Gajer P, Tarca AL, Fadrosh DW, Nikita L, et al. The composition and stability of the vaginal microbiota of normal pregnant women is different from that of non-pregnant women. Microbiome. 2014;2(1):4.
3. Puri R, Malhotra J. Recurrent urinary tract infection (UTI) in women. South Asian Feder Obstet Gynecol. 2009;1(1):10-3.
4. Martin DH. The microbiota of the vagina and its influence on women's health and disease. Am J Med Sci. 2012;343(1):2-9.
5. Aduloju OP, Akintayo AA, Aduloju T. Prevalence of bacterial vaginosis in pregnancy in a tertiary health institution, south western Nigeria. The Pan Afr Med J 2019;3:33.
6. Gopalan U, Rajendiran S, Jayakumar K, Karnaboopathy R. Composition of Vaginal microbiota and their antibiotic susceptibility in symptomatic women. Int J Reprod Contracept Obstet Gynecol. 2017;6(2):427-32.
7. Adeyba OA, Adeoye MO, Adesiji YO. Bacteriological and parasitological vaginitis in pregnant women in Iseyin, Oyo state, Nigeria. Clin Exp Microbiol. 2003;4:11-6.
8. Krohn MA, Thwin SS, Rabe LK, Brown Z, Hillier SL. Vaginal colonization by *Escherichia co*li as a risk factor for very low birth weight delivery and other perinatal complications. J Infect Dis. 1997;175(3):606-10.
9. Phares CR, Lynfield R, Farley MM, Mohle-Boetani J, Harrison LH, Petit S, et al. Epidemiology of Invasive Group B Streptococcal Disease in the United States, 1999-2005. JAMA. 2008;299(17):2056–65.
10. Andreu A. *Lactobacillus* as probiotic for preventing urogenital infection. Rev Med Microbiol. 2004;15:1-6.
11. Nugent RP, Krohn MA, Hillier SL. Reliability of diagnosing bacterial vaginosis is improved by a standardized method of gram stain interpretation. J Clin Microbiol. 1991;29(2):297-301.
12. Ekström L, Adolfsson A, Ericson H, Poutakidis G, Charonis G, Larsson PG. Vaginal flora and urinary and vaginal group B *Streptococci* in early pregnancy. Gynecology. 2013;1:5.
13. Syed TS, Braverman PK. Vaginitis in adolescents. Adolesc Med Clin. 2004;15(2):235-51.

14. Owen MK, Clenney TL. Management of vaginitis. Am Fam Phys. 2004;70(11):2125-32.
15. Puri KJ, Madhan A, Bajaj K. Incidence of various causes vaginal discharge among sexually active females in age group 20-40 years. Indian J Dermatol Venereol Leprol. 2003;69(2):122-5.
16. Abdul-Aziz M, Mahdy MAK, Abdul-Ghani R, Alhilali NA, Al Mujahed L, Alabsi SA, et al. Bacterial vaginosis, vulvovaginal candidiasis and trichomonal vaginitis among reproductive-aged women seeking primary healthcare in Sana'a city, Yemen. BMC Infect Dis. 2019;19(1):879.
17. Nester M, Anderson D, Roberts Jr C, Pearsall N, Nester M. Microbiology- a human perspective. Host-microbe interactions. Madrid: McGraw Hill; 2002.
18. Kanj SS, Kanafani ZA, eds. Current concepts in antimicrobial therapy against resistant gram-negative organisms: extended spectrum β-lactamase-producing *Enterobacteriaceae*, carbapenem resistant *Enterobacteriaceae*, and multidrug-resistant *Pseudomonas aeruginosa*. Mayo Clin Proc. 2011;86(3):250-9.
19. Kumar G, Singh K. Microbial profile of high vaginal swab from symptomatic women of reproductive age group: data from tertiary care hospital. Int J Sci Res. 2015;4(7):2672-3.
20. Masri SN, Noor SM, Nor LA, Osman M, Rahman MM. Candida isolates from pregnant women and their antifungal susceptibility in a Malaysian tertiary-care hospital. Pak J Med Sci. 2015;31(3):658.
21. Schuchat A. Epidemiology of group B streptococcal disease in the United States: shifting paradigms. Clin Microbiol Rev. 1998;11(3):497-513.
22. Cherian A, Sasikumari O. Microbial profile of high vaginal swab from women of reproductive age group in a tertiary care hospital. Int J Curr Microbiol App Sci. 2017;6(7):2366-70.
23. Soni P, Kulsrestha S, Parihar R, Khatri P. A comparative study of sexually transmitted and non-sexually transmitted reproductive tract infections at a tertiary care center in western Rajasthan, India. Indian J Microbiol Res. 2016;3(2):107-12.

Cite this article as: Verma S, Hassan S, Shukla P, Ahmad A, Nag R. Bacterial analysis of high vaginal swabs from women of reproductive age at a tertiary hospital in Lucknow. Int J Res Med Sci 2025;13:1094-9.