

Vancomycin-Resistant *Enterococci* in Urinary Isolates: A One-Year Species-Wise Surveillance from a Tertiary Care Hospital in Central India**Kamlesh Kumar B. Patel¹, Bhumika Baveja², Neeraj Katore³, Namrata Naithani⁴**¹Professor & HOD, Department of Microbiology, SAIMS Medical College and PG Institute, Indore, Madhya Pradesh, India²Assistant Professor, Department of Microbiology, SAIMS Medical College and PG Institute, Indore, Madhya Pradesh, India³Assistant Professor, Department of Microbiology, LNCT Medical College & Sewakunj Hospital, Indore, Madhya Pradesh, India⁴Assistant Professor, Department of Microbiology, SAIMS Medical College and PG Institute, Indore, Madhya Pradesh, India

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Abstract

Background: Enterococcus faecalis and Enterococcus faecium are important causes of healthcare-associated urinary tract infection and are increasingly encountered with acquired antimicrobial resistance. Vancomycin-resistant enterococci (VRE), particularly vancomycin-resistant E. faecium, pose challenges for antimicrobial treatment and infection prevention. However, contemporary data specifically describing species distribution and vancomycin resistance among urinary enterococcal isolates from Central India remain limited.

Aim: To determine the frequency and species distribution of Enterococcus isolated from urine cultures over one year and to assess vancomycin resistance according to species, gender and patient location.

Materials and Methods: A retrospective laboratory-based surveillance study was conducted in the Department of Clinical Microbiology of a tertiary care hospital in Indore, Madhya Pradesh, from 1 May 2024 to 30 April 2025. A total of 2829 urine cultures were processed during the study period. Enterococcal isolates were identified to species level using the VITEK 2 Compact system. Vancomycin susceptibility was assessed using automated antimicrobial susceptibility testing and resistant isolates were confirmed by vancomycin E-test. Results were interpreted according to Clinical and Laboratory Standards Institute criteria. Species-wise proportions were compared using the chi-square test.

Results: Among 2829 urine cultures, 191 (6.8%; 95% CI, 5.9–7.7) yielded Enterococcus species. E. faecium accounted for 98 isolates (51.3%), while E. faecalis accounted for 93 (48.7%). Vancomycin resistance was detected in 49 of 191 enterococcal isolates (25.7%; 95% CI, 20.0–32.3). Resistance was more frequent among E. faecium (30/98; 30.6%; 95% CI, 22.4–40.3) than E. faecalis (19/93; 20.4%; 95% CI, 13.5–29.7), although the difference was not statistically significant ($\chi^2=2.59$, df=1; p=0.107). Female patients contributed 97 isolates (50.8%) and male patients 94 (49.2%). Thirty-seven isolates (19.4%) were obtained from intensive care units.

Conclusion: A substantial proportion of urinary enterococcal isolates in this tertiary-care setting were vancomycin-resistant, with E. faecium accounting for slightly more isolates and demonstrating a higher, although statistically non-significant, resistance proportion than E. faecalis. These findings support continued species-level surveillance, prudent antimicrobial use and hospital-wide measures aimed at preventing transmission and unnecessary treatment of enterococcal bacteriuria.

Keywords: Enterococcus faecium; Enterococcus faecalis; vancomycin-resistant enterococci; urinary tract infection; antimicrobial resistance; antimicrobial stewardship; infection prevention; Central India.

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Introduction

Enterococci are facultatively anaerobic Gram-positive cocci that form part of the normal gastrointestinal microbiota but have become important opportunistic pathogens in healthcare settings. Among the numerous species within the

genus, Enterococcus faecalis and Enterococcus faecium account for the majority of clinically significant human infections. Their clinical importance is closely linked to their ability to persist in the hospital environment, colonize

patients exposed to antimicrobial therapy and acquire multiple resistance determinants. [1-3] Enterococcal infections include urinary tract infections, bloodstream infections, intra-abdominal infections, wound infections and infective endocarditis. The epidemiology of enterococcal disease has changed considerably over recent decades, with *E. faecium* becoming increasingly prominent among healthcare-associated and multidrug-resistant isolates. [1,9] Enterococci possess intrinsic resistance to several commonly used antimicrobial agents and can acquire additional resistance through chromosomal mutations, mobile genetic elements and horizontal gene transfer. [2,3]

The urinary tract represents an important clinical niche for enterococci, particularly among hospitalized patients. Urinary catheterization, structural or functional urinary tract abnormalities, previous instrumentation, prolonged hospitalization and previous antimicrobial exposure have all been associated with enterococcal urinary colonization or infection.⁴ Antimicrobial exposure may also facilitate enterococcal intestinal and urinary tract colonization by suppressing susceptible competing organisms. [2,4]

An important clinical consideration is that isolation of enterococci from urine does not necessarily indicate symptomatic urinary tract infection. Asymptomatic bacteriuria is common in several patient populations, particularly among individuals with urinary catheters or underlying urological abnormalities. Current guidance recommends avoiding antimicrobial treatment of asymptomatic bacteriuria in most clinical situations because unnecessary therapy provides little benefit and contributes to antimicrobial selection pressure. [5]

The emergence of glycopeptide resistance substantially increased the clinical significance of enterococci. Vancomycin-resistant enterococci were first reported clinically in Europe in 1988, including plasmid-mediated resistance in *E. faecium*. [6] Resistance is most commonly mediated by acquired *van* gene clusters, particularly *vanA* and *vanB*. [7] These determinants alter the terminal target of peptidoglycan precursors, reducing the affinity of glycopeptide antibiotics for their target. The *vanA* phenotype is generally associated with high-level resistance to vancomycin and resistance to teicoplanin, whereas *vanB* isolates generally retain susceptibility to teicoplanin. [7,8]

The epidemiological importance of VRE extends beyond individual treatment decisions. *E. faecium* lineages adapted to healthcare environments have demonstrated substantial genomic plasticity and an ability to accumulate antimicrobial resistance determinants. [9] The World Health Organization

has consequently included vancomycin-resistant *E. faecium* among high-priority antimicrobial-resistant bacterial pathogens for which development of new therapeutic options is needed. [10] The therapeutic options for VRE infection are influenced by the site of infection, clinical severity and susceptibility profile. Agents such as linezolid and daptomycin may be required for serious infections, while selected oral agents may retain utility for appropriately selected lower urinary tract infections. [11,15] Antimicrobial therapy should therefore be guided by clinical assessment and susceptibility testing rather than by isolation of VRE alone.

Indian data indicate considerable geographical and temporal variation in VRE occurrence. A systematic review and meta-analysis published in 2023 estimated the pooled prevalence of VRE among human clinical isolates in India at 12.4% (95% CI, 8.6–17.5%), based on 19 studies and 3683 enterococcal isolates. The analysis also demonstrated substantial heterogeneity between studies and an increase in estimated VRE prevalence over time. [12] Importantly, this pooled estimate included multiple specimen types and therefore cannot be considered a urinary-specific national prevalence. Urinary surveillance studies from other healthcare systems have also demonstrated variable VRE rates. For example, a decade-long surveillance study from a tertiary hospital in the United Kingdom identified vancomycin resistance in 542 of 5528 positive enterococcal urine cultures (9.8%). [14] Such differences highlight the influence of geographical location, patient population, referral patterns, antimicrobial exposure and local infection-control practices.

Despite the clinical importance of VRE, species-specific information from urinary isolates in Central India remains limited. Local surveillance data are important because resistance patterns can vary considerably between hospitals and geographical regions and because laboratory-level information can support antimicrobial stewardship and infection-prevention strategies.

The present study therefore evaluated the frequency and species distribution of enterococci isolated from urine cultures over a one-year period at a tertiary-care hospital in Indore, Central India. We further assessed the proportion of vancomycin-resistant isolates according to species, gender and patient location.

Materials and Methods

Study design and setting: This retrospective laboratory-based surveillance study was conducted in the Department of Clinical Microbiology of a tertiary-care hospital in Indore, Madhya Pradesh,

India. The study period extended from 1 May 2024 to 30 April 2025.

The study was designed to characterize enterococcal urinary isolates identified during routine diagnostic microbiology services and to describe their species distribution and vancomycin susceptibility.

Study population and urine samples: All urine culture specimens received in the microbiology laboratory during the study period were considered for analysis. The specimens included midstream clean-catch urine and catheter-associated urine samples submitted according to clinical requirements. A total of 2829 urine cultures were processed during the study period. For patients from whom repeated isolates of the same species were recovered, only the first isolate was retained for the species-wise surveillance analysis.

Important verification before submission: this sentence should remain only if your laboratory dataset actually applied a “first isolate per patient” rule. If all 191 isolates represent unique patients, state that explicitly instead.

Culture and identification: Urine samples were inoculated using a calibrated loop onto cystine lactose electrolyte deficient agar and 5% sheep blood agar and incubated aerobically at 37°C for 18–24 hours.

Significant bacteriuria was defined according to the laboratory's routine urine culture protocol, with a colony count of $\geq 10^5$ colony-forming units (CFU)/mL considered significant in the study protocol. Presumptive enterococci were identified based on colony morphology, Gram staining, catalase reaction, bile-esculin hydrolysis and growth in 6.5% sodium chloride. Species-level identification was performed using the VITEK 2 Compact system (bioMérieux, France) with appropriate Gram-positive identification cards.

Antimicrobial susceptibility testing: Antimicrobial susceptibility testing was performed using the VITEK 2 Compact automated system with appropriate antimicrobial susceptibility testing cards. Vancomycin-resistant isolates and isolates showing elevated vancomycin minimum inhibitory concentrations (MICs) on automated testing underwent confirmatory testing using vancomycin E-test strips on Mueller–Hinton agar. Vancomycin susceptibility was interpreted according to the applicable Clinical and Laboratory Standards Institute M100 breakpoints. [13] Isolates with a vancomycin MIC of ≥ 32 µg/mL were classified as resistant according to the study's applied CLSI interpretive criteria. *E. faecalis* ATCC 29212 and

the appropriate vancomycin-resistant quality-control strain were used for quality assurance.

Important Verification: If ATCC 51299 was actually used as the VRE quality-control strain, retain it. If only ATCC 29212 was used, do not state that ATCC 51299 was used. The QC strain statement should exactly reflect the laboratory records.

Data Collection

Data were retrieved from the laboratory information system and included:

1. species identification;
2. vancomycin susceptibility category;
3. patient gender; and
4. Patient location at the time of specimen collection.

For analysis of patient location, isolates were categorized as originating from an intensive care unit (ICU) or from non-ICU locations, including general wards and outpatient areas.

Statistical Analysis: Categorical variables were summarized as frequencies and percentages. For proportions, 95% confidence intervals were calculated using the Wilson score method. The proportion of vancomycin-resistant isolates was compared between *E. faecium* and *E. faecalis* using the chi-square test. A two-tailed p value < 0.05 was considered statistically significant. The odds ratio (OR) for vancomycin resistance among *E. faecium* compared with *E. faecalis* was calculated with its 95% confidence interval. All analyses were performed using the laboratory surveillance dataset.

Ethical Considerations: The study used de-identified retrospective laboratory data generated during routine patient care. Individual informed consent was waived in accordance with the applicable institutional policy for retrospective laboratory surveillance. Institutional Ethics Committee approval/exemption was obtained before analysis.

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Results

Frequency of enterococcal isolation: During the study period, 2829 urine cultures were processed. Enterococcus species were recovered from 191 cultures, giving an enterococcal isolation rate of 6.8% (95% CI, 5.9–7.7%). The remaining 2638 cultures (93.2%) yielded organisms other than enterococci or did not demonstrate significant enterococcal growth.

Table 1: Frequency of Enterococcus isolation among urine cultures

Culture outcome	Number	Percentage	95% CI
Enterococcus species isolated	191	6.8	5.9–7.7
Other organisms/ no significant enterococcal growth	2638	93.2	92.3–94.1
Total urine cultures	2829	100.0	—

CI: confidence interval.

Species distribution: Among the 191 enterococcal urinary isolates, *E. faecium* was slightly more frequent than *E. faecalis*. *E. faecium* accounted for 98 isolates (51.3%; 95% CI, 44.3–58.3%), while *E. faecalis* accounted for 93 isolates (48.7%; 95% CI, 41.7–55.7%).

Table 2: Species distribution of enterococcal urinary isolates

Species	Number of isolates	Percentage	95% CI
<i>E. faecium</i>	98	51.3	44.3–58.3
<i>E. faecalis</i>	93	48.7	41.7–55.7
Total	191	100.0	—

Vancomycin resistance: Vancomycin resistance was confirmed in 49 of 191 enterococcal isolates, corresponding to an overall VRE proportion of 25.7% (95% CI, 20.0–32.3%) among urinary enterococcal isolates. Among *E. faecium*, 30 of 98 isolates were resistant, giving a resistance proportion of 30.6% (95% CI, 22.4–40.3%). Among *E. faecalis*, 19 of 93 isolates were resistant, corresponding to 20.4% (95% CI, 13.5–29.7%). The odds of vancomycin resistance were higher among *E. faecium* than *E. faecalis* (OR, 1.72; 95% CI, 0.89–3.33). However, the difference was not statistically significant ($\chi^2=2.59$, $df=1$; $p=0.107$).

Table 3: Vancomycin resistance according to Enterococcus species

Species	Total isolates	Vancomycin-R, n (%)	Vancomycin-S, n (%)	95% CI for resistance	p value
<i>E. faecium</i>	98	30 (30.6)	68 (69.4)	22.4–40.3	0.107
<i>E. faecalis</i>	93	19 (20.4)	74 (79.6)	13.5–29.7	—
Total	191	49 (25.7)	142 (74.3)	20.0–32.3	—

Chi-square test without continuity correction; $\chi^2=2.59$; $df=1$. OR for vancomycin resistance in *E. faecium* compared with *E. faecalis*=1.72 (95% CI, 0.89–3.33). S: Sensitive, R: Resistant

Gender distribution: The distribution of isolates by gender was almost equal. Female patients contributed 97 isolates (50.8%; 95% CI, 43.8–57.8%), while male patients contributed 94 isolates (49.2%; 95% CI, 42.2–56.3%).

Table 4: Gender distribution of enterococcal urinary isolates

Gender	Number	Percentage	95% CI
Female	97	50.8	43.8–57.8
Male	94	49.2	42.2–56.3
Total	191	100.0	—

Distribution according to patient location: Most enterococcal isolates were recovered from patients outside the ICU. A total of 154 isolates (80.6%; 95% CI, 74.4–85.6%) originated from non-ICU locations, while 37 isolates (19.4%; 95% CI, 14.4–25.6%) were obtained from ICU patients.

Table 5: Distribution of enterococcal urinary isolates according to patient location

Patient location	Number	Percentage	95% CI
Non-ICU	154	80.6	74.4–85.6
ICU	37	19.4	14.4–25.6
Total	191	100.0	—

ICU, intensive care unit.

Discussion

The present study provides a one-year description of enterococcal urinary isolates from a tertiary-care hospital in Central India. Among 2829 urine cultures processed during the study period, 191 (6.8%) yielded *Enterococcus* species. *E. faecium* and *E. faecalis* occurred in almost equal proportions, although *E. faecium* was slightly more

frequent. The principal finding was that 49 of 191 enterococcal urinary isolates (25.7%) were resistant to vancomycin.

The observed VRE proportion is higher than the 12.4% pooled estimate reported in a recent Indian systematic review and meta-analysis. [12] However, direct comparison requires caution. The national estimate was derived from 19 studies involving different specimen types, patient

populations and geographical settings and showed marked statistical heterogeneity. [12] The present study, in contrast, was restricted to urinary isolates from a single tertiary-care hospital and therefore reflects the local epidemiology of a selected healthcare population rather than national prevalence.

The urinary-specific comparison with the United Kingdom study by Toner et al. is also informative. In that retrospective surveillance study, 542 of 5528 positive *Enterococcus* urine cultures were vancomycin-resistant, corresponding to 9.8%. [14] The higher proportion observed in the present study may reflect differences in patient characteristics, referral patterns, antimicrobial exposure, infection-control practices, laboratory methods and the time periods studied. These differences prevent attribution of the observed variation to any single factor.

The species distribution in the present study was notable. *E. faecium* represented 51.3% of the urinary enterococcal isolates, compared with 48.7% for *E. faecalis*. This near-equivalence differs from the broader Indian meta-analysis, in which *E. faecalis* was more frequently represented among all enterococcal isolates.¹² Such differences are plausible because species distribution can vary substantially according to specimen type, hospital setting and patient population.

The increasing importance of *E. faecium* in healthcare-associated infection has been described extensively. [1,9] Hospital-adapted *E. faecium* populations possess substantial genomic plasticity and have acquired combinations of antimicrobial resistance determinants that facilitate persistence under healthcare-associated antimicrobial pressure. [9,18] In the present study, the higher proportion of vancomycin resistance among *E. faecium* compared with *E. faecalis* is consistent with this broader epidemiological pattern.

Vancomycin resistance was observed in 30.6% of *E. faecium* and 20.4% of *E. faecalis*. Although the point estimate suggested a higher odds of resistance among *E. faecium* (OR 1.72), the difference did not achieve statistical significance ($p=0.107$). Therefore, the present study does not establish a statistically significant species association with vancomycin resistance. The confidence interval around the OR was wide and included unity, indicating uncertainty around the magnitude of the association. A larger sample would provide greater precision. The presence of vancomycin resistance in approximately one-fifth of *E. faecalis* isolates is also clinically relevant. However, phenotypic resistance in the current study was not accompanied by molecular characterization. Consequently, the underlying van genotype cannot be inferred from the present findings. Previous

studies have demonstrated that *vanA* and *vanB* are major determinants of acquired glycopeptide resistance, with *vanA* particularly important among healthcare-associated VRE populations. [7,8,15] Molecular characterization would therefore be an important extension of this surveillance work.

The gender distribution was nearly equal, with 50.8% of isolates recovered from females and 49.2% from males. This differs from the strong female predominance commonly associated with uncomplicated community-acquired urinary tract infection. However, the present study did not include clinical information regarding symptoms, catheterization, underlying urinary tract abnormalities or healthcare exposure. Therefore, the gender distribution should not be interpreted as evidence of a particular mechanism of acquisition.

The distribution according to patient location showed that most enterococcal urinary isolates originated from non-ICU areas (80.6%), whereas 19.4% were recovered from ICU patients. This finding is important from an infection-prevention perspective but requires careful interpretation. The absolute number of isolates cannot be converted into a location-specific risk because the study did not provide the number of urine cultures processed separately in ICUs and non-ICU areas. Thus, the finding demonstrates where the isolates were recovered, but it does not establish that the risk of VRE was greater outside or inside the ICU.

This distinction is important because ICU patients may have a higher prevalence of recognized VRE risk factors, including severe illness, prolonged hospitalization, invasive devices and exposure to broad-spectrum antimicrobial therapy. Conversely, the larger number of isolates from non-ICU areas may simply reflect the larger underlying patient population and greater number of urine cultures submitted from those areas.

From a clinical perspective, detection of an enterococcal urinary isolate should not automatically lead to antimicrobial treatment. Asymptomatic bacteriuria is common in catheterized and other high-risk populations, and indiscriminate treatment can increase unnecessary antimicrobial exposure without improving outcomes. [5] Clinical symptoms, patient-specific risk factors and the possibility of contamination or colonization should therefore be considered before initiating therapy. When symptomatic VRE urinary infection is established, antimicrobial selection should be based on the site and severity of infection and the susceptibility profile of the isolate. Previous studies of VRE urinary isolates have demonstrated activity of agents such as nitrofurantoin and linezolid in selected circumstances, although susceptibility patterns vary and treatment should be individualized. [11,15] For

complicated or invasive disease, systemic agents such as linezolid or daptomycin may be considered according to susceptibility testing and clinical circumstances. [11,16]

The infection-control implications of VRE are equally important. Enterococci can persist in healthcare environments and may be transmitted between patients through contaminated hands, surfaces and equipment. [8,16] Consequently, identification of VRE in the laboratory should trigger appropriate communication with the clinical and infection-prevention teams according to institutional policy.

The findings also support the value of antimicrobial stewardship. Exposure to antimicrobial agents, particularly broad-spectrum antibiotics, can favour colonization and persistence of resistant enterococci. [2,16] Strategies aimed at reducing unnecessary antimicrobial exposure should therefore complement infection-prevention interventions.

Strengths of the study: The principal strengths of this study include its one-year surveillance period, inclusion of a large number of urine cultures, species-level identification of enterococci and phenotypic confirmation of vancomycin resistance using an independent testing method.

The study also provides local data from Central India, where institution-specific surveillance information is useful because VRE rates can vary considerably between hospitals and geographical regions.

Limitations

Several limitations should be considered: First, this was a retrospective single-centre laboratory surveillance study. The findings therefore describe the local microbiological pattern and cannot be assumed to represent the prevalence of VRE in Central India or India as a whole. Second, clinical information was not available to distinguish symptomatic urinary tract infection from asymptomatic bacteriuria or urinary colonization. This is particularly important because enterococci are frequently recovered from catheterized patients without clinical infection. Third, information regarding urinary catheterization, recent hospitalization, previous antimicrobial exposure, underlying urological disease and duration of hospitalization was not analyzed. These variables could have provided insight into risk factors for VRE isolation.

Fourth, the study did not include molecular characterization of *vanA*, *vanB* or other glycopeptide-resistance determinants. Consequently, the genetic basis of the observed phenotypic resistance could not be determined.

Fifth, clonal relatedness was not investigated. Molecular typing would be required to determine whether the observed VRE isolates represented transmission of particular clones or independent acquisition of resistant strains.

Sixth, the analysis focused on vancomycin resistance and did not provide a comprehensive analysis of susceptibility to other clinically relevant agents such as ampicillin, high-level aminoglycosides, linezolid, daptomycin, nitrofurantoin or fosfomycin.

Finally, because ICU and non-ICU denominators were not analyzed separately, the distribution of isolates by location should not be interpreted as a location-specific incidence or risk estimate.

Conclusion

This one-year surveillance study identified *Enterococcus* species in 6.8% of urine cultures processed at a tertiary-care hospital in Central India. *E. faecium* and *E. faecalis* were represented in nearly equal proportions, with *E. faecium* accounting for a slightly larger share. Vancomycin resistance was identified in 25.7% of enterococcal urinary isolates, with a higher proportion among *E. faecium* than *E. faecalis*; however, the species-wise difference was not statistically significant.

The findings emphasize the importance of continued local surveillance of VRE, particularly with species-level identification. Laboratory detection should be integrated with antimicrobial stewardship and infection-prevention programs. Importantly, isolation of enterococci from urine should be interpreted in the clinical context so that asymptomatic bacteriuria is not unnecessarily treated.

Future prospective studies incorporating clinical risk factors, antimicrobial exposure, catheterization status, outcome data and molecular characterization of van determinants would help determine the epidemiological drivers of VRE in this setting and clarify whether resistant isolates represent persistent local clones or repeated independent acquisition.

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