

Original Research Article

Speciation of *Enterococcus species*: better way to deal with clinical infections at resource limited settings

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ABSTRACT

Background: *Enterococcus* species are well known for its intrinsic resistance pattern to several antibiotics. Hence, appropriate management and prevention is essential in any healthcare facility. Present study was conducted to establish an accessible biochemical tests to differentiate *Enterococcus* species at resource limited settings.

Methods: *Enterococci* isolated from various clinical specimens were speciated using an array of biochemical reactions and antimicrobial susceptibility testing was performed by Kirby-Bauer disc diffusion method. Results were interpreted as per Clinical and Laboratory Standards Institute (CLSI) guidelines.

Results: Out of 107 enterococcal isolates, 63(59%) were *E. faecium*, 40(37%) were *E. faecalis*, 2(2%) were *E. hirae*, 1(0.9%) was *E. raffinosus* and 1(0.9%) was *E. gallinarum*. *E. faecium* and *E. faecalis* showed 23% and 7% vancomycin resistance respectively, while *E. gallinarum* showed low level vancomycin resistance.

Conclusions: *Enterococcus* speciation can be done using simple biochemical reactions and its susceptibility pattern enables to distinguish Van phenotypes too. Hence, it is helpful for management of infections in resource limited settings to a greater extent.

Keywords: Antimicrobial susceptibility, Biochemical reactions, *Enterococcus*, Phenotypes

INTRODUCTION

Since from era of 'Streptococci of fecal origin' in late 19th century, *Enterococci* species was considered commensal organism and have been studied so far.¹ Many species of *Enterococci* known with clinical significance till date.² Amongst them, *E. faecalis* and *E. faecium* accounts for upto 90% of clinical infections.³ However, other species were underestimated because of lack of speciation. But, recently an alarming increase in incidence of clinical infections related to non faecalis and non faecium *Enterococci* were noted.^{4,5} Amongst these, *E. gallinarum* and *E. casseliflavus* were found to be involved in causing serious infections,⁶ especially in hospitalized patients. Hence, there is a need of species differentiation because of varied antimicrobial

susceptibility pattern of each species. Simple biochemical tests can be used in resource limited settings routinely because even only one phenotypic character can easily differentiates one species from another.⁷

Enterococci are intrinsically resistant to several antimicrobials especially, glycopeptide resistance which is mediated by six *van* genes. Amongst them, *van A* and *van B* are most clinically relevant *van C* phenotype shows intrinsic, low level resistance to vancomycin and but susceptible to teicoplanin. These genotype is seen in *E. gallinarum*, *E. casseliflavus* and *E. flavescens*.⁸ Species identification can be useful in reporting antimicrobial susceptibility pattern which help in differentiation of Van phenotypes also. So, aim of the present study was to make a panel of biochemical

reactions for enterococcal speciation which will help in appropriate interpretation at resource limited settings.

METHODS

Retrospective study was conducted at Department of Microbiology after taking approval from ethical committee of institute for the period one year from June 2011 to May 2012.

Inclusion criteria

Specimens from all age group patients admitted with complaint of urinary tract infection, skin and soft tissue infections, bacteraemia and meningitis were included.

Exclusion criteria

All patients besides above criteria admitted were excluded.

Total 270 specimens were enrolled in study, out of which 107 enterococcal isolates obtained from urine, swab, blood culture, CSF, body fluids and invasive medical devices were during the period of one year. Species differentiation was done by panel of conventional tests. Colony of *Enterococci* isolate was inoculated into 5ml todd-hewitt broth (HiMedia Lab., Mumbai) and incubated overnight at 37°C. This broth was added as an inoculum in all liquid media (arginine dihydrolase, pyruvate broth, sugars) and was streaked on tryptic soy agar culture plate for pigment production. Carbohydrate fermentation tests were performed using 1% solution of following sugars: mannitol, raffinose, sucrose and arabinose. All the above inoculated media were incubated at 37°C and results were interpreted after 24 hour.⁹

Antimicrobial susceptibility was determined by Kirby Bauer disc diffusion method. Various antibiotics tested were: penicillin (10U/disc), ampicillin (10µg), high level gentamicin (120µg), high level Streptomycin (300µg), ciprofloxacin (5µg), levofloxacin (5µg), vancomycin (30µg), teicoplanin (30µg), linezolid (30µg), tetracycline (30µg) and nitrofurantoin (300µg).

Interpretation was done after 24 hours of incubation and zones were read using transmitted light for vancomycin as per CLSI guidelines.¹⁰ MIC of vancomycin greater than or equal to 32µg/ml was considered resistant, which was done by using HiComb™ MIC test (HiMedia Laboratories Pvt. Ltd., Mumbai). All required dehydrated media and antibiotic discs were procured from HiMedia Laboratories Pvt. Ltd. (Mumbai) and *E.faecalis* ATCC 29212 used for quality control was procured from Microbiologics (USA).

RESULTS

Total 107 *Enterococci* isolated were speciated by using biochemical reactions. Amongst them, 63(59%) were *E.*

faecium, 40(37%) were *E. faecalis*, 2(2%) were *E. hirae*, 1(0.9%) was *E. raffinosus* and 1(0.9%) was *E. gallinarum* (Figure 1).

E. faecium was found to be more resistant to beta-lactams, fluoroquinolones, tetracycline and high level aminoglycosides including 23% vancomycin resistance while 7% vancomycin resistance in *E. faecalis*. 1 isolate of *E. faecium* was resistant to both vancomycin and teicoplanin indicating Van A phenotype. *E. hirae* showed resistance to penicillin (50%) and ampicillin (50%). However, *E. raffinosus* was resistant to beta lactams (100%) and High level streptomycin (100%). Besides, *E. gallinarum* which was identified by pigment production on tryptic soy agar was resistant to beta-lactams, fluoroquinolones, tetracycline and high level aminoglycosides with low level resistance to vancomycin having MIC of 8 - 16 µg/ml (Figure 2).

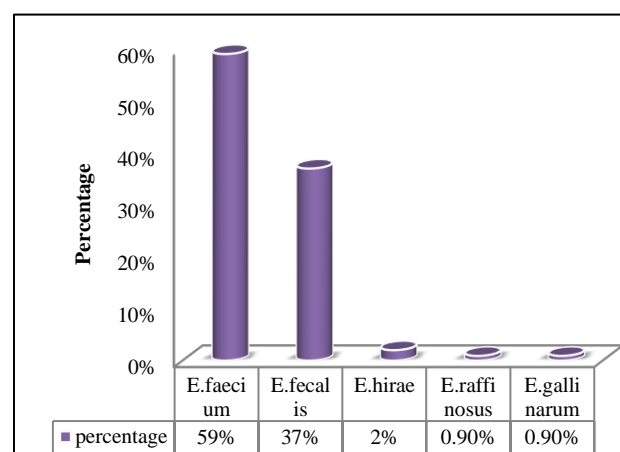


Figure 1: Distribution of enterococcus species isolated from various specimens.

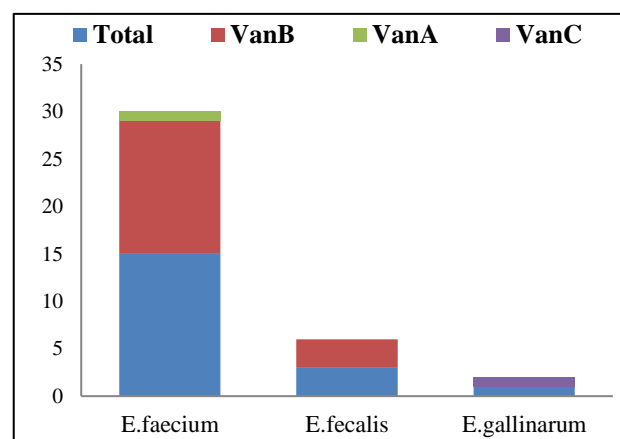


Figure 2: Prevalence of Van phenotype among *Enterococcus* species.

On basis of biochemical reactions, *E. faecium* were identified by arginine dihydrolase test, mannitol and sucrose fermentation while *E. faecalis* by arginine dihydrolase test, pyruvate utilisation test and mannitol, arabinose, raffinose and sucrose fermentation.

Amongst other species, *E. hirae* was identified by arginine dihydrolase test, raffinose and sucrose fermentation. *E. raffinosus* by pyruvate utilisation and

mannitol, arabinose, raffinose and sucrose fermentation and *E. gallinarum* by pigment production on tryptic soy agar (Table 1).

Table 1: Panel of biochemical tests used for identification of enterococcal speciation.

<i>Enterococci</i> spp.	Arginine deamination	Pyruvate utilisation	Mannitol fermentation	Arabinose fermentation	Raffinose fermentation	Sucrose fermentation	Pigment on trypticsoy agar	Motility
<i>E. faecalis</i>	+	+	+	-	+	-	-	
<i>E. faecium</i>	+	-	+	+	V	+	-	
<i>E. avium</i>	-	-	+	+	-	+	-	
<i>E. hirae</i>	+	-	-	-	+	+	-	
<i>E. raffinosus</i>	-	+	+	+	+	+	-	
<i>E. dispar</i>	+	+	+	-	+	+	-	
<i>E. durans</i>	+	-	-	-	-	-	-	
<i>E. mundtii</i>	+	-	+	+	+	+	+	
<i>E. casseliflavus</i>	+	V	+	+	+	+	+	
<i>E. gallinarum</i>	+	-	+	+	+	+	-	

DISCUSSION

Species differentiation is helpful in clinical infections because of the naturally occurring differences in the susceptibility pattern of *Enterococcus* species. Also, it was helpful for epidemiologic surveillance within hospitals. Most of the studies from India had reported *E. faecalis* and *E. faecium* as the only prevalent species.¹¹⁻¹⁴ In present study, *E. faecium* (59%) and *E. faecalis* (37%) were predominant isolates followed by *E. hirae* (2%), *E.*

raffinosus (0.9%) and *E. gallinarum* (0.9%). Mohanty *et al* used the same panel of biochemical reactions for enterococcal speciation and isolated *E. mundtii*, *E. dispar*, *E. durans*, *E. avium*, *E. raffinosus* and *E. gallinarum*.¹⁵ While, Bekhit *et al* reported *E. faecalis*, *E. faecium*, *E. avium*, *E. hirae*, *E. casseliflavus* and *E. gallinarum* by using API strep.¹⁶ These *Enterococci* species were less frequently isolated but had a major clinical significance because of resistance to commonly used antibiotics.

Table 2: Antimicrobial susceptibility pattern of Enterococcal spp. by Kirby Bauer disc diffusion method.

Antibiotic tested	<i>E. faecium</i> (n=63)	<i>E. faecalis</i> (n=40)	<i>E. hirae</i> (n=2)	<i>E. raffinosus</i> (n=1)	<i>E. gallinarum</i> (n=1)
Penicillin (10 units)	60 (95)	40 (100)	1 (50)	100	100
Ampicillin (10 µg)	60 (95)	39 (97)	1 (50)	100	100
High level gentamycin (120 µg)	54 (85)	33 (82)	0 (0)	0(0)	100
High level streptomycin (300 µg)	49 (77)	24 (60)	0 (0)	100	100
Ciprofloxacin (5 µg)	60 (95)	31 (77)	0 (0)	0	100
Levofloxacin (5 µg)	60 (95)	31 (77)	0 (0)	0	100
Linezolid (30 µg)	0 (0)	0 (0)	0 (0)	0	0
Vancomycin (30 µg)	15 (23)	3 (7)	0 (0)	0	100
Teicoplanin (µg)	1 (1)	0	0	0	0
Tetracycline (30 µg)	52 (82)	31 (77)	0 (0)	100	100
Nitrofurantoin (300 µg)	23 (36)	1 (2)	0 (0)	100	100

Enterococci are intrinsically resistant to several antimicrobials. Especially, glycopeptide resistance which is mediated by six *van* genes. Amongst them, *vanA* and

vanB are most clinically relevant because they are associated with transposons, hence easily transferred from one to other organisms. *Van A* gene mediates high

level resistance to vancomycin and teicoplanin while vanB genotype have acquired inducible resistance to vancomycin but susceptible to teicoplanin. Besides these, vanC phenotype, which is chromosomal in origin shows intrinsic, low level resistance to vancomycin and but susceptible to teicoplanin. These genotype is seen in *E. gallinarum*, *E. casseliflavus* and *E. flavescens*.⁸

Biochemical reactions like pigment production and motility test are helpful to distinguish species with acquired resistance to vancomycin (Van A and Van B) from those with intrinsic intermediate level resistance (Van C), such as in *E. gallinarum* and *E. casseliflavus*.⁹ In present study, 95% *E. faecium* were resistant to beta lactams and fluoroquinolones, 51% were resistant to high level aminoglycoside, 82% and 36% were resistant to tetracycline and nitrofurantoin respectively. While, *E. fecalis* showed less resistance as compared to *E. faecium*. Similarly, *E. raffinosus* was resistant to beta lactam, high level aminoglycosides and tetracycline but susceptible to fluoroquinolones. On contrary, *E. hirae* was resistant to beta lactams only. Above all, *E. gallinarum* showed intermediate level resistance to vancomycin and showed resistance to beta lactam, fluoroquinolones, tetracycline and high level aminoglycosides (Table 2). Resistance among *Enterococcus* species were higher in present study as compared to previous study in Jordan and Saudi Arabia.^{17,18} Bekhit *et al* also reported Van C in 3 isolates of *E. gallinarum*.¹⁵

Speciation will help to distinguish species with acquired resistance to vancomycin observed in *E. faecium* and *E. fecalis* from those with intrinsic intermediate level resistance such as in *E. gallinarum* and *E. casseliflavus*. It is also necessary to perform biochemical reactions when isolates show vancomycin MICs 8-16µg/ml. This panel of tests will help resource limited settings to manage enterococcal infections more effectively.

Present study had limitation that sample size was very less. More enterococcal isolates were needed to be studied for better correlation of biochemical reactions and antibacterial drug susceptibility pattern. Also, teicoplanin resistance was given by disk diffusion method which should be further confirmed by MIC method.

CONCLUSION

Increasing resistance among *Enterococcus* species highlights the significance of rapid and accurate identification up to the species level. Therefore, developing simple and reliable tests for speciation and its antimicrobial susceptibility pattern is a need of present day therapeutics. Present study is a guide to resource limited settings so they too can contribute in antimicrobial stewardship.

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REFERENCES

1. Tendolkar PM, Baghdayan AS, Shankar N. Pathogenic Enterococci new development in 21st century. Cell Molec Life Sci. 2003;60:2622-36.
2. Tyrrell GJ, Turnbull L, Teixeira LM, Lefebvre J, CarvalhoMda G, Facklam RR, et al. Enterococcus gilvus sp. nov. and enterococcus pallens sp. nov. isolated from human clinical specimens. J clin Microbiol. 2002;40:1140-5.
3. Murray BE. The life and times of the enterococcus. Clin Microbiol Rev. 1990;3:46-65.
4. Dutka MS, Evers S, Courvalin P. Detection of glycopeptide resistance genotypes and identification to the species level of clinically relevant enterococci by PCR. J Clin Microbiol. 1995;33:24-7.
5. Goedon S, Swenson JM, Hill BC, Pigott NE, Facklam RR, Cooksey RC, et al. Antimicrobial susceptibility patterns of common and unusual species of enterococci causing infections in the United States Enterococcal Study Group. J Clin Microbiol. 1992;30:2373-8.
6. Quinones D, Goni P, Carmen RM, Duran E, Gomez LR. Enterococci spp isolated from Cuba: species frequency of occurrence and antimicrobial susceptibility profile. Diag Microbiol Infect Diseases. 2005;51(1):63-7.
7. Teixara LM, Facklam RR, Steigerwait AG, Pigott NE, Merquior VL, Brenner DJ. Correlation between phenotypic characteristics and DNA relatedness within enterococcus faecium strains. J Clin Microbiol. 1995;33:1520-3.
8. Koneman EW, Allen SD, Janda WM, Schreckenberger PC, Winn WC. The gram positive cocci part II: streptococci, enterococci and the streptococci like bacteria. Color Atlas and Textbook of Diagnostic Microbiology. 5th edition. New York: JB Lipincott; 1997:577-649.
9. Facklam RR, Collins MD. Identification of enterococcus species isolated from human infection by a conventional test scheme. J Clin Microbiol. 1989;27:731-4.
10. Clinical laboratory standards institute. Performance standards for antimicrobial susceptibility testing: twenty second information supplement. Wayne, PA, USA.
11. Nischal M, Macaden R. Biochemical speciation and hemolytic activity in enterococci. Indian J Med Microbiol. 1996;14:205-8.
12. Gulati V, Aggarwal A, Khanna S, Narang VK. Biochemical speciation of enterococci causing human infections. Indian J Med Sci. 1997;51:310-2.
13. Devi PS, Rao PS, Shivananda PG. Characterization, antibiotic susceptibility pattern and detection of beta-lactamases in Enterococci. Indian J Pathol Microbiol. 2002;45:79-82.

14. Bhat KG, Paul C, Bhat MG. High level aminoglycoside resistance in enterococci isolated from hospitalized patients. Indian J Med Res. 1997;105:198-9.
15. Mohanty S, Jose S, Singhal R, Sood S, Dhawan B, Das BK, et al. Species prevalence and antimicrobial susceptibility of enterococci isolated in a tertiary care hospital of north India. Southeast Asian J Trop Med Public Health. 2005;36:962-5.
16. Bekhit MM, Moussa IMI, Muharram MM, Alanazy FK, Hefni HM. Prevalence and antimicrobial resistance pattern of multidrug resistant enterococci isolated from clinical specimens. Indian J Med Microbiol. 2012;30(1):44-51.
17. Osoba AO, Jeha MT, Bakheshwain S, Anazi K, Bertlett F. Septicemia due to vancomycin-resistant enterococcus: a case report. Saudi Med J. 1995;16:67-9.
18. Mahafzah AM, Khader IB, Bakri FG. Characterization of enterococci causing nosocomial infections at the Jordan University hospital over a five year period. J Med J. 2008;42:1-9.

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