ANTIMICROBIAL AGENTS AND CHEMOTHERAPY, Apr. 1984, p. 532–533
0066-4804/84/040532-02$02.00/0

Vol. 25, No. 4

Susceptibilities of Enterococci to Twelve Antibiotics

ROBERT W. TOFTE,*† JoANNE SOLLIDAY, AND KENT B. CROSSLEY

Section of Infectious Diseases, Department of Internal Medicine, St. Paul-Ramsey Medical Center, St. Paul, Minnesota 55101

Received 23 January 1984/Accepted 30 January 1984

The susceptibilities of 347 urine isolates of enterococci (*Streptococcus faecalis*, 44%; *S. faecalis* subsp. *zymogenes*, 37%; *S. faecalis* subsp. *liquefaciens*, 19%) to ampicillin, azlocillin, mezlocillin, piperacillin, vancomycin, gentamicin, erythromycin, rosaramicin, rifampin, rifampin plus trimethoprim (1:4), trimethoprim-sulfamethoxazole (1:20), and chloramphenicol were determined by the agar dilution technique. There were no significant differences in susceptibility to individual agents among the subspecies of *S. faecalis*. Azlocillin and mezlocillin (MIC for 90% of isolates, 0.78 μg/ml) and piperacillin, ampicillin, and vancomycin (MIC for 90% of isolates, 1.56 μg/ml) were the most active agents and were significantly more potent than the other reference antibiotics tested.

Enterococci, classified as Lancefield group D streptococci, are composed of four biotypically distinct species and two subspecies: *Streptococcus faecalis*, *S. faecalis* subsp. *zymogenes*, *S. faecalis* subsp. *liquefaciens*, *S. faecium*, *S. durans*, and *S. avium*). *S. faecalis* and its subspecies account for 95% of clinical isolates of enterococci and are important primary pathogens in bacterial endocarditis and urinary tract infections (3). Enterococci are also commonly isolated as copathogens in polymicrobial soft tissue and intraabdominal infections (4).

The purpose of this study was to evaluate the relative susceptibilities of 347 recent enterococcal urine culture isolates to 10 currently available and 2 investigational antibiotics and to determine any differences in susceptibility among *S. faecalis* subspecies.

The test organisms were stored in 50% horse serum at −70°C until susceptibility testing was performed. *S. faecalis* subspecies were identified by a modified version of the scheme described by Facklam (2). The antimicrobial agents tested were ampicillin (Bristol Laboratories, Syracuse, N.Y.), piperacillin (Pfizer Inc., New York, N.Y.), mezlocillin and azlocillin (Miles Pharmaceuticals, West Haven, Conn.), rosaramicin and gentamicin (Schering Corp., Kenilworth, N.J.), vancomycin (Eli Lilly & Co., Indianapolis, Ind.), erythromycin (Abbott Laboratories, North Chicago, Ill.), chloramphenicol (Parke, Davis & Co., Morris Plains, N.J.), trimethoprim-sulfamethoxazole (Burroughs Wellcome Co., Research Triangle Park, N.C.), and rifampin and rifampin-trimethoprim (Merrell Dow Pharmaceuticals, Inc., Cincinnati, Ohio).

The MICs were determined by a standard technique with Mueller-Hinton agar containing twofold serial dilutions of each antibiotic (1). Stock solutions containing 10,000 μg of each antibiotic per ml were prepared and stored at −70°C and were thawed only once before use. Oxoid sensitivity agar containing 5% lysed horse blood (thymine-and thymidine-free) was also used when testing trimethoprim-sulfamethoxazole.

The activities of the 12 antimicrobial agents tested against the 347 strains of *S. faecalis* are shown in Table 1. Ampicillin, vancomycin, and the acylureidopenicillins (azlocillin, mezlocillin, and piperacillin) were the most potent compounds studied, with an MIC for 90% of isolates [MIC_{90}] of ≤ 1.56 μg/ml. Among the other currently licensed agents, rifampin and trimethoprim-sulfamethoxazole tested in thymidine-free agar were significantly less active, with an MIC_{90} of ≤4 μg/ml. These organisms were moderately resistant to chloramphenicol (MIC_{90}, 12.5 to 25 μg/ml) and highly resistant to erythromycin, rosaramicin, and gentamicin (MIC_{90}, 6.25 to 200 μg/ml) and to trimethoprim-sulfamethoxazole tested in non-thymidine-free agar (MIC_{90}, 32 μg/ml). There were no significant differences in susceptibility to any of the antibiotics among the various *S. faecalis* subspecies.

* Corresponding author.

† Present address: Department of Internal Medicine, Park-Nicollet Medical Center, 5000 West 39th Street, Minneapolis, MN 55416.

TABLE 1. Comparative activities of 12 antimicrobial agents against 347 isolates of enterococci

Antibiotic	Bacterium[a]	MIC (μg/ml)[b]			
		Range	50%	75%	90%
Ampicillin	*S. faecalis*	<0.39–3.12	0.39	0.78	1.56
	S. faecalis subsp. *zymogenes*	<0.39–6.25	0.39	0.78	1.56
	S. faecalis subsp. *liquefaciens*	<0.39–1.56	0.39	0.78	0.78
Azlocillin	*S. faecalis*	0.39–3.12	0.39	0.78	0.78
	S. faecalis subsp. *zymogenes*	0.39–1.56	0.39	0.78	0.78
	S. faecalis subsp. *liquefaciens*	0.39–1.56	0.39	0.78	0.78
Mezlocillin	*S. faecalis*	0.39–1.56	0.39	0.39	0.78
	S. faecalis subsp. *zymogenes*	0.39–1.56	0.39	0.78	0.78
	S. faecalis subsp. *liquefaciens*	0.39–1.56	0.39	0.78	0.78

TABLE 1—*Continued*

Antibiotic	Bacterium[a]	MIC (μg/ml)[b]			
		Range	50%	75%	90%
Piperacillin	*S. faecalis*	0.39–3.12	0.78	1.56	1.56
	S. faecalis subsp. *zymogenes*	0.39–3.12	0.78	1.56	1.56
	S. faecalis subsp. *liquefaciens*	0.39–1.56	1.56	1.56	1.56
Vancomycin	*S. faecalis*	<0.39–50	1.56	1.56	1.56
	S. faecalis subsp. *zymogenes*	<0.39–6.25	1.56	1.56	1.56
	S. faecalis subsp. *liquefaciens*	<0.39–3.12	1.56	1.56	1.56
Rifampin	*S. faecalis*	<0.39–25	0.78	1.56	3.12
	S. faecalis subsp. *zymogenes*	<0.39–50	0.78	1.56	3.12
	S. faecalis subsp. *liquefaciens*	<0.39–12.5	1.56	3.12	3.12
Rifampin-trimethoprim (1:4)	*S. faecalis*	<0.39–6.25	0.78	1.56	3.12
	S. faecalis subsp. *zymogenes*	<0.39–6.25	0.78	1.56	3.12
	S. faecalis subsp. *liquefaciens*	<0.39–12.5	0.78	1.56	6.25
Trimethoprim-sulfamethoxazole (1:20)	*S. faecalis*				
	MHA[c]	0.063–32	32	32	32
	Oxoid	0.125–2.5	0.25	0.5	2
	S. faecalis subsp. *zymogenes*				
	MHA	0.5–32	32	32	32
	Oxoid	0.063–1.25	0.125	0.25	4
	S. faecalis subsp. *liquefaciens*				
	MHA	0.063–32	32	32	32
	Oxoid	0.063–1.25	0.125	0.25	0.5
Chloramphenicol	*S. faecalis*	0.39–25	3.12	6.25	12.5
	S. faecalis subsp. *zymogenes*	0.39–200	3.12	12.5	25
	S. faecalis subsp. *liquefaciens*	0.39–25	3.12	6.25	12.5
Erythromycin	*S. faecalis*	<0.39–200	1.56	100	200
	S. faecalis subsp. *zymogenes*	<0.39–200	6.25	100	200
	S. faecalis subsp. *liquefaciens*	<0.39–200	1.56	100	200
Rosaramicin	*S. faecalis*	<0.39–200	1.56	200	200
	S. faecalis subsp. *zymogenes*	<0.39–200	6.25	200	200
	S. faecalis subsp. *liquefaciens*	<0.39–200	3.12	200	200
Gentamicin	*S. faecalis*	6.25–200	6.25	6.25	200
	S. faecalis subsp. *zymogenes*	6.25–200	6.25	6.25	12.5
	S. faecalis subsp. *liquefaciens*	6.25–200	6.25	200	200

[a] There were 152 *S. faecalis*, 128 *S. faecalis* subsp. *zymogenes*, and 67 *S. faecalis* subsp. *liquefaciens* isolates tested against each antibiotic.
[b] 50%, 75%, and 90%, MICs for 50, 75, and 90%, respectively, of the isolates tested.
[c] MHA, Grown in Mueller-Hinton agar; Oxoid, grown in Oxoid agar.

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