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Short communication

In vitro activity of tigecycline and comparators against Gram-positive and Gram-negative isolates collected from the Middle East and Africa between 2004 and 2011

Souha S. Kanj[a,*], Andrew Whitelaw[b,c], Michael J. Dowzicky[d]

[a] Department of Internal Medicine, Division of Infectious Diseases, American University of Beirut Medical Center, P.O. Box 11-0236, Riad El-Solh, 1107 2020 Beirut, Lebanon
[b] Division of Medical Microbiology, Faculty of Health Sciences, University of Stellenbosch, Cape Town, South Africa
[c] National Health Laboratory Service, Tygerberg Hospital, Cape Town, South Africa
[d] Pfizer Inc., Collegeville, PA 19426, USA

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ABSTRACT

The Tigecycline Evaluation and Surveillance Trial (T.E.S.T.) was established in 2004 to monitor longitudinal changes in bacterial susceptibility to numerous antimicrobial agents, specifically tigecycline. In this study, susceptibility among Gram-positive and Gram-negative isolates between 2004 and 2011 from the Middle East and Africa was examined. Antimicrobial susceptibilities were determined using Clinical and Laboratory Standards Institute (CLSI) interpretive criteria, and minimum inhibitory concentrations (MICs) were determined by broth microdilution methods. US Food and Drug Administration (FDA)-approved breakpoints were used for tigecycline. In total, 2967 Gram-positive and 6322 Gram-negative isolates were examined from 33 participating centres. All *Staphylococcus aureus* isolates, including meticillin-resistant *S. aureus*, were susceptible to tigecycline, linezolid and vancomycin. Vancomycin, linezolid, tigecycline and levofloxacin were highly active (>97.6% susceptibility) against *Streptococcus pneumoniae*, including penicillin-non-susceptible strains. All *Enterococcus faecium* isolates were susceptible to tigecycline and linezolid, including 32 vancomycin-resistant isolates. Extended-spectrum β-lactamases were produced by 16.6% of *Escherichia coli* and 32.9% of *Klebsiella pneumoniae*. More than 95% of *E. coli* and *Enterobacter* spp. were susceptible to amikacin, tigecycline, imipenem and meropenem. The most active agents against *Pseudomonas aeruginosa* and *Acinetobacter baumannii* were amikacin (88.0% susceptible) and minocycline (64.2% susceptible), respectively; the MIC_{90} (MIC required to inhibit 90% of the isolates) of tigecycline against *A. baumannii* was low at 2 mg/L. Tigecycline and carbapenem agents were highly active against most Gram-negative pathogens. Tigecycline, linezolid and vancomycin showed good activity against most Gram-positive pathogens from the Middle East and Africa.

1. Introduction

Antimicrobial resistance has been reported to all major groups of antibiotics and is a cause of global concern. Resistance has appeared in the Middle East and Africa over the past decade (e.g. carbapenem-resistant *Acinetobacter baumannii* in Lebanon [1] and extended-spectrum β-lactamase (ESBL)-producing *Escherichia coli* and *Klebsiella pneumoniae* in South Africa [2]). Antimicrobial surveillance is critical for monitoring emerging trends in antimicrobial resistance and for guiding clinicians to appropriate empirical antimicrobial therapy.

Tigecycline, a broad-spectrum antimicrobial agent, is licensed for the treatment of complicated skin and intra-abdominal infections (as well as community-acquired bacterial pneumonia in the USA) [3]. The Tigecycline Evaluation and Surveillance Trial (T.E.S.T.) is a global surveillance study designed to monitor bacterial susceptibility to tigecycline and comparator antimicrobial agents. We report on the activity of tigecycline and comparators against Gram-positive and Gram-negative pathogens from the Middle East and Africa between 2004 and 2011. This paper updates some of the data presented by Bertrand and Dowzicky [4], who examined antimicrobial susceptibility among Gram-negative isolates from North America, Europe, the Asia-Pacific Rim, Latin

* Corresponding author. Tel.: +961 1 350 000; fax: +961 1 370 814.
E-mail address: sk11@aub.edu.lb (S. Kanj).

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Table 1a
MIC_{90} values (in mg/L) and percent antimicrobial susceptibility (%S) among Gram-positive isolates (including resistant phenotypes) collected in the Middle East and Africa between 2004 and 2011.[a,b]

	N	AMC		AMP		CRO		IPM		LVX		LZD		MEM		MIN		PEN		TZP		TIG		VAN	
		MIC_{90}	%S	MIC_{90}	%S	MIC_{90}	%S	MIC_{90}	%S	MIC_{90}	%S	MIC_{90}	%S	MIC_{90}	%S	MIC_{90}	%S	MIC_{90}	%S	MIC_{90}	%S	MIC_{90}	%S	MIC_{90}	%S
Staphylococcus aureus																									
Israel	631	≥16	71.8	≥32	11.3	≥128	70.8	–	–	16	68.8	4	100	≥32 (*n* = 631)	76.7	0.5	98.1	≥16	9.8	≥32	74.3	0.5	100	1	100
Jordan	29	8	69.0	≥32	3.4	≥128	65.5	–	–	4	89.7	4	100	8 (*n* = 29)	89.7	0.5	96.6	≥16	3.4	≥32	82.8	0.25	100	1	100
Lebanon	25	8	88.0	≥32	8.0	64	84.0	0.25 (*n* = 25)	96.0	0.25	92.0	2	100	–	–	≤0.25	100	≥16	8.0	8	96.0	0.25	100	1	100
Mauritius	24	≥16	58.3	≥32	12.5	≥128	54.2	–	–	8	66.7	4	100	≥32 (*n* = 24)	66.7	8	62.5	≥16	12.5	≥32	62.5	0.25	100	2	100
Namibia	24	8	87.5	≥32	8.3	16	87.5	–	–	0.5	91.7	2	100	4 (*n* = 24)	91.7	≤0.25	100	≥16	8.3	8	91.7	0.25	100	1	100
Oman	29	4	93.1	≥32	10.3	16	89.7	–	–	0.5	100	2	100	0.5 (*n* = 29)	100	≤0.25	100	≥16	10.3	4	100	0.12	100	1	100
Pakistan	62	8	88.7	≥32	8.1	64	85.5	1 (*n* = 46)	93.5	8	83.9	4	100	≥32 (*n* = 16)	81.3	1	95.2	≥16	6.5	16	88.7	0.5	100	1	100
Saudi Arabia	42	≥16	76.2	≥32	4.8	≥128	76.2	–	–	8	78.6	2	100	≥32 (*n* = 42)	78.6	≤0.25	95.2	≥16	4.8	≥32	78.6	0.25	100	1	100
South Africa	350	≥16	77.7	≥32	7.1	≥128	76.3	≥32 (*n* = 106)	74.5	8	79.1	2	100	≥32 (*n* = 244)	84.0	4	95.1	≥16	6.6	≥32	78.9	0.25	100	1	100
All countries	1216	≥16	75.3	≥32	9.4	≥128	73.9	≥32 (*n* = 177)	82.5	16	75.0	4	100	≥32 (*n* = 1039)	79.7	1	96.4	≥16	8.4	≥32	77.9	0.25	100	1	100
Meticillin-resistant *S. aureus*																									
Israel	190	≥16	6.3	≥32	0.0	≥128	6.8	–	–	≥64	8.4	4	100	≥32 (*n* = 190)	22.6	0.5	96.3	≥16	0.0	≥32	14.7	0.25	100	2	100
Jordan	9	–	[0]	–	[0]	–	[0]	–	–	–	[7]	–	[9]	– (*n* = 9)	[6]	–	[8]	–	[0]	–	[4]	–	[9]	–	[9]
Lebanon	8	–	[5]	–	[0]	–	[4]	–	[7]	–	[6]	–	[8]	–	–	–	[8]	–	[0]	–	[7]	–	[8]	–	[8]
Mauritius	11	≥16	9.1	≥32	0.0	≥128	0.0	–	–	8	27.3	4	100	≥32 (*n* = 11)	27.3	≥16	27.3	≥16	0.0	≥32	18.2	0.5	100	2	100
Namibia	3	–	[0]	–	[0]	–	[0]	–	–	–	[1]	–	[3]	– (*n* = 3)	[1]	–	[3]	–	[0]	–	[1]	–	[3]	–	[3]
Oman	4	–	[2]	–	[0]	–	[1]	–	–	–	[4]	–	[4]	– (*n* = 4)	[4]	–	[4]	–	[0]	–	[4]	–	[4]	–	[4]
Pakistan	8	–	[1]	–	[0]	–	[0]	–	[2]	–	[0]	–	[8]	– (*n* = 3)	[0]	–	[5]	–	[0]	–	[1]	–	[8]	–	[8]
Saudi Arabia	10	≥16	0.0	≥32	0.0	≥128	0.0	–	–	16	10.0	2	100	≥32 (*n* = 10)	10	8	80.0	≥16	0.0	≥32	10.0	0.25	100	2	100
South Africa	95	≥16	17.9	≥32	0.0	≥128	16.8	≥32 (*n* = 44)	38.6	8	26.3	2	100	≥32 (*n* = 51)	23.5	8	84.2	≥16	0.0	≥32	22.1	0.5	100	1	100
All countries	338	≥16	11.2	≥32	0.0	≥128	10.1	≥32 (*n* = 57)	45.6	32	18.6	2	100	≥32 (*n* = 281)	24.9	8	89.3	≥16	0.0	≥32	20.4	0.5	100	1	100
Streptococcus pneumoniae																									
Israel	336	2	92.0	4	NA	1	92.3	–	–	1	97.3	1	100	1 (*n* = 336)	75.9	≥16	59.2	2	51.8	4	NA	0.03	99.7	0.5	100
Jordan	14	4	50.0	8	NA	2	78.6	–	–	2	100	1	100	1 (*n* = 14)	21.4	≥16	28.6	4	7.1	8	NA	0.03	100	0.5	100
Mauritius	9	–	[7]	–	NA	–	[7]	–	–	–	[9]	–	[9]	– (*n* = 9)	[4]	–	[0]	–	[2]	–	NA	–	[9]	–	[9]
Oman	15	1	100	2	NA	1	100	–	–	1	100	1	100	0.5 (*n* = 15)	73.3	2	93.3	2	53.3	2	NA	0.03	100	0.5	100
Pakistan	32	0.12	100	0.25	NA	0.25	100	0.25 (*n* = 15)	86.7	1	93.8	1	100	≤0.12 (*n* = 17)	100	8	50.0	0.25	62.5	≤0.25	NA	0.06	100	0.5	100
Saudi Arabia	18	2	94.4	4	NA	2	83.3	–	–	1	100	1	100	0.5 (*n* = 18)	55.6	≥16	44.4	4	22.2	4	NA	0.06	94.4	0.5	100
South Africa	174	4	85.6	4	NA	1	97.1	0.5 (*n* = 50)	52.0	1	100	1	99.4	1 (*n* = 124)	63.7	4	82.8	2	31.6	4	NA	0.03	98.3	0.5	100
All countries	598	4	89.6	4	NA	1	93.5	0.5 (*n* = 65)	60.0	1	98.2	1	99.8	1 (*n* = 533)	71.1	8	64.4	2	44.1	4	NA	0.03	99.2	0.5	100
Penicillin-non-susceptible *S. pneumoniae*[c]																									
Israel	162	4	83.3	4	NA	2	84.0	–	–	2	95.1	1	100	1 (*n* = 162)	50.0	≥16	52.5	4	0.0	4	NA	0.03	100	0.5	100
Jordan	13	4	46.2	8	NA	2	76.9	–	–	2	100	1	100	1 (*n* = 13)	15.4	≥16	30.8	4	0.0	8	NA	0.03	100	0.5	100
Mauritius	7	–	[5]	–	NA	–	[5]	–	–	–	[7]	–	[7]	– (*n* = 7)	[2]	–	[0]	–	[0]	–	NA	–	[7]	–	[7]
Oman	7	–	[7]	–	NA	–	[7]	–	–	–	[7]	–	[7]	– (*n* = 7)	[3]	–	[6]	–	[0]	–	NA	–	[7]	–	[7]
Pakistan	12	0.25	100	0.5	NA	0.25	100	– (*n* = 5)	[3]	0.5	100	1	100	– (*n* = 7)	[7]	≥16	33.3	0.5	0.0	0.5	NA	0.06	100	0.5	100
Saudi Arabia	14	2	92.9	4	NA	2	78.6	–	–	1	100	1	100	0.5 (*n* = 14)	42.9	≥16	35.7	4	0.0	4	NA	0.03	92.9	0.5	100
South Africa	119	4	79.0	4	NA	1	95.8	0.5 (*n* = 36)	33.3	1	100	1	99.2	1 (*n* = 83)	45.8	8	77.3	4	0.0	4	NA	0.06	98.3	0.5	100
All countries	334	4	81.4	4	NA	2	88.3	0.5 (*n* = 41)	36.6	1	97.6	1	99.7	1 (*n* = 293)	47.4	≥16	58.7	4	0.0	4	NA	0.03	99.1	0.5	100
Streptococcus agalactiae																									
Israel	255	0.12	NA	0.12	100	0.12	100	–	–	1	97.3	1	100	≤0.12 (*n* = 255)	100	≥16	20.0	0.12	100	0.5	NA	0.12	100	0.5	100
Jordan	15	0.12	NA	0.12	100	0.25	100	–	–	1	100	2	100	0.5 (*n* = 15)	100	≥16	26.7	0.12	100	0.5	NA	0.5	66.7	1	100
Lebanon	10	0.12	NA	0.12	100	0.12	100	≤0.12 (*n* = 10)	NA	1	100	1	100	–	–	≥16	30.0	0.12	100	≥32	NA	2	0	0.5	100
Mauritius	9	–	NA	–	[9]	–	[9]	–	–	–	[9]	–	[9]	– (*n* = 9)	[9]	–	[0]	–	[9]	–	NA	–	[9]	–	[9]
Namibia	5	–	NA	–	[5]	–	[5]	–	–	–	[5]	–	[5]	– (*n* = 5)	[5]	–	[0]	–	[5]	–	NA	–	[5]	–	[5]
Oman	8	–	NA	–	[8]	–	[8]	–	–	–	[8]	–	[8]	– (*n* = 8)	[8]	–	[1]	–	[8]	–	NA	–	[8]	–	[8]
Pakistan	24	0.12	NA	0.12	100	0.12	100	0.25 (*n* = 15)	NA	1	100	1	100	– (*n* = 9)	[9]	≥16	8.3	0.12	100	≤0.25	NA	0.06	100	0.5	100
Saudi Arabia	16	0.12	NA	0.12	100	0.12	100	–	–	1	100	1	100	≤0.12 (*n* = 16)	100	≥16	18.8	≤0.06	100	≤0.25	NA	0.5	68.8	0.5	100
South Africa	123	0.12	NA	0.12	100	0.12	100	0.5 (*n* = 41)	NA	1	100	1	100	≤0.12 (*n* = 82)	100	≥16	8.9	0.12	100	≤0.25	NA	0.12	94.3	0.5	100
All countries	465	0.12	NA	0.12	100	0.12	100	0.25 (*n* = 66)	NA	1	98.5	1	100	≤0.12 (*n* = 399)	100	≥16	16.1	0.12	100	0.5	NA	0.12	94.2	0.5	100
Enterococcus faecalis																									
Israel	284	1	NA	2	99.6	≥128	NA	–	–	≥64	52.8	2	100	8 (*n* = 284)	NA	≥16	27.1	4	99.6	8	NA	0.25	99.6	2	98.9
Jordan	28	1	NA	2	100	≥128	NA	–	–	≥64	53.6	2	100	8 (*n* = 28)	NA	≥16	28.6	4	100	8	NA	0.25	100	2	100
Mauritius	9	–	NA	–	[9]	–	NA	–	–	–	[1]	–	[9]	– (*n* = 9)	NA	–	[1]	–	[9]	–	NA	–	[9]	–	[9]
Namibia	13	1	NA	1	100	≥128	NA	–	–	32	76.9	2	100	8 (*n* = 13)	NA	≥16	38.5	4	100	8	NA	0.25	100	2	100
Oman	15	0.5	NA	1	100	≥128	NA	–	–	32	66.7	2	100	4 (*n* = 15)	NA	8	40.0	2	100	4	NA	0.12	100	2	100
Pakistan	23	2	NA	2	100	≥128	NA	2 (*n* = 11)	NA	≥64	43.5	2	100	≥32 (*n* = 12)	NA	8	17.4	8	100	16	NA	0.12	100	2	100
Saudi Arabia	8	–	NA	–	[8]	–	NA	–	–	–	[4]	–	[8]	– (*n* = 8)	NA	–	[2]	–	[8]	–	NA	–	[8]	–	[8]
South Africa	185	1	NA	1	100	≥128	NA	4 (*n* = 54)	NA	≥64	63.8	2	99.5	8 (*n* = 131)	NA	≥16	26.5	4	100	4	NA	0.12	100	2	100
All countries	565	1	NA	2	99.8	≥128	NA	4 (*n* = 65)	NA	≥64	56.3	2	99.8	8 (*n* = 500)	NA	≥16	26.9	4	99.8	8	NA	0.25	99.8	2	99.5