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Activity of Telavancin against Gram-Positive Cocci from Canadian Hospitals: CANWARD 2007-2009

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ABSTRACT

Background: Telavancin is a lipoglycopeptide with rapid bactericidal activity against a broad spectrum of gram-positive pathogens. The purpose of this study was to assess the activity of telavancin and comparators against gram-positive cocci obtained from Canadian hospitals as part of the ongoing national CANWARD surveillance study.
Methods: From January 2007 through December 2009, sentinel hospitals representing 8 of 10 provinces in Canada submitted isolates from patients attending hospital clinics, emergency rooms, medical/surgical wards, and intensive care units. Each centre was asked to submit pathogens (consecutive, one per patient per infection site) from blood, respiratory specimens, urine, and wound/IV sites. 18538 isolates were collected in total, including 7956 gram-positive cocci. Susceptibility testing was performed against 5290 pathogens by broth microdilution using CLSI methodology for comparator agents and FDA-approved dry-form panels for telavancin.
Results: MIC_{50} and MIC_{90} values for telavancin, vancomycin, daptomycin and linezolid are shown below:

Organism (n)	Telavancin MIC_{50} / MIC_{90}	Vancomycin MIC_{50} / MIC_{90}	Daptomycin MIC_{50} / MIC_{90}	Linezolid MIC_{50} / MIC_{90}
MSSA (2697)	0.25 / 0.5	1 / 1	0.12 / 0.25	2 / 2
MRSA (889)	0.25 / 0.5	1 / 1	0.12 / 0.25	2 / 2
- HA-MRSA (643)	0.25 / 0.5	1 / 1	0.12 / 0.25	2 / 2
- CA-MRSA (225)	0.25 / 0.5	1 / 1	0.25 / 0.25	2 / 2
MSSE (268)	0.25 / 0.5	1 / 2	0.12 / 0.25	0.5 / 1
MRSE (45)	0.25 / 0.5	2 / 2	0.12 / 0.25	1 / 1
S. pneumoniae - All (1391)	≤0.06 / ≤0.06	≤0.25 / 0.25	0.06 / 0.12	0.5 / 1
- PenS (1117)	≤0.06 / ≤0.06	≤0.25 / 0.25	0.06 / 0.06	1 / 1
- PenI (200)	≤0.06 / ≤0.06	≤0.25 / 0.5	0.06 / 0.12	1 / 1
- PenR (58)	≤0.06 / ≤0.06	≤0.25 / 0.5	0.06 / 0.12	0.5 / 1

MSSA, methicillin-susceptible *S. aureus*; MRSA, methicillin-resistant *S. aureus*; HA-MRSA, healthcare-associated MRSA; CA-MRSA, community-associated MRSA; MSSE, methicillin-susceptible *S. epidermidis*; MRSE, methicillin-resistant *S. epidermidis*.

Conclusions: Telavancin is more active in vitro than vancomycin and linezolid and has comparable activity to daptomycin against MSSA, MRSA (including CA-MRSA and HA-MRSA), MSSE, MRSE and *S. pneumoniae*.

BACKGROUND

Antibiotic resistance among gram-positive pathogens such as *Streptococcus pneumoniae*, *Staphylococcus aureus* and *Staphylococcus epidermidis* is a growing concern. The global escalation in both community- and nosocomial-acquired antibiotic-resistant organisms is threatening our ability to effectively treat patients by significantly limiting the therapeutic options available to clinicians and increasing the risk of treatment failures. Management of infections caused by these difficult-to-treat pathogens is often complicated further by the fact that many of these strains are multidrug-resistant. These observations underscore the need for continued surveillance, more judicious antibiotic prescribing practices and new treatment alternatives.

Telavancin is a semisynthetic lipoglycopeptide with a dual mechanism of action against a broad spectrum of clinically relevant gram-positive bacteria, including both susceptible and multidrug-resistant staphylococci and streptococci (1-4). The rapid bactericidal activity of telavancin is derived from its ability to inhibit synthesis of the bacterial cell wall as well as to disrupt bacterial membrane integrity and increase cell membrane permeability (1-4).

PURPOSE

The purpose of this study was to assess the activity of telavancin and comparators against gram-positive cocci obtained from Canadian hospitals in 2007-2009 as part of the ongoing national CANWARD surveillance study.

MATERIALS & METHODS

CANWARD Study Design

Between January 2007 and December 2007, 18538 clinical isolates, including 7956 gram-positive cocci, were collected as part of the ongoing CANWARD study assessing pathogen prevalence and antibiotic resistance in Canadian hospitals. Isolates were received from tertiary-care medical centres (12 in 2007, 10 in 2008, 15 in 2009) that were geographically distributed in a population-based fashion in eight of the ten Canadian provinces. Each study site was asked to submit clinical isolates (consecutive, one per patient per infection site) from inpatients and outpatients with respiratory, urine, wound and bloodstream infections. Isolates were collected from patients attending hospital clinics, emergency rooms, medical/surgical wards and intensive care units. All organisms were identified by the submitting centre and were deemed clinically significant using local site criteria. Isolates were shipped on Amies semi-solid transport media to the coordinating laboratory (Health Sciences Centre, Winnipeg, Canada) where they were subcultured onto appropriate media and stocked in skim milk at -80°C.

Antimicrobial Susceptibility Testing

Following two subcultures from frozen stock, the *in vitro* activities of telavancin and comparator agents, including cefazolin, ceftriaxone, clarithromycin, clindamycin, ciprofloxacin, daptomycin, doxycycline, ertapenem, levofloxacin, linezolid, meropenem, moxifloxacin, penicillin, piperacillin-tazobactam, tigecycline, trimethoprim-sulfamethoxazole and vancomycin, were determined against 5290 pathogens by broth microdilution in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines (5-6). Antimicrobial minimum inhibitory concentrations (MICs) were determined using 96-well custom designed microtitre panels for comparator agents and FDA-approved dry-form panels for telavancin. Quality control was performed using the following ATCC organisms: *S. pneumoniae* ATCC 49619 and *S. aureus* ATCC 29213. MIC interpretive standards were defined according to CLSI breakpoints (7). The following interpretive breakpoint (FDA) was used for tigecycline susceptible: *S. aureus*, ≤0.5 µg/ml.

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RESULTS

Table 1. Activity of telavancin and comparators against gram-positive cocci from CANWARD 2007-2009

Organism (n), Antibiotic	% of Isolates per Category S	I	R	MIC_{50}	MIC_{90}	Range Min	Range Max
S. aureus							
MSSA (2697)							
Telavancin	100			0.25	0.5	≤ 0.06	1
Vancomycin	100			1	1	≤ 0.25	2
Cefazolin	99.9		0.1	0.5	1	≤ 0.5	32
Clarithromycin	74.9	0.3	24.7	0.25	> 16	≤ 0.25	> 16
Clindamycin	91.8	0.6	7.7	≤ 0.25	≤ 0.25	≤ 0.25	> 8
Daptomycin	100			0.12	0.25	≤ 0.06	1
Levofloxacin	90.1	0.3	9.6	0.25	1	≤ 0.06	> 32
Linezolid	100			2	2	≤ 0.12	4
Meropenem	100			0.12	0.25	≤ 0.12	4
Moxifloxacin	90.4	0.6	9.1	≤ 0.06	0.25	≤ 0.06	> 16
Pip-Tazo	99.9		0.1	2	≤ 1	≤ 1	32
Tigecycline[2]	99.8			0.25	0.25	≤ 0.03	1
TMP/SMX	99.3		0.7	≤ 0.12	≤ 0.12	≤ 0.12	> 8
MRSA (889)							
Telavancin	100			0.25	0.5	0.12	1
Vancomycin	99.9	0.1		1	1	≤ 0.25	4
Cefazolin	100		100.0[6]	64	> 128	1	> 128
Clarithromycin	11.7	0.1	88.2	> 16	> 16	≤ 0.25	> 16
Clindamycin	44	0.1	55.9	> 8	> 8	≤ 0.25	> 8
Daptomycin	100			0.12	0.25	0.06	1
Levofloxacin	14.1		85.9	> 32	> 32	0.12	> 32
Linezolid	100			2	2	≤ 0.12	4
Meropenem			100.0[7]	8	32	0.12	> 32
Moxifloxacin	14.1	1	84.9	8	> 16	≤ 0.06	> 16
Pip-Tazo			100.0[7]	64	128	≤ 1	512
Tigecycline[2]	99.3			0.25	0.5	0.06	1
TMP/SMX	90.3		9.7	≤ 0.12	1	≤ 0.12	> 8
CA-MRSA (225)							
Telavancin	100			0.25	0.5	0.12	1
Vancomycin	100			1	1	0.5	2
Cefazolin			100.0[6]	16	64	1	> 128
Clarithromycin	26.9	0.5	72.7	> 16	> 16	≤ 0.25	> 16
Clindamycin	86.1		13.9	≤ 0.25	> 8	≤ 0.25	> 8
Daptomycin	100			0.25	0.25	0.12	1
Levofloxacin	39.9		60.1	4	8	0.12	32
Linezolid	100			2	2	1	4
Meropenem			100.0[7]	2	4	0.12	16
Moxifloxacin	39.9	3.6	56.5	2	2	≤ 0.06	8
Pip-Tazo			100.0[7]	16	32	2	64
Tigecycline[2]	99.6			0.25	0.25	0.06	1
TMP/SMX	100			≤ 0.12	≤ 0.12	≤ 0.12	2
HA-MRSA (643)							
Telavancin	100			0.25	0.5	0.12	1
Vancomycin	99.8	0.2		1	1	≤ 0.25	4
Cefazolin			100.0[6]	128	> 128	1	> 128
Clarithromycin	4.3		95.7	> 16	> 16	≤ 0.25	> 16
Clindamycin	27.8	0.2	72	> 8	> 8	≤ 0.25	> 8
Daptomycin	100			0.12	0.25	0.06	1
Levofloxacin	2.9		97.1	> 32	> 32	0.12	> 32
Linezolid	100			2	2	≤ 0.12	4
Meropenem			100.0[6]	16	> 32	0.25	> 32
Moxifloxacin	2.9	0.2	97	8	> 16	≤ 0.06	> 16
Pip-Tazo	8.6		100.0[6]	64	128	≤ 1	512
Tigecycline[2]	99.2			0.25	0.5	0.12	1
TMP/SMX	86.5		13.5	≤ 0.12	8	≤ 0.12	> 8

[2] Interpretive breakpoints defined by FDA.
[6] Based on oxacillin susceptibility.

S, susceptible; I, intermediate; R, resistant. No BP, no breakpoints defined.

CA-MRSA, community-associated methicillin-resistant *S. aureus*.
HA-MRSA, healthcare-associated methicillin-resistant *S. aureus*.

Organism (n), Antibiotic	% of Isolates per Category S	I	R	MIC_{50}	MIC_{90}	Range Min	Range Max
S. pneumoniae							
All (1391)							
Telavancin	No BP			≤ 0.06	≤ 0.06	≤ 0.06	0.12
Vancomycin	100			≤ 0.25	0.25	≤ 0.25	1
Ceftriaxone	99.4	0.4	0.2	≤ 0.12	0.12	≤ 0.12	4
Clarithromycin	81.3	4.3	14.5	0.03	2	≤ 0.03	> 32
Clindamycin	93.5	0.6	5.9	≤ 0.12	≤ 0.12	≤ 0.12	> 8
Doxycycline	No BP			≤ 0.25	1	≤ 0.25	> 16
Levofloxacin	99.1	0.2	0.8	1	1	≤ 0.06	32
Linezolid	100			0.5	1	≤ 0.12	2
Meropenem	96.4	2.5	1.1	≤ 0.06	≤ 0.06	≤ 0.06	2
Penicillin	81.1	14.5	4.4	0.03	0.25	≤ 0.03	> 8
Tigecycline	No BP			≤ 1	1	≤ 0.03	0.06
TMP/SMX	85.6	6.3	8.1	≤ 0.12	1	≤ 0.12	> 8
PSSP (1117)							
Telavancin	No BP			≤ 0.06	≤ 0.06	≤ 0.06	0.12
Vancomycin	100			≤ 0.25	0.25	≤ 0.25	1
Ceftriaxone	100			≤ 0.12	≤ 0.12	≤ 0.12	0.25
Clarithromycin	89.1	3.3	7.6	≤ 0.03	0.5	≤ 0.03	> 32
Clindamycin	97.9	0.3	1.8	≤ 0.12	≤ 0.12	≤ 0.12	> 8
Doxycycline	No BP			≤ 0.25	≤ 0.25	≤ 0.25	> 16
Levofloxacin	99.2	0.2	0.6	1	1	≤ 0.06	32
Linezolid	100			0.5	1	≤ 0.12	2
Meropenem	99.9	0.1		≤ 0.06	≤ 0.06	≤ 0.06	0.5
Penicillin	100.0			≤ 0.03	0.06	≤ 0.03	0.06
Tigecycline	No BP			≤ 0.03	0.06	≤ 0.03	0.5
TMP/SMX	91.9	5.3	2.8	≤ 0.12	0.5	≤ 0.12	> 8
PISP (200)							
Telavancin	No BP			≤ 0.06	≤ 0.06	≤ 0.03	0.06
Vancomycin	99.5		0.5	≤ 0.25	0.5	≤ 0.12	2
Ceftriaxone	99	0.5	0.5	≤ 0.06	0.25	≤ 0.06	4
Clarithromycin	49.3	10.2	40.1	0.5	> 32	≤ 0.03	> 32
Clindamycin	78.4	1.5	20.1	≤ 0.12	16	≤ 0.12	> 64
Doxycycline	No BP			≤ 0.25	16	≤ 0.25	> 16
Levofloxacin	98		2	1	1	0.25	16
Linezolid	100			0.5	1	≤ 0.12	2
Meropenem	95	4	1	≤ 0.06	0.25	≤ 0.06	1
Penicillin	100		100	0.12	1	0.12	1
Tigecycline	No BP			0.03	0.06	≤ 0.03	0.06
TMP/SMX	69.5	11.5	19	0.25	8	≤ 0.12	> 8
PRSP (61)							
Telavancin	No BP			≤ 0.06	≤ 0.06	≤ 0.06	0.06
Vancomycin	100			≤ 0.25	0.5	≤ 0.25	1
Ceftriaxone	90.2	6.6	3.3	0.5	1	≤ 0.12	4
Clarithromycin	41	3.3	55.7	2	> 32	≤ 0.03	> 32
Clindamycin	62.3	3.3	34.4	≤ 0.12	> 8	≤ 0.12	> 8
Doxycycline	No BP			1	4	≤ 0.25	> 16
Levofloxacin	100			1	1	0.25	2
Linezolid	100			0.5	1	0.25	2
Meropenem	36.1	42.6	21.3	0.5	1	≤ 0.06	2
Penicillin			100	2	4	2	> 8
Tigecycline	No BP			0.03	0.06	≤ 0.03	0.12
TMP/SMX	21.3	8.2	70.5	4	> 8	≤ 0.12	> 8

[6] Penicillin resistance defined as an MIC ≥2 µg/ml.

S, susceptible; I, intermediate; R, resistant. No BP, no breakpoints defined.

PSSP, penicillin-susceptible *S. pneumoniae*.
PISP, penicillin-intermediate *S. pneumoniae*.
PRSP, penicillin-resistant *S. pneumoniae*.

Organism (n), Antibiotic	% of Isolates per Category S	I	R	MIC_{50}	MIC_{90}	Range Min	Range Max
S. epidermidis							
MSSE (268)							
Telavancin	No BP			0.25	0.5	≤ 0.06	1
Vancomycin	100			1	2	≤ 0.12	2
Cefazolin	100			1	4	≤ 0.5	8
Clarithromycin	34.3	2.2	63.4	> 16	> 32	≤ 0.03	> 32
Clindamycin	62.3	0.4	37.3	≤ 0.25	> 8	≤ 0.12	> 8
Daptomycin	100			0.12	0.25	≤ 0.03	1
Levofloxacin	51.9	1.1	47	0.25	> 32	0.12	> 32
Linezolid	100			0.5	1	≤ 0.12	2
Meropenem	84	10.1	6	1	8	≤ 0.06	32
Moxifloxacin	53.7	7.8	38.4	0.12	8	≤ 0.06	> 16
Pip-Tazo	98.9		1.1	≤ 1	2	≤ 1	16
Tigecycline	No BP			0.25	0.5	≤ 0.03	1
TMP/SMX	64.9		35.1	0.25	8	≤ 0.12	> 8
MRSE (45)							
Telavancin	No BP			0.25	0.5	0.12	1
Vancomycin	100		2	2	2	1	2
Cefazolin			100.0[6]	64	128	32	> 128
Clarithromycin	11.1		88.9	> 16	> 16	≤ 0.25	> 16
Clindamycin	13.3		86.7	> 8	> 8	≤ 0.25	> 8
Daptomycin	100			0.12	0.25	≤ 0.06	0.5
Levofloxacin	2.2	2.2	95.6	> 32	> 32	1	> 32
Linezolid	100			1	1	0.25	1
Meropenem			100.0[6]	32	32	8	> 32
Moxifloxacin	4.4	2.2	93.3	> 16	> 16	0.12	> 16
Pip-Tazo			100.0[7]	32	64	8	128
Tigecycline	No BP			0.25	0.25	0.06	0.5
TMP/SMX	24.4		75.6	4	8	≤ 0.12	> 8

[6] Based on oxacillin susceptibility.

S, susceptible; I, intermediate; R, resistant. No BP, no breakpoints defined.

MSSE, methicillin-susceptible *S. epidermidis*.
MRSE, methicillin-resistant *S. epidermidis*.

Table 2. MIC distribution of telavancin against gram-positive cocci from CANWARD 2007-2009

Organism (no. tested)	Number (cumulative percentage) at each MIC ≤0.06	0.12	0.25	0.5	1
Methicillin-susceptible *S. aureus* (1980)	15 (0.8)	544 (28.2)	798 (68.5)	525 (95.1)	98 (100)
Methicillin-resistant *S. aureus* (631)		128 (20.3)	264 (62.1)	202 (94.1)	37 (100)
Community-associated MRSA (173)		34 (19.7)	71 (60.7)	58 (94.2)	10 (100)
Healthcare-associated MRSA (433)		89 (20.6)	180 (62.1)	137 (93.8)	27 (100)
Methicillin-susceptible *S. epidermidis* (202)	5 (2.5)	73 (38.6)	78 (77.2)	39 (96.5)	7 (100)
Methicillin-resistant *S. epidermidis* (34)		8 (23.5)	20 (82.4)	3 (91.2)	3 (100)
S. pneumoniae (1391)	1389 (99.9)	2 (100)			
Penicillin-susceptible *S. pneumoniae* (1114)	1112 (99.8)	2 (100)			
Penicillin-intermediate *S. pneumoniae* (200)	200 (100)				
Penicillin-resistant *S. pneumoniae* (61)	62 (100)				

MIC, minimum inhibitory concentration (µg/ml).

CONCLUSIONS

Against methicillin-susceptible and methicillin-resistant *S. aureus* (including both community- and healthcare-associated strains), telavancin had comparable activity to daptomycin and superior activity to vancomycin and linezolid as measured by the MIC.

Telavancin was more active than vancomycin and linezolid against methicillin-susceptible and methicillin-resistant *S. epidermidis* and was comparable to daptomycin.

Against *S. pneumoniae*, telavancin was more active than vancomycin, linezolid and penicillin. Telavancin was the most potent agent tested against penicillin-resistant *S. pneumoniae*.

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