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In Vitro Activity of Ceftaroline Tested Against Bacterial Pathogens Frequently Isolated in United States (USA) Medical Centers: Results From the AWARE Surveillance Program

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Abstract

Background:
Ceftaroline (CPT) is a new broad-spectrum cephalosporin with activity against *S. aureus* (SA), including MRSA, multidrug-resistant *S. pneumoniae* (SPN) and common Gram-negative enteric bacilli (EB). CPT is approved in the USA for treatment of acute bacterial skin and skin structure infection (ABSSSI) and community-acquired bacterial pneumonia. We evaluated the activity of CPT against prevalent Gram-positive and -negative species isolated in USA hospitals.

Methods:
23,053 consecutive, nonduplicate isolates from bloodstream, ABSSSI, and respiratory tract infections were collected from 62 medical centers in 2008 (n=10,494), 2009 (n=9,037) and 2010 (n=3,522) and tested for susceptibility (S) to CPT and comparator agents using CLSI broth microdilution methods.

Results:
CPT inhibited all SA strains (52.8% MRSA) at ≤2 μg/mL and was very active against MRSA (MIC_{90}, 1 μg/mL; Table 1). CPT was 4- and >32-fold more active than ceftriaxone (CRO) against methicillin-S SA and MRSA, respectively. CPT inhibited all SPN at ≤0.5 μg/mL and remained active against MDR SPN (penicillin-R [21.5% at ≥2 μg/mL] and CRO-R [11.0% at ≥2 μg/mL]). The highest CPT MIC value among β-haemolytic streptococci was only 0.06 μg/mL. CPT activity against the most common EB (MIC_{50}, 0.12-0.25 μg/mL) was similar to CRO and ceftazidime. ESBL phenotypes were observed in 7.8% of *E. coli* and 12.4% of *Klebsiella* spp., and all cephalosporins showed limited activity against ESBL-producing strains. *H. influenzae* (HI) strains were highly CPT-S (MIC_{90}, 0.015 μg/mL; Table 1).

Conclusions:
CPT demonstrated enhanced activity against staphylococci, including MRSA, different streptococcal groups, and HI. CPT also demonstrated activity against EB similar to that of currently available broad-spectrum cephalosporins.

Introduction

Ceftaroline is the active metabolite of the prodrug ceftaroline fosamil, an N-phosphonoamino water-soluble cephalosporin. Ceftaroline fosamil was recently approved by the United States Food and Drug Administration (USA-FDA) for the treatment of acute bacterial skin and skin structure infections (ABSSSIs) and community-acquired bacterial pneumonia (CABP).

Ceftaroline has demonstrated potent *in vitro* activity against the organisms most frequently responsible for ABSSSI and CABP, including methicillin-resistant *Staphylococcus aureus* (MRSA) and multidrug-resistant (MDR) strains of *Streptococcus pneumoniae*. As part of the Assessing Worldwide Antimicrobial Resistance Evaluation (AWARE) Program, a global ceftaroline surveillance study, we evaluated the activity of ceftaroline against prevalent Gram-positive and -negative species isolated in USA hospitals.

Methods

Organism collection: A total of 23,053 (21,001 presented) clinically significant, consecutively collected, non-duplicate isolates from patients hospitalized in 62 USA medical centers in 2008 (n=10,494), 2009 (n=9,037) and 2010 (n=3,522) were used for this study.

Susceptibility methods: Broth microdilution test methods conducted according to the Clinical and Laboratory Standards Institute (CLSI) were performed to determine antimicrobial susceptibility of ceftaroline and 11 comparators. Validated MIC panels were manufactured by TREK Diagnostics (Cleveland, Ohio, USA). *S. aureus* strains were tested in cation-adjusted Mueller-Hinton broth (CA-MHB). β-haemolytic streptococci were tested in CA-MHB supplemented with 3-5% lysed horse blood (M07-A8, 2009).

Concurrent quality control (QC) testing was performed to assure proper test conditions and procedures. QC strains included: *S. aureus* ATCC 29213, *Enterococcus faecalis* ATCC 29212 and *S. pneumoniae* ATCC 49619. Susceptibility percentages and validation of QC results were based on the CLSI guidelines (M100-S21) and susceptibility breakpoints were used to determine susceptibility/resistance rates (CLSI and EUCAST, 2011). USA-FDA interpretive criteria for ceftaroline susceptibility were used when available.

Results

- Ceftaroline exhibited potent activity against methicillin-susceptible *S. aureus* (MSSA) isolates (MIC_{50} and MIC_{90}, 0.25 μg/mL) and MRSA isolates (MIC_{50} and MIC_{90}, 1 μg/mL). Against MSSA, ceftaroline was 16-fold more active than ceftriaxone (MIC_{50} and MIC_{90}, 4 μg/mL). The highest ceftaroline MIC results observed were 1 and 2 μg/mL for MSSA and MRSA, respectively (Tables 1 and 2)
- The most active agents against MRSA were: ceftaroline (MIC_{90}, 1 μg/mL; 96.0% susceptible [S] and 100.0% inhibited at ≤2 μg/mL), linezolid (MIC_{90}, 2 μg/mL; 100% S), vancomycin (MIC_{90}, 1 μg/mL; 100% S), daptomycin (MIC_{90}, 0.5 μg/mL; 100% S), and tigecycline (MIC_{90}, 0.25 μg/mL; 100% S; Table 2)
- Ceftaroline activity against *S. pneumoniae* varied according to the susceptibility of this organism to penicillin (data not shown), but ceftaroline demonstrated potent activity against all subsets of organisms. Ceftaroline (MIC_{90}, 0.25 μg/mL) was 8-fold more active than ceftriaxone (MIC_{90}, 2 μg/mL) and 32-fold more active than amoxicillin/clavulanate (MIC_{90}, 8 μg/mL; Table 2)
- Ceftaroline inhibited all *S. pneumoniae* at ≤0.5 μg/mL and remained active against MDR, penicillin-resistant [21.5% at ≥2 μg/mL] and ceftriaxone-non-susceptible [11.0% at ≥2 μg/mL]) strains (Table 2)
- Ceftaroline was highly active against *Haemophilus influenzae* ($MIC_{50/90}$, ≤0.008/0.015 μg/mL; 100.0% S), with the highest MIC value being 0.12 μg/mL. Comparators with the highest S rates were ceftriaxone, levofloxacin, amoxicillin/clavulanate, cefuroxime, and azithromycin (≥98.6% S; Table 2)
- Against β-haemolytic streptococci, ceftaroline demonstrated very potent activity ($MIC_{50/90}$, 0.015/0.03 μg/mL), comparable to that of penicillin ($MIC_{50/90}$, ≤0.03/0.06 μg/mL). Decreased susceptibility was observed only with erythromycin (MIC_{90}, >2 μg/mL; 67.6% S) and clindamycin (MIC_{90}, >2 μg/mL; 84.0% S by CLSI criteria; Table 2)
- Ceftaroline activity against coagulase-negative staphylococci (CoNS; $MIC_{50/90}$, 0.25/0.5 μg/mL) was slightly greater (2-fold) than that observed against *S. aureus* ($MIC_{50/90}$, 0.5/1 μg/mL). Oxacillin (methicillin) resistance was observed in 72.5% of CoNS strains (Table 2)
- Ceftaroline exhibited marginal in vitro activity against *E. faecalis* ($MIC_{50/90}$, 2/8 μg/mL). Other cephalosporins tested showed very limited activity against these organisms (Table 2)
- Ceftaroline and ceftriaxone had similar in vitro activities against *Escherichia coli*, *Klebsiella* spp., *Enterobacter* spp. and *Proteus mirabilis* (Table 2). Isolates S to ceftriaxone generally had low ceftaroline MIC values (data not shown)
- ESBL phenotypes were observed in 7.8% of *E. coli* and 12.4% of *Klebsiella* spp., and all cephalosporins showed limited activity against ESBL-producing strains.

Table 1. Summary of Ceftaroline Activity Tested Against the Main Pathogen Groups

	Number of isolates (cumulative %) inhibited at MIC (μg/mL) of:										
Organism (no. tested)	≤0.008	0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8
S. aureus (7,614)	1 (<0.1)	2 (<0.1)	3 (0.1)	17 (0.3)	247 (3.6)	3,123 (44.6)	2,086 (72.0)	1,974 (97.9)	161 (100.0)	-	-
MSSA (3,597)	1 (<0.1)	2 (0.1)	3 (0.2)	17 (0.6)	244 (7.4)	3,066 (92.7)	261 (99.9)	3 (100.0)	-	-	-
MRSA (4,017)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (0.1)	57 (1.5)	1,825 (46.9)	1,971 (96.0)	161 (100.0)	-	-
S. pneumoniae (2,618)	1,275 (48.7)	317 (60.8)	196 (68.3)	234 (77.2)	317 (89.3)	243 (98.6)	36 (100.0)	-	-	-	-
β-haemolytic streptococci (1,570)	757 (48.2)	584 (85.4)	221 (99.5)	8 (100.0)	-	-	-	-	-	-	-
CoNS (1,274)	3 (0.2)	5 (0.6)	28 (2.8)	194 (18.0)	169 (31.3)	411 (63.5)	380 (93.3)	69 (98.8)	15 (100.0)	-	-
E. faecalis (1,102)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (0.3)	8 (1.0)	18 (2.6)	266 (26.8)	497 (71.9)	174 (87.7)	114 (98.0)
E. coli (2,591)	1 (<0.1)	15 (0.6)	216 (9.0)	807 (40.1)	663 (65.7)	385 (80.6)	177 (87.4)	72 (90.2)	35 (91.5)	16 (92.1)	21 (92.9)
Klebsiella spp. (2,175)	5 (0.2)	8 (0.6)	79 (4.2)	600 (61.8)	655 (61.9)	307 (76.1)	151 (83.0)	69 (86.2)	20 (87.1)	21 (88.1)	21 (89.0)
Enterobacter spp. (675)	2 (0.3)	4 (0.9)	22 (3.3)	75 (14.4)	135 (34.4)	174 (60.2)	78 (71.7)	31 (76.3)	9 (77.6)	4 (78.2)	17 (80.7)
P. mirabilis (376)	0 (0.0)	0 (0.0)	8 (2.1)	110 (31.4)	163 (74.7)	45 (86.7)	23 (92.8)	13 (96.3)	4 (97.3)	2 (97.9)	0 (97.9)
H. influenzae (1,006)	709 (70.5)	225 (92.8)	49 (97.7)	20 (99.7)	3 (100.0)	-	-	-	-	-	-

Table 2. Antimicrobial Activity of Ceftaroline and Comparator Agents Tested Against Bacterial Isolates from USA Medical Centers (2008-2010)

Antimicrobial agent	MIC_{50}	MIC_{90}	Range	CLSI[a] %S / %R	EUCAST[a] %S / %R
Staphylococcus aureus (7,615)					
Ceftaroline[b]	0.5	1	≤0.008 – 2	97.9 / -	- / -
Oxacillin	>2	>2	≤0.25 – >2	47.2 / 52.8	47.2 / 52.8
Ceftriaxone[c]	>8	>8	≤0.25 – >8	45.6 / 52.8	47.2 / 52.8
Erythromycin	>2	>2	≤0.25 – >2	35.5 / 63.7	35.7 / 63.9
Clindamycin	≤0.25	>2	≤0.25 – >2	79.0 / 20.6	78.6 / 21.0
Daptomycin	0.25	0.5	≤0.06 – 4	99.9 / -	99.9 / 0.1
Levofloxacin	≤0.5	>4	≤0.5 – >4	57.3 / 41.8	57.3 / 41.8
Linezolid	1	2	≤0.12 – >8	99.9 / 0.1	99.9 / 0.1
Tigecycline[d]	0.12	0.25	≤0.03 – 1	>99.9 / -	>99.9 / <0.1
Trimethoprim/sulfamethoxazole	≤0.5	≤0.5	≤0.5 – >2	98.5 / 1.5	98.5 / 1.5
Vancomycin	1	1	≤0.12 – 2	100.0 / 0.0	100.0 / 0.0
MSSA (3,597)					
Ceftaroline[b]	0.25	0.25	≤0.008 – 1	100.0 / -	- / -
Ceftriaxone[c]	4	4	≤0.06 – >8	95.8 / 0.3	100.0 / 0.0
Erythromycin	≤0.25	>2	≤0.25 – >2	66.2 / 32.7	66.6 / 32.9
Clindamycin	≤0.25	≤0.25	≤0.25 – >2	93.7 / 6.0	93.3 / 6.3
Daptomycin	0.25	0.5	≤0.06 – 1	100.0 / -	100.0 / 0.0
Levofloxacin	≤0.5	4	≤0.5 – >4	88.5 / 10.8	88.5 / 10.8
Linezolid	1	2	≤0.12 – 2	100.0 / 0.0	100.0 / 0.0
Tigecycline[d]	0.12	0.25	≤0.03 – 0.5	100.0 / -	100.0 / 0.0
Trimethoprim/sulfamethoxazole	≤0.5	≤0.5	≤0.5 – >2	98.7 / 1.3	98.7 / 1.3
Vancomycin	1	1	≤0.12 – 2	100.0 / 0.0	100.0 / 0.0
MRSA (4,018)					
Ceftaroline[b]	1	1	0.12 – 2	96.0 / -	- / -
Ceftriaxone[c]	>8	>8	≤0.25 – >8	0.0 / 100.0	0.0 / 100.0
Erythromycin	>2	>2	≤0.25 – >2	8.0 / 91.5	8.1 / 91.5
Clindamycin	≤0.25	>2	≤0.25 – >2	65.9 / 33.7	65.4 / 34.1
Daptomycin	0.25	0.5	≤0.06 – 4	99.8 / -	99.8 / 0.2
Levofloxacin	4	>4	≤0.5 – >4	29.4 / 69.6	29.4 / 69.6
Linezolid	1	2	≤0.12 – >8	99.8 / 0.2	99.8 / 0.2
Tigecycline[d]	0.12	0.25	≤0.03 – 1	>99.9 / -	>99.9 / <0.1
Trimethoprim/sulfamethoxazole	≤0.5	≤0.5	≤0.5 – >2	98.3 / 1.7	98.3 / 1.6
Vancomycin	1	1	0.25 – 2	100.0 / 0.0	100.0 / 0.0
Streptococcus pneumoniae (2,618)					
Ceftaroline[b]	0.015	0.25	≤0.008 – 0.5	98.6 / -	- / -
Ceftriaxone	≤0.25	2	≤0.25 – 8	89.0 / 2.2	78.0 / 2.2
Penicillin[e]	≤0.03	4	≤0.03 – >4	85.0 / 1.8	- / -
Penicillin[f]	≤0.03	4	≤0.03 – >4	57.4 / 21.5	57.4 / 15.0
Amoxicillin/clavulanate	≤1	8	≤1 – >8	82.7 / 14.2	- / -
Cefuroxime	≤2	8	≤2 – >8	70.7 / 25.2	70.2 / 29.3
Clindamycin	≤0.25	>1	≤0.25 – >1	78.5 / 21.2	78.8 / 21.2
Erythromycin	≤0.25	>2	≤0.25 – >2	60.0 / 39.4	60.0 / 39.4
Levofloxacin	1	1	≤0.5 – >4	99.3 / 0.6	99.3 / 0.7
Linezolid	1	1	≤0.12 – 4	>99.9 / -	100.0 / 0.0
Tigecycline[d]	≤0.03	0.06	≤0.03 – 0.25	90.8 / -	- / -
Trimethoprim/sulfamethoxazole	≤0.5	>2	≤0.5 – >2	65.9 / 26.0	71.3 / 26.0
Vancomycin	1	1	≤1 – 1	100.0 / -	100.0 / 0.0
Haemophilus influenzae (1,066)					
Ceftaroline[b]	≤0.008	0.02	≤0.008 – 0.12	100.0 / -	- / -
Ceftriaxone	≤0.25	≤0.25	≤0.25 – 0.5	100.0 / -	99.6 / 0.4
Cefuroxime	≤2	≤2	≤2 – >8	99.1 / 0.1	80.9 / 4.4
Ampicillin	≤1	>8	≤1 – >8	73.5 / 25.7	73.5 / 26.5
Amoxicillin/clavulanate	≤1	≤1	≤1 – 8	99.8 / 0.2	91.7 / 8.3
Azithromycin	1	2	≤0.5 – >4	98.6 / -	9.9 / 1.4
Clarithromycin	8	16	≤0.25 – >32	74.7 / 4.6	1.1 / 0.8
Levofloxacin	≤0.5	≤0.5	≤0.5	100.0 / -	100.0 / 0.0
Trimethoprim/sulfamethoxazole	≤0.5	>2	≤0.5 – >2	77.8 / 19.2	77.8 / 21.2
β-haemolytic streptococci (1,570)[g]					
Ceftaroline[b]	0.015	0.03	≤0.008 – 0.06	- / -	- / -
Ceftriaxone	≤0.25	≤0.25	≤0.25 – 0.5	100.0 / -	100.0 / 0.0
Penicillin	≤0.03	0.06	≤0.03 – 0.12	100.0 / -	100.0 / 0.0
Erythromycin	≤0.25	>2	≤0.25 – >2	67.6 / 31.1	67.6 / 31.1
Clindamycin	≤0.25	>2	≤0.25 – >2	84.0 / 15.4	84.6 / 15.4
Levofloxacin	≤0.5	1	≤0.5 – >4	98.5 / 1.3	94.6 / 1.5
Linezolid	1	1	≤0.12 – 2	100.0 / -	100.0 / 0.0
Daptomycin	0.12	0.25	≤0.06 – 0.5	100.0 / -	100.0 / 0.0
Vancomycin	0.5	0.5	≤0.12 – 1	100.0 / -	100.0 / 0.0
Coagulase-negative staphylococci (1,275)[h]					
Ceftaroline[b]	0.25	0.5	≤0.008 – 4	- / -	- / -
Ceftriaxone[c]	8	>8	≤0.25 – >8	27.5 / 72.5	27.5 / 72.5
Oxacillin	>2	>2	≤0.25 – >2	27.5 / 72.5	27.5 / 72.5
Erythromycin	>2	>2	≤0.25 – >2	32.1 / 66.8	32.5 / 66.9
Clindamycin	≤0.25	>2	≤0.25 – >2	66.7 / 31.0	64.6 / 33.3
Daptomycin	0.25	0.5	≤0.06 – 4	99.8 / -	99.8 / 0.2
Levofloxacin	4	>4	≤0.5 – >4	45.6 / 52.6	45.6 / 52.6
Linezolid	1	1	0.12 – >8	98.3 / 1.7	98.3 / 1.7
Tigecycline[d]	0.12	0.25	≤0.03 – 0.5	- / -	100.0 / 0.0
Trimethoprim/sulfamethoxazole	≤0.5	>2	≤0.5 – >2	59.4 / 40.6	59.4 / 39.8
Vancomycin	1	2	≤0.12 – 4	100.0 / 0.0	99.4 / 0.6
Enterococcus faecalis (1,102)					
Ceftaroline[b]	2	8	0.12 – >16	- / -	- / -
Ceftriaxone	>8	>8	2 – >8	- / -	- / -
Ampicillin	≤1	2	≤1 – 8	100.0 / 0.0	99.8 / 0.0
Daptomycin	1	2	≤0.06 – 8	99.9 / -	- / -
Levofloxacin	1	>4	≤0.5 – >4	65.2 / 34.5	- / -
Linezolid	1	2	0.25 – >8	99.9 / 0.1	99.9 / 0.1
Vancomycin	1	2	0.25 – >16	94.7 / 5.1	94.7 / 5.3
Escherichia coli (2,591)					
Ceftaroline[b]	0.12	1	≤0.008 – >16	87.4 / 9.8	- / -
Ceftriaxone	≤0.25	≤0.25	≤0.25 – >8	92.7 / 7.0	92.7 / 7.0
Ceftazidime	≤1	≤1	≤1 – >16	94.7 / 4.4	92.2 / 5.3
Ampicillin/sulbactam	8	>16	≤2 – >16	51.0 / 26.2	- / 49.0
Piperacillin/tazobactam	2	8	≤0.5 – >64	94.7 / 2.6	92.6 / 5.3
Meropenem	≤0.12	≤0.12	≤0.12 – 4	>99.9 / <0.1	>99.9 / 0.0
Gentamicin	≤2	>8	≤2 – >8	88.7 / 10.8	87.5 / 11.3
Levofloxacin	≤0.5	>4	≤0.5 – >4	71.8 / 27.4	71.7 / 28.2
Tigecycline[c]	0.12	0.25	≤0.03 – 2	100.0 / 0.0	99.8 / 0.0
Klebsiella spp. (2,175)[i]					
Ceftaroline[b]	0.12	>16	≤0.008 – >16	83.0 / 13.8	- / -
Ceftriaxone	≤0.25	8	≤0.25 – >8	88.0 / 11.6	88.0 / 11.6
Ceftazidime	≤1	8	≤1 – >16	89.7 / 9.5	87.7 / 10.3
Ampicillin/sulbactam	8	>16	≤2 – >16	74.7 / 15.0	- / 25.3
Piperacillin/tazobactam	2	32	≤0.5 – >64	89.7 / 8.3	84.4 / 10.3
Meropenem	≤0.12	≤0.12	≤0.12 – >8	95.7 / 4.0	96.0 / 2.8
Gentamicin	≤2	≤2	≤2 – >8	93.3 / 5.5	92.9 / 6.7
Levofloxacin	≤0.5	4	≤0.5 – >4	89.4 / 9.7	87.7 / 10.6
Tigecycline[d]	0.25	1	0.06 – >4	98.6 / 0.1	94.8 / 1.4
Enterobacter spp. (675)[j]					
Ceftaroline[b]	0.25	>16	≤0.008 – >16	71.7 / 23.7	- / -
Ceftriaxone	≤0.25	>32	≤0.25 – >32	75.7 / 22.8	75.7 / 22.8
Ceftazidime	≤1	>16	≤1 – >16	78.4 / 20.1	75.1 / 21.6
Ampicillin/sulbactam	16	>16	≤2 – >16	33.0 / 42.2	- / 67.0
Piperacillin/tazobactam	2	64	≤0.5 – >64	83.3 / 8.6	79.3 / 16.7
Meropenem	≤0.12	≤0.12	≤0.12 – >8	98.1 / 1.6	98.4 / 0.3
Gentamicin	≤2	≤2	≤2 – >8	93.5 / 5.8	92.7 / 6.5
Levofloxacin	≤0.5	1	≤0.5 – >4	93.8 / 4.7	91.7 / 6.2
Tigecycline[d]	0.25	1	0.06 – >4	98.8 / 0.1	92.1 / 1.2

a. Criteria as published by the CLSI [2011] and EUCAST [2011]. β-lactam susceptibility should be directed by the oxacillin test results.
b. US-FDA breakpoints were applied when available [Teflaro® Product Insert, 2010].
c. US-FDA breakpoints were applied when available [Rocephin® Product Insert, 2010].
d. US-FDA breakpoints were applied when available [Tygacil® Product Insert, 2010].
e. Criteria as published by the CLSI [2011] for "Penicillin parenteral (non-meningitis)".
f. Criteria as published by the CLSI [2011] for "Penicillin (oral penicillin V)".
g. Includes: *Streptococcus dysgalactiae* (21 strains), *S. equi* (1 strain), *S. equisimilis* (1 strain), Group A *Streptococcus* (597 strains), Group B *Streptococcus* (754 strains), Group C *Streptococcus* (79 strains), Group F *Streptococcus* (18 strains), Group G *Streptococcus* (97 strains), and unspecified β-haemolytic streptococci (2 strains).
h. Includes: *Staphylococcus auricularis* (11 strains), *S. capitis* (33 strains), *S. cohnii* (1 strain), *S. epidermidis* (489 strains), *S. haemolyticus* (45 strains), *S. hominis* (78 strains), *S. intermedius* (2 strains), *S. lugdunensis* (48 strains), *S. saccharolyticus* (2 strains), *S. saprophyticus* (16 strains), *S. sciuri* (3 strains), *S. simulans* (5 strains), *S. succinus* (1 strain), *S. warneri* (1 strain), *S. warneri* (21 strains), *S. xylosus* (2 strains), and unspecified coagulase-negative staphylococci (517 strains).
i. Includes: *Klebsiella oxytoca* (379 strains), *K. ozaenae* (4 strains), *K. pneumoniae* (1729 strains), and unspecified *Klebsiella* (63 strains).
j. Includes: *Enterobacter aerogenes* (130 strains), *E. amnigenus* (2 strains), *E. asburiae* (14 strains), *E. cancerogenus* (2 strains), *E. cloacae* (502 strains), *E. gergoviae* (5 strains), *E. hormaechei* (1 strain), *E. intermedius* (1 strain), *E. sakazakii* (2 strains), and unspecified *Enterobacter* (16 strains).

Conclusions

- Ceftaroline demonstrated enhanced in vitro activity against staphylococci (including MRSA), all tested streptococcal groups, and *H. influenzae* isolated in the AWARE Surveillance Program from USA hospitals
- Ceftaroline also demonstrated activity against Enterobacteriaceae similar to that of currently available broad-spectrum cephalosporins.

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