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Update of contemporary antimicrobial resistance rates across China: reference testing results for 12 medical centers (2011)

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ABSTRACT

Antimicrobial resistance (R) surveillance across Asia and especially in China has documented unique patterns and mechanisms. This 2011 study reports results for 2278 isolates from 12 hospitals in China (94–216 strains/site); most from bacteremia (20.4%), pneumonias (29.1%), or skin and skin structure infections (20.9%). Samples were tested by reference broth microdilution methods, interpreted by published susceptibility (S) breakpoints. The most common species were *Staphylococcus aureus* (343, 45.8% MRSA), *Escherichia coli* (EC; 288), *Pseudomonas aeruginosa* (PSA; 221), *Klebsiella* spp. (KSP; 208), acinetobacters (ACB; 178), enterobacters (155), *Streptococcus pneumoniae* (SPN; 154, 46.8% penicillin-S), and enterococci (ENT; 137). Among 849 Gram-positive (GP) cocci, linezolid, tigecycline (TIG), daptomycin, and vancomycin provided best antimicrobial coverage (≥99.7% S). Resistance patterns of concern were 0.3% VISA, 15.4% teicoplanin non-S coagulase-negative staphylococci, 1.5% vancomycin-R ENT (all *Enterococcus faecium*), 1.9% levofloxacin-R β-haemolytic streptococci, and 35.1 and 12.7% ceftriaxone-non-S rates for SPN and viridans group streptococci, respectively. For Gram-negative bacilli, R among Enterobacteriaceae was highest against β-lactams (extended spectrum β-lactamase-phenotype strains at 73.6 and 42.8% in EC and KSP, respectively; carbapenem-R was only 2.1–4.3% with KPC and IMP type enzymes detected in KSP). The widest spectrum agents were cefoperazone/sulbactam (79.5–86.1%), piperacillin/tazobactam (88.9–92.0%), TIG (98.6–100%), amikacin (AMK; 91.8–93.7%), and meropenem (95.7–97.1% S). PSA was most inhibited by AMK (90.5% S) and colistin (COL; 99.5%), with cefepime (67.9%) best among the tested β-lactams. Only COL (100% S) and TIG (MIC_{90}, 2 μg/mL) showed significant potencies against ACB. In conclusion, R among pathogens from 12 Chinese hospitals illustrates several agents active against GP pathogens, but more serious R problems were noted among Enterobacteriaceae, PSA, and ACB. Combination treatment for the latter multidrug-R strains appears necessary, guided by local antibiograms and national surveillance results applying reference methods.

1. Introduction

As stated in excellent, comprehensive reviews of Chinese antimicrobial resistance surveillance (Xiao et al., 2012; Yezli and Li, 2012), emerging resistance mechanisms continue to impact this nation having 20% of the world's population. The living conditions of the Chinese people (population density, association with livestock) and their proximity to resistance problems in nearby heavily populated countries (India, Indonesia, etc) also with great resistance burdens emphasize the importance of monitoring antimicrobial profiles (Bonnet, 2004; Farrell et al., 2010; Flamm et al., 2013; Hawser et al., 2012; Kumarasamy et al., 2010; Rolain et al., 2010; Woodford and Livermore, 2009). Yezli and Li (2012) noted that the healthcare system in China has limited application of antimicrobial stewardship and, in fact, encourages overprescribing and self-medication, thus leading to high rates of resistance among bacteria, tubercule bacillus, and fungi. Data clearly illustrate that extended-spectrum β-lactamases (ESBLs) and carbapenem resistances (CRs) are escalating among *Escherichia coli*, *Klebsiella* spp., and *Pseudomonas aeruginosa* through 2009 (Wang et al., 2008; Wang et al., 2009; Wang et al., 2010a, 2010b; Xiao et al., 2012; Zhang et al., 2010b). Also extremely resistant clones of *Acinetobacter baumannii* have been recently documented (Chen et al., 2011b, 2011c; Zhang et al., 2010a).

The mechanisms of some highly resistant Gram-negative (GNB) bacilli have been detected, including the serine-carbapenamases (KPC types) in *Klebsiella pneumoniae* and *P. aeruginosa* (Chen et al., 2011a; Ge et al., 2011; Qi et al., 2011; Wei et al., 2007), and metallo-β-

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Table 1
Activity of antimicrobial agents when tested against GP isolates in China.

Organism (no. tested)/antimicrobial agent	MIC (μg/mL)			CLSI[a] %S/%R	EUCAST[a] %S/%R
	50%	90%	Range		
S. aureus					
MSSA (186)					
Ceftriaxone	4	4	1 to >8	99.5/0.0	100.0/0.0
Clindamycin	≤0.25	>2	≤0.25 to >2	67.7/32.3	67.7/32.3
Daptomycin	0.25	0.5	0.12 to 0.5	100.0/–	100.0/0.0
Doxycycline	0.12	1	≤0.06 to >8	97.3/0.5	90.9/3.8
Erythromycin	>16	>16	≤0.12 to >16	40.9/57.5	41.4/58.6
Gentamicin	≤1	>8	≤1 to >8	80.6/18.3	79.6/20.4
Levofloxacin	0.25	0.5	≤0.12 to >4	91.4/8.1	91.4/8.1
Linezolid	1	1	0.5 to 2	100.0/0.0	100.0/0.0
Meropenem	0.12	0.12	≤0.06 to 0.25	100.0/0.0	100.0/0.0
Penicillin	8	>8	≤0.06 to >8	8.6/91.4	8.6/91.4
Piperacillin/tazobactam	2	2	≤0.5 to 4	100.0/0.0	100.0/0.0
Teicoplanin	≤2	≤2	≤2	100.0/0.0	100.0/0.0
Tigecycline[b]	0.06	0.12	≤0.03 to 0.25	100.0/–	100.0/0.0
Trimethoprim/sulfamethoxazole	≤0.5	1	≤0.5 to >4	94.6/5.4	94.6/5.4
Vancomycin	1	1	0.5 to 2	100.0/0.0	100.0/0.0
MRSA (157)					
Clindamycin	>2	>2	≤0.25 to >2	18.5/81.5	18.5/81.5
Daptomycin	0.5	0.5	0.25 to 1	100.0/–	100.0/0.0
Doxycycline	8	8	≤0.06 to >8	28.0/6.4	17.8/82.2
Erythromycin	>16	>16	0.25 to >16	7.6/89.2	8.3/91.1
Gentamicin	>8	>8	≤1 to >8	19.1/80.3	18.5/81.5
Levofloxacin	>4	>4	≤0.12 to >4	8.3/91.1	8.3/91.1
Linezolid	1	1	0.5 to 2	100.0/0.0	100.0/0.0
Teicoplanin	≤2	≤2	≤2 to 8	100.0/0.0	92.4/7.6
Tigecycline[b]	0.12	0.25	≤0.03 to 0.5	100.0/–	100.0/0.0
Trimethoprim/sulfamethoxazole	≤0.5	2	≤0.5 to >4	90.4/9.6	90.4/8.9
Vancomycin	1	2	0.5 to 4	99.4/0.0	99.4/0.6
Coagulase-negative staphylococci (65)[c]					
Clindamycin	≤0.25	>2	≤0.25 to >2	56.9/40.0	56.9/43.1
Daptomycin	0.5	0.5	≤0.06 to 1	100.0/–	100.0/0.0
Doxycycline	0.5	4	≤0.06 to >8	93.8/4.6	80.0/12.3
Erythromycin	>16	>16	≤0.12 to >16	23.1/76.9	23.1/76.9
Gentamicin	8	>8	≤1 to >8	44.6/41.5	36.9/63.1
Levofloxacin	4	>4	≤0.12 to >4	24.6/67.7	24.6/67.7
Linezolid	0.5	1	0.25 to 1	100.0/0.0	100.0/0.0
Meropenem	2	>8	≤0.06 to >8	4.6/95.4	4.6/95.4
Oxacillin	>2	>2	≤0.25 to >2	4.6/95.4	4.6/95.4
Penicillin	8	>8	≤0.06 to >8	3.1/96.9	3.1/96.9
Teicoplanin	≤2	8	≤2 to 16	96.9/0.0	84.6/15.4
Tigecycline[b]	0.12	0.12	≤0.03 to 0.25	–/–	100.0/0.0
Trimethoprim/sulfamethoxazole	1	>4	≤0.5 to >4	61.5/38.5	61.5/30.8
Vancomycin	1	2	0.25 to 2	100.0/0.0	100.0/0.0
E. faecalis (60)					
Ampicillin	1	4	0.5 to 8	100.0/0.0	90.0/0.0
Daptomycin	1	1	0.5 to 4	100.0/–	–/–
Doxycycline	8	>8	≤0.06 to >8	20.0/23.3	–/–
Erythromycin	>16	>16	≤0.12 to >16	6.7/75.0	–/–
Imipenem	1	4	≤0.12 to 8	90.0/–	90.0/0.0
Levofloxacin	1	>4	≤0.12 to >4	65.0/30.0	–/–
Linezolid	1	1	0.5 to 2	100.0/0.0	100.0/0.0
Teicoplanin	≤2	≤2	≤2	100.0/0.0	100.0/0.0
Tigecycline[b]	0.06	0.06	≤0.03 to 0.25	100.0/–	100.0/0.0
Vancomycin	1	2	0.5 to 4	100.0/0.0	100.0/0.0
E. faecium (67)					
Ampicillin	>8	>8	1 to >8	13.4/86.6	13.4/86.6
Daptomycin	2	2	0.5 to 4	100.0/–	–/–
Doxycycline	1	>8	≤0.06 to >8	56.7/32.8	–/–
Erythromycin	>16	>16	1 to >16	0.0/86.6	–/–
Imipenem	>8	>8	1 to >8	–/–	9.0/86.6
Levofloxacin	>4	>4	1 to >4	6.0/88.1	–/–
Linezolid	1	2	0.5 to 2	100.0/0.0	100.0/0.0
Teicoplanin	≤2	≤2	≤2 to >16	98.5/1.5	98.5/1.5
Tigecycline[b]	≤0.03	0.06	≤0.03 to 0.12	100.0/–	100.0/0.0
Vancomycin	1	1	0.5 to >16	98.5/1.5	98.5/1.5
S. pneumoniae					
Penicillin-susceptible (72)					
Amoxicillin/clavulanate	≤1	≤1	≤1 to >8	97.2/1.4	–/–

(*continued on next page*)