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Comparison of the SUPERCARBA, CHROMagar KPC, and Brilliance CRE screening media for detection of Enterobacteriaceae with reduced susceptibility to carbapenems☆,☆☆

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ABSTRACT

The recently developed SUPERCARBA medium was evaluated together with 2 commercially available selective culture media containing carbapenems: CHROMagar KPC (CHROMagar) and Brilliance CRE (Oxoid, Thermofisher Scientific). A total of 142 enterobacterial isolates were tested, including 131 isolates with reduced susceptibility to carbapenems. The SUPERCARBA medium has the highest sensitivity (96.5%) (detecting virtually all carbapenemase producers including OXA-48–like producers) as compared to Brilliance CRE (76.3%) and CHROMagar KPC (43%). The specificity of the screening media was similar, ranging from 57% to 68%.

The spread of carbapenemase-producing Enterobacteriaceae is increasingly reported worldwide (Castanheira et al., 2011; Nordmann et al., 2011, 2012a; Poirel et al., 2012). Targeted surveillance of high-risk patients and screening are essential to prevent outbreaks of nosocomial infections by these organisms. The clinically significant carbapenemases in Enterobacteriaceae belong either to Ambler class A (KPC-type) hydrolysing all β-lactams except cephamycins; Ambler class B (NDM, VIM, and IMP), which are zinc-dependent metallo-β-lactamases (MBL) hydrolysing all β-lactams except aztreonam; and Ambler class D enzymes (OXA-48–like) hydrolysing carbapenems but weakly (or not) broad-spectrum cephalosporins (Nordmann et al., 2011, 2012a). The level of resistance to carbapenems conferred by those carbapenemase producers may vary significantly, making their detection difficult when just based on their in vitro susceptibility profile (Landman et al., 2010). The SUPERCARBA medium has been specifically developed for the detection of carbapenemase producers and, in particular, of OXA-48 carbapenemase-producing organisms (Nordmann et al., 2012b). OXA-48 producers currently represent a worrisome threat in North African countries, the Middle East, Turkey, and the Indian subcontinent and Europe (Poirel et al., 2012). Moreover, the spread of MBL and KPC producers has created a real need for a reliable medium that is efficient for the detection of all types of carbapenemase-producing isolates (Adler et al., 2011; Vatopoulos, 2008). The present study was aimed to compare the performance of the recently developed SUPERCARBA medium (Nordmann et al., 2012b), which is supplemented with ertapenem, cloxacillin, and zinc sulfate, with commercially available selective media for the screening of carbapenemase producers.

One hundred and forty-two enterobacterial isolates were tested, including 131 isolates exhibiting reduced susceptibility or resistance to carbapenems. The β-lactamase content of all these isolates has been characterized at the molecular level (Table 1). The tested isolates were as follows: OXA-48–like producers ($n = 43$), KPC producers ($n = 20$), VIM producers ($n = 18$), IMP producers ($n = 17$), and NDM producers ($n = 16$), and noncarbapenemase producers with reduced susceptibility or resistance to carbapenems (AmpC overproducers, extended-spectrum β-lactamase [ESBL] producers combining porin deficiency) ($n = 17$), and carbapenem-susceptible isolates ($n = 11$). Strains with reduced susceptibility to ertapenem due to an overexpressed AmpC or to an ESBL, and/or porin deficiency had been previously characterized (inhibition of AmpC activity by using cloxacillin containing plates, polymerase chain reaction and sequencing of AmpC genes, measurement of carbapenem hydrolysis by UV spectrophotometry) (Nordmann et al., 2012b; Caroff et al., 2000).

MIC values of imipenem, ertapenem, and meropenem were determined by Etest and interpreted according to the updated 2012 Clinical and Laboratory Standards Institute (CLSI) guidelines (CLSI, 2012) (Table 1). The lowest detection limit of the carbapenemase

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Table 1
Sensitivity of detection of SUPERCARBA, Brilliance CRE, and CHROMagar KPC media for 142 carbapenemase- and/or ESBL/AmpC-producing enterobacterial isolates.

Strains	β-Lactamase content	MIC (mg/L)			Lowest detection limit (CFU/mL)[b]		
		IPM[a]	ETP	MEM	SUPER CARBA	Brilliance CRE	CHROMagar KPC
Carbapenemase OXA-48-type ($n = 43$)							
K. pneumoniae BIC	**OXA-48**[c]	0.5	2	0.5	1×10^1	1×10^1	5×10^6
K. pneumoniae BEL	**OXA-48**	1	4	1	1×10^1	1×10^1	1×10^6
K. pneumoniae RAM	**OXA-48**	1	4	1	1×10^1	1×10^1	1×10^5
K. pneumoniae LIB	**OXA-48**	16	16	16	1×10^1	$>2 \times 10^7$	5×10^4
K. pneumoniae SCO	**OXA-48**	0.5	0.75	0.25	1×10^1	$>2 \times 10^7$	$>2 \times 10^7$
K. pneumoniae LOU	**OXA-48**	4	16	0.5	1×10^1	$>6 \times 10^7$	$>6 \times 10^7$
K. pneumoniae TIK	**OXA-48**	0.75	2	0.38	1×10^1	1×10^1	$>1 \times 10^8$
K. pneumoniae OM14	**OXA-48** + TEM-1	0.5	1	0.38	1×10^1	$>5 \times 10^7$	5×10^7
K. pneumoniae CHA	**OXA-48** + TEM-1	0.38	1	0.5	1×10^1	$>3 \times 10^7$	$>3 \times 10^7$
K. pneumoniae BOU	**OXA-48** + CTX-M-15	0.38	0.5	0.25	1×10^1	$>1 \times 10^7$	1×10^8
K. pneumoniae EGY	**OXA-48** + CTX-M-15	2	3	2	1×10^1	1×10^1	1×10^5
K. pneumoniae ROU	**OXA-48** + CTX-M-15	0.5	1.5	0.25	1×10^1	1×10^1	$>1 \times 10^8$
K. pneumoniae BEY	**OXA-48** + CTX-M-15 + TEM-1	0.38	0.38	0.38	5×10^2	1×10^1	1×10^8
K. pneumoniae DAL	**OXA-48** + CTX-M-15 + TEM-1	0.38	2	0.38	1×10^1	1×10^1	4×10^5
K. pneumoniae BAJ	**OXA-48** + CTX-M-15 + SHV-28 + TEM-1	0.5	1.5	0.38	1×10^1	1×10^1	$>1 \times 10^8$
K. pneumoniae BEN	**OXA-48** + CTX-M-15 + SHV-28 + TEM-1	0.38	1	0.25	1×10^1	1×10^1	$>1 \times 10^8$
K. pneumoniae DUW	**OXA-48** + CTX-M-15 + TEM-1 + SHV-28	32	32	32	1×10^1	1×10^1	1×10^1
K. pneumoniae SIC	**OXA-48** + CTX-M-15 + SHV-28	0.25	1	0.25	1×10^1	1×10^1	$>1 \times 10^8$
K. pneumoniae AEL	**OXA-48** + CTX-M-15 + SHV-28+ OXA-1	0.5	6	0.38	1×10^1	1×10^1	5×10^2
K. pneumoniae AMS	**OXA-48** + CTX-M-15 + TEM-1 + OXA-1	0.5	2	0.38	1×10^1	1×10^1	$>1 \times 10^8$
K. pneumoniae ELK	**OXA-48** + CTX-M-15 + TEM-1 + SHV-11	0.5	3	0.38	1×10^1	1×10^1	$>1 \times 10^8$
K. pneumoniae VER	**OXA-48** + CTX-M-15 + TEM-1 + SHV-11	0.38	2	0.38	1×10^1	1×10^1	$>1 \times 10^8$
K. pneumoniae VSG	**OXA-48** + CTX-M-15 + OXA-1 + TEM-1	0.75	3	0.75	1×10^1	1×10^1	$>1 \times 10^8$
K. pneumoniae HPA	**OXA-48** + CTX-M-15 + OXA-1 + TEM-1	1.5	>32	12	1×10^1	1×10^1	$>1 \times 10^8$
K. pneumoniae OM11	**OXA-48** + CTX-M-14 + TEM-1	0.5	0.75	0.25	1×10^1	1×10^1	5×10^7
E. coli ROV	**OXA-48**	0.5	0.75	0.25	2×10^1	$>6 \times 10^7$	$>6 \times 10^7$
E. coli HAN	**OXA-48** + CTX-M-15	3	16	1	5×10^1	$>6 \times 10^7$	3×10^4
E. coli BOU	**OXA-48** + CTX-M-15	0.5	0.75	0.12	2×10^1	$>4 \times 10^7$	$>4 \times 10^7$
E. coli OM3	**OXA-48** + CTX-M-15 + TEM-1	0.5	1	0.38	1×10^1	1×10^1	$>1 \times 10^8$
E. coli OM22	**OXA-48** + CTX-M-15 + TEM-1	0.5	1	0.25	1×10^1	1×10^1	$>1 \times 10^8$
E. coli BER	**OXA-48** + CTX-M-15 + TEM-1	0.38	1.5	0.19	5×10^1	$>1 \times 10^7$	$>1 \times 10^7$
E. coli AME	**OXA-48** + CTX-M-24	0.25	0.5	0.19	2×10^1	$>1 \times 10^8$	$>1 \times 10^8$
E. coli ZAN	**OXA-48** + TEM-1 + CTX-M-14	0.38	8	0.75	1×10^1	1×10^1	$>1 \times 10^8$
E. coli BON	**OXA-48** + CTX-M-24 + TEM-1	0.38	0.5	0.19	1×10^2	1×10^2	$>1 \times 10^8$
E. coli BOK	**OXA-48** + CTX-M-15	0.25	0.38	0.19	1×10^2	1×10^1	$>1 \times 10^8$
E. cloacae TUR	**OXA-48** + SHV-5	0.5	0.5	0.5	1×10^1	1×10^1	1×10^7
E. cloacae 501	**OXA-48** + CTX-M-15 + TEM-1	1	16	1.5	1×10^1	1×10^1	1×10^1
E. cloacae BEU	**OXA-48** + CTX-M-15 + TEM-1 + SHV-12	0.5	8	0.5	1×10^2	1×10^2	1×10^4
C. koseri ROU	**OXA-48**	0.38	2	0.38	1×10^1	$>1 \times 10^8$	$>1 \times 10^8$
C. koseri VER	**OXA-48**	0.75	2	0.38	1×10^1	$>1 \times 10^8$	$>1 \times 10^8$
K. pneumoniae HOL	**OXA-181** + CTX-M-15	1	4	1	1×10^1	1×10^1	1×10^1
K. pneumoniae KP3	**OXA-181** + CTXM-15 + OXA-1	0.5	2	0.5	1×10^1	1×10^1	$>1 \times 10^8$
P. rettgeri RAP	**OXA-181** + OXA-1	8	1	2	5×10^2	1×10^1	1×10^1
KPC ($n = 20$)							
K. pneumoniae 2303	**KPC-2** + SHV-11	>32	>32	>32	1×10^1	$>6 \times 10^7$	1×10^1
K. pneumoniae SAG	**KPC-2** + OXA-9 + TEM-1	>32	>32	>32	1×10^1	1×10^1	1×10^1
K. pneumoniae TOR	**KPC-2** + OXA-9 + TEM-1	4	12	4	1×10^1	1×10^1	1×10^1
K. pneumoniae THO	**KPC-2** + OXA-9 + TEM-1	>32	>32	>32	1×10^1	1×10^1	1×10^1
K. pneumoniae 20111	**KPC-2** + OXA-9 + TEM-1	6	8	2	1×10^1	1×10^1	1×10^1
K. pneumoniae TIF	**KPC-2** + OXA-9 + TEM-1	>32	>32	>32	1×10^1	1×10^1	1×10^1
K. pneumoniae LIE	**KPC-2** + OXA-9 + TEM-1	>32	>32	>32	5×10^1	1×10^1	1×10^1
K. pneumoniae 588	**KPC-2** + OXA-9 + SHV-11 + TEM-1	24	32	16	1×10^1	1×10^1	1×10^1
K. pneumoniae YC	**KPC-2** + OXA-9 + SHV-11 + SHV-12 + TEM-1	4	24	2	1×10^1	1×10^1	1×10^1
K. pneumoniae A28006	**KPC-2** + CTX-M-2 + SHV-11 + TEM-1	16	24	32	2×10^1	1×10^1	1×10^1
K. pneumoniae A33504	**KPC-2** + CTX-M-2 + SHV-11 + OXA-9 + TEM-1	>32	>32	>32	1×10^1	1×10^1	1×10^1
K. pneumoniae COL	**KPC-2** + TEM-1 + SHV-1 + CTXM-15	4	4	32	1×10^1	1×10^1	1×10^1
K. pneumoniae 475	**KPC-2** + CTX-M-15 + SHV-11	16	>32	>32	1×10^1	1×10^1	1×10^1
K. pneumoniae KAM	**KPC-3** + TEM-1	8	12	2	1×10^1	1×10^1	5×10^3
E. coli PSP	**KPC-2** + TEM-1 + OXA-1	0.5	0.5	0.5	1×10^2	1×10^1	1×10^4
E. coli COL	**KPC-2** + CTX-M-9 + TEM-1	4	4	2	1×10^1	1×10^1	1×10^3
E. cloacae HPT2	**KPC-2**	1	1.5	0.75	1×10^1	$>8 \times 10^7$	1×10^4
E. cloacae CFVL	**KPC-2** + TEM-3	4	2	1	1×10^1	$>6 \times 10^7$	5×10^3
E. cloacae HMG	**KPC-2** + TEM-1	24	>32	16	1×10^2	1×10^1	1×10^1
E. cloacae HPTU	**KPC-2** + SHV-11 + TEM-1	2	4	1.5	1×10^1	1×10^1	1×10^3
MBL ($n = 51$)							
K. pneumoniae UK	**NDM-1** + CTX-M-15 + CMY-4 + OXA-1	>32	>32	>32	1×10^1	1×10^1	1×10^1
K. pneumoniae 6642	**NDM-1** + CTX-M-15 + OXA-1 + OXA-10	1	16	3	1×10^1	1×10^1	1×10^1
K. pneumoniae 6759	**NDM-1** + CTX-M-15 + TEM-1 + OXA-1 + OXA-9 + OXA-10 + CMY16	12	>32	>32	1×10^1	1×10^1	1×10^1
K. pneumoniae 1OMA	**NDM-1** + CTX-M-15 + TEM-1 + SHV-11 + SHV-28 + OXA-1 + OXA-9	>32	>32	>32	1×10^1	1×10^1	1×10^1
K. pneumoniae 2OMA	**NDM-1** + SHV-11 + OXA-1	1.5	6	2	1×10^1	1×10^1	1×10^2
K. pneumoniae AFR7	**NDM-1** + CTX-M-15 + TEM-1 + CMY-6 + OXA-1 + OXA-9	>32	>32	>32	1×10^1	1×10^1	1×10^1
K. pneumoniae IND	**NDM-1** + CTX-M-15 + TEM-1 + SHV-28 + CMY-6 + OXA-1 + OXA-9	1	8	4	1×10^1	1×10^1	1×10^1

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