

ORIGINAL ARTICLE

Clinical Treatment Options for Carbapenem-Resistant Gram-Negative Infections in China: a Single Center Real-World Experience

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SUMMARY

Background: Carbapenem-resistant gram-negative bacteria pose a serious threat worldwide, and some patients even have rapidly aggravated life-threatening infection. However, as a result of the complexities of clinical therapy, antibiotic options against carbapenem-resistant pathogens have not yet been fully standardized. It should be individualized to control carbapenem-resistant pathogens in accordance with the different region.

Methods: In this study, we conducted a retrospective study in 65,000 inpatients over a 2-year period that involved a total of 86 patients from whom carbapenem-resistant gram-negative bacteria were isolated.

Results: Monotherapy using trimethoprim/ sulfamethoxazole, amikacin, meropenem, and/or doxycycline in our hospital exhibited a clinical success rate of 83.3% for carbapenem-resistant *Klebsiella pneumoniae*, monotherapy using moxifloxacin, piperacillin/tazobactam, cefepime, and/or ceftazidime for carbapenem-resistant *Pseudomonas aeruginosa* exhibited a clinical success rate of 77.7%, and monotherapy using cefoperazone/sulbactam or combination therapy with tigecycline and cefoperazone/sulbactam for carbapenem-resistant *Acinetobacter baumannii* exhibited a clinical success rate of 62.1%.

Conclusions: Taken together, our findings highlight the clinical strategies used in our hospital to successfully treat carbapenem-resistant gram-negative bacterial infections.

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Supplementary Data

Table S1. Laboratory tests of patients diagnosed with *CRKP* infection.

Patient	Temperature	WBC ($\times 10^9/L$)	PMN (%)	CRP (mg/L)	PCT (ng/mL)	IL-6 (pg/mL)
1	> 38°C	10.98	83.7	8.32	0.04	1.70
2	> 38°C	15.56	89.7	1.42	0.15	76.41
3	> 38°C	11.04	81.4	23.15	0.26	5.11
4	< 38°C	13.20	87.0	12.35	0.04	13.90
5	< 38°C	11.67	77.1	NA	NA	NA
6	38°C	12.65	79.5	232.47	0.05	18.49
Average		12.51 \pm 1.73	83.06 \pm 4.71	55.54 \pm 99.21	0.18 \pm 0.10	23.12 \pm 30.53

Table S2. *In vitro* susceptibility test of the 15 key antibiotics against *CRKP*.

Strain	MIC values (mg/L)									KB (mm)					
	CIP	LVX	GEN	NIT	SAM	TZP	CZO	CAZ	FEP	CSL	CXM	FOX	FOS	IPM	TGC
1	> 4	> 8	> 16	128	> 32	> 128	> 64	> 64	> 64	14	6	6	6	6	20
2	> 4	> 8	> 16	64	> 32	> 128	> 64	> 64	> 64	8	6	6	6	8	19
3	> 4	> 8	< 1	> 512	> 32	> 128	> 64	> 64	> 64	6	6	6	6	8	19
4	< 0.25	0.5	< 1	128	> 32	> 128	> 64	> 64	32	8	6	6	18	16	19
5	> 4	> 8	> 16	> 512	> 32	> 128	> 64	> 64	> 64	6	6	6	16	6	19
6	> 4	> 8	> 16	64	> 32	> 128	> 64	> 64	> 64	6	6	6	6	6	20

CIP - Ciprofloxacin, LVX - Levofloxacin, GEN - Gentamicin, NIT - Nitrofurantoin, SAM - Ampicillin Sulbactam, TZP - Piperacillin Tazobactam, CZO - Cefazolin, CAZ - Ceftazidime, FEP - Cefepime, CSL - Cefoperazone sulbactam, CXM - Cefuroxime, FOX - Cefoxitin, FOS - Fosfomycin, IPM - Imipenem, TGC - Tigecycline.

Table S3. Laboratory test of patients diagnosed with *CRPA* infection.

Patient	Temperature	WBC ($\times 10^9/L$)	PMN (%)	CRP (mg/L)	PCT (ng/mL)	IL-6 (pg/mL)
1	> 38°C	14.48	76.3	5.76	0.16	NA
2	38°C	12.15	78.0	127.36	0.13	NA
3	> 38°C	10.35	84.8	63.46	0.23	50.49
4	< 38°C	14.30	84.8	86.78	NA	NA
5	< 38°C	9.30	70.1	12.78	0.11	NA
6	> 38°C	14.71	88.4	61.75	2.69	NA
7	> 38°C	9.53	69.2	86.43	0.10	14.87
8	> 38°C	9.93	72.8	186.58	0.29	92.46
9	38°C	5.31	70.1	22.47	0.10	25.61
Average		11.11 \pm 3.10	77.16 \pm 7.32	72.59 \pm 58.24	0.47 \pm 0.89	45.87 \pm 34.46

Table S4. *In vitro* susceptibility test of the 10 key antibiotics against CRPA.

Strain	MIC values (mg/L)						KB (mm)				
	CIP	LVX	GEN	NIT	IPM	AMK	CSL	IPM	PIP	ATM	CFP
1	0.5	1	< 1	> 512	8	< 2	15	NA	15	10	14
2	> 4	> 8	4	> 512	> 16	4	12	NA	7	14	7
3	0.5	0.5	4	> 512	NA	4	23	NA	27	25	12
4	> 4	> 8	8	> 512	NA	16	21	NA	19	16	12
5	> 4	> 8	4	NA	NA	4	13	10	18	19	NA
6	2	1	< 1	NA	NA	< 2	21	10	23	23	NA
7	> 4	4	4	NA	NA	4	13	8	14	20	NA
8	> 4	4	4	NA	NA	4	14	8	10	16	NA
9	0.5	1	4	NA	NA	16	14	12	6	10	NA

PIP - Piperacillin, ATM - Aztreonam, CFP - Cefoperazone.

Table S5. Laboratory test of patients diagnosed with CRAB infection.

Patient	Temperature	WBC ($\times 10^9/L$)	PMN (%)	CRP (mg/L)	PCT (ng/mL)	IL-6 (pg/mL)
1	> 38°C	12.44	82.6	14.04	0.11	NA
2	> 38°C	7.81	73.4	82.09	0.04	NA
3	> 38°C	12.70	83.7	6.77	2.71	29.03
4	> 38°C	12.44	82.0	41.68	0.16	159.30
5	> 38°C	9.90	9.2	9.12	9.27	1,337.00
6	> 38°C	9.88	80.6	66.93	0.11	24.87
7	> 38°C	11.16	85.9	120.89	0.95	NA
8	< 38°C	15.69	76.8	207.42	7.82	349.90
9	< 38°C	13.54	89.6	4.55	0.06	NA
10	> 38°C	22.78	86.2	10.86	0.17	184.80
11	> 38°C	11.81	83.0	9.43	NA	NA
12	< 38°C	13.94	73.9	38.52	NA	NA
13	> 38°C	10.55	90.1	12.46	0.09	28.53
14	> 38°C	10.96	85.7	5.37	NA	NA
15	> 38°C	12.34	87.6	75.33	40.19	3,388.00
16	> 38°C	17.87	86.0	69.29	1.32	29.16
17	> 38°C	13.67	88.8	52.93	5.06	NA
18	> 38°C	10.52	84.0	30.49	0.99	30.36
19	< 38°C	15.41	81.8	71.87	NA	NA
20	> 38°C	10.05	94.9	127.37	8.94	NA
21	> 38°C	14.18	89.5	59.19	1.87	52.70
22	> 38°C	20.57	90.8	43.98	NA	NA
23	> 38°C	28.57	89.5	11.11	0.14	53.43
24	> 38°C	10.57	79.1	216.30	2.66	169.30
25	> 38°C	11.68	92.2	58.24	NA	NA
26	< 38°C	15.31	87.5	0.49	0.15	9.58
27	> 38°C	13.08	78.3	4.17	0.16	19.63
28	> 38°C	17.03	91.6	18.06	1.51	76.79
29	> 38°C	13.19	91.4	149.19	2.21	NA
Average		13.78 \pm 4.32	82.61 \pm 15.14	55.79 \pm 58.69	3.76 \pm 8.44	371.40 \pm

Table S6. *In vitro* susceptibility test of the 10 key antibiotics against CRAB.

Strain	MIC values (mg/L)							KB (mm)		
	CIP	GEN	NIT	SAM	CAZ	CRO	FEP	PIP	AMK	MNO
1	> 4	> 16	> 512	16	> 64	> 64	> 64	6	6	18
2	> 4	> 16	> 512	> 32	> 64	> 64	> 64	8	88	11
3	> 4	> 16	> 512	16	> 64	> 64	> 64	8	17	16
4	> 4	4	> 512	16	> 64	> 64	> 64	9	6	17
5	> 4	> 16	> 512	> 32	> 64	> 64	> 64	6	6	19
6	> 4	> 16	NA	> 32	> 64	NA	> 64	NA	18	6
7	> 4	4	> 512	16	> 64	> 64	> 64	8	6	13
8	> 4	> 16	> 512	> 32	> 64	> 64	> 64	6	6	16
9	> 4	> 16	> 512	> 32	> 64	> 64	> 64	6	6	17
10	> 4	> 16	NA	> 32	> 64	NA	> 64	NA	6	14
11	> 4	> 16	> 512	> 32	> 64	> 64	> 64	6	6	15
12	> 4	8	NA	> 32	> 64	NA	> 64	NA	6	17
13	> 4	> 16	NA	16	> 64	NA	> 64	NA	6	18
14	> 4	> 16	NA	> 32	> 64	NA	> 64	NA	6	17
15	> 4	> 16	NA	16	> 64	NA	> 64	NA	6	14
16	> 4	> 16	NA	> 32	> 64	NA	> 64	NA	6	14
17	> 4	> 16	NA	> 32	> 64	NA	> 64	NA	6	12
18	> 4	> 16	NA	> 32	> 64	NA	> 64	NA	6	13
19	> 4	> 16	NA	> 32	> 64	NA	> 64	NA	6	15
20	> 4	> 16	NA	> 32	> 64	NA	> 64	NA	6	11
21	> 4	> 16	NA	> 32	> 64	NA	> 64	NA	6	17
22	> 4	> 16	NA	> 32	> 64	NA	> 64	NA	6	14
23	> 4	> 16	NA	8	> 64	NA	> 64	NA	6	11
24	> 4	> 16	NA	> 32	> 64	NA	> 64	NA	6	16
25	> 4	> 16	NA	> 32	> 64	NA	> 64	NA	6	15
26	> 4	> 16	NA	> 32	> 64	NA	> 64	NA	6	16
27	> 4	> 16	NA	16	> 64	NA	> 64	NA	6	12
28	> 4	> 16	NA	16	> 64	NA	> 64	NA	6	11
29	> 4	> 16	NA	16	> 64	NA	> 64	NA	6	8

CRO - Ceftriaxone, MNO - Minocycline.