



The Detection of Carbapenemases in Carbapenem-Resistant Gram-Negative Bacteria from an Academic Medical Center

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Abstract

Background

Multidrug-resistant Gram-negative (MDRGN) bacteria are increasing in prevalence worldwide and are associated with an increase in morbidity and mortality. The most prevalent resistance mechanisms are carbapenemases. The different carbapenemases have different epidemiology and therapeutic options. Therefore, it is important to understand the resistance mechanisms of carbapenem resistance in your hospital. The objective of this study was to understand the carbapenemase epidemiology at University of Maryland Medical Center (UMMC).

Materials

We collected 100 isolates of MDRGN bacteria from patients admitted to UMMC from April through September 2014. We identified and performed susceptibilities by Vitek II (BioMerieux, Durham, NC) or disk diffusion method following CLSI guidelines. Isolates were tested using the Acuitas® MDRO Gene Test (OpGen, Gaithersburg, MD), which is a PCR-based multiplex assay that detects the *KPC*, *NDM*, *VIM*, *IMP*, *OXA-23*, *OXA-48*, *OXA-51*, *CTX-M*, and *vanA* resistance gene families. The Acuitas® MDRO Gene Test results were then compared with the susceptibility results of the isolates.

Results

We analyzed 100 isolates of MDRGN with 86 resistant or intermediate to at least 1 carbapenem. We analyzed 31 *Acinetobacter baumannii*, 11 *Escherichia coli*, 19 *Klebsiella pneumoniae*, 1 *Klebsiella oxytoca*, 17 *Enterobacter cloacae* complex, 2 *Enterobacter aerogenes*, 2 *Pantoea* sp., 1 *Citrobacter freundii*, and 16 *Pseudomonas aeruginosa*. *NDM*, *VIM*, *IMP*, and *OXA-48* genes were not detected. All 31 *A. baumannii* had *OXA-51* detected and only 21 *OXA-23*. Seventeen were *KPC* positive, with the majority detected in *K. pneumoniae* (7/17), 2 out of 17 isolates also had a *CTX-M* detected. All but one isolate positive for the *KPC* gene were resistant to both ertapenem and meropenem. Thirteen isolates were positive for *CTX-M* only, with 6 resistant to both meropenem and ertapenem. There were 62 isolates in which a carbapenemase or *CTX-M* was found.

Conclusion

Of the 100 isolates of MDRGN, *A. baumannii* was the most resistant, with *OXA-51* and *OXA-23* being the most prevalent carbapenemases detected. *KPC* was the only carbapenemase found in Enterobacteriaceae, however 27% had *CTX-M* detected. The molecular detection of carbapenemases is important in order to understand the local epidemiology of MDRGN resistance.

Objective

The objective of this study was to understand the carbapenemase epidemiology at University of Maryland Medical Center (UMMC).

Antibiogram of 100 Multidrug-Resistant Gram-negative Isolates

n	Ampicillin Subactam	Piperacillin Tazobactam	Cefepime	Ceftazidime	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Ciprofloxacin	Levofloxacin	Tetracycline
<i>Acinetobacter baumannii</i>	31	29%	0%	3%		3%		45%	29%	0%		
OXA-51 only	10	40%	0%	10%	--	--	10%	--	40%	20%	0%	--
OXA-51 and OXA-23	21	24%	0%	0%	--	--	0%	--	48%	33%	0%	--
<i>Escherichia coli</i>	11	0%	9%	27%	--	36%	--	64%	82%	73%	--	9%
KPC	3	0%	0%	33%	--	33%	--	0%	67%	33%	--	0%
CTX-M	5	0%	20%	0%	--	60%	--	80%	100%	100%	--	20%
No resistance detected	3	0%	0%	67%	--	0%	--	100%	67%	67%	--	0%
<i>Citrobacter freundii</i>	1	--	0%	0%	--	0%	--	0%	100%	--	100%	100%
KPC	1	--	0%	0%	--	0%	--	0%	100%	--	0%	100%
<i>Enterobacter</i> sp.	19	--	11%	32%	--	11%	--	53%	100%	74%	--	58%
KPC	3	--	0%	0%	--	0%	--	0%	100%	0%	--	0%
KPC and CTX-M	1	--	0%	0%	--	0%	--	0%	100%	0%	--	0%
No resistance detected	15	--	13%	40%	--	13%	--	67%	100%	93%	--	73%
<i>Klebsiella</i> sp.	20	0%	0%	0%	--	25%	--	30%	45%	40%	--	20%
KPC	7	0%	0%	0%	--	0%	--	0%	43%	29%	--	17%
CTX-M	8	0%	0%	0%	--	25%	--	38%	50%	25%	--	13%
KPC and CTX-M	1	0%	0%	0%	--	0%	--	0%	100%	0%	--	100%
No resistance detected	4	0%	0%	0%	--	75%	--	75%	25%	100%	--	25%
<i>Pantoea</i> sp.	2	0%	0%	0%	--	0%	--	100%	100%	100%	--	100%
KPC	1	0%	0%	0%	--	0%	--	--	100%	100%	--	100%
<i>Pseudomonas</i> sp.	16	--	44%	69%	75%	--	0%	0%	88%	56%	25%	--

Conclusions

- Of the 100 isolates tested, *A. baumannii* had the most resistance genes detected, with *OXA-51* and *OXA-23* being the most prevalent carbapenemases detected.
- The *KPC* gene was the only carbapenemase found in Enterobacteriaceae, however 27% had *CTX-M* detected.
- Of the isolates with the *CTX-M* gene detected, half were resistant to both meropenem and ertapenem.
- Detection of carbapenemases through molecular methods is important in order to understand the local epidemiology of MDRGN resistance.

Background

- Multidrug resistant Gram-negative (MDRGN) bacteria are increasing in prevalence worldwide.
- MDRGN are associated with an increase in morbidity and mortality.
- Carbapenemases are the most prevalent resistance mechanism in gram-negative bacteria.
- The Acuitas® MDRO Gene Test is a PCR-based multiplex assay that detects *KPC*, *NDM*, *VIM*, *IMP*, *OXA-23*, *OXA-48*, *OXA-51*, *CTX-M*, and *vanA* resistance gene families.

Methods

- Cultures from patients admitted to UMMC were cultured and bacteria isolated underwent identification and had susceptibilities performed by Vitek II (Biomérieux, Durham, NC) or by disk diffusion method following CLSI guidelines.
- A total of 100 MDRGN bacteria were selected due to their resistance patterns from identified isolates.
- Isolates were tested for resistance genes using the Acuitas® MDRO Gene Test (OpGen, Gaithersburg, MD).
- Results from the Acuitas® MDRO Gene Test were compared with susceptibility results.

Results

- A total of 86 isolates were resistant or intermediate to at least 1 carbapenem.
- All 31 *Acinetobacter baumannii* were positive for *OXA-51*, with 21 of the 31 positive for *OXA-23*.
- There were 17 *KPC* positive Enterobacteriaceae, with the majority identified as *Klebsiella pneumoniae* and 2 of the *KPC* organisms also being positive for *CTX-M*.
- All but one *KPC* positive isolate was resistant to both meropenem and ertapenem.
- Thirteen Enterobacteriaceae were positive for *CTX-M*, with 6 resistant to both meropenem and ertapenem.
- A total of 62 isolates were not positive for any of the resistance genes tested for by the Acuitas® MDRO Gene Test.
- No isolates were positive for *IMP*, *VIM*, *NDM*, or *OXA-48* genes.