

# Regional Differences in Carbapenem Non-Susceptibility in US Hospitals in 2015-2016

McCann E, PhD<sup>1</sup>; Gupta V, PharmD, BCPS<sup>2</sup>; DeRyke CA, PharmD<sup>1</sup>; Johannes RS, MD, MS<sup>2,3</sup>; DePestel DD, PharmD<sup>1</sup>; Tabak YP, PhD<sup>2</sup>

<sup>1</sup>Merck & Co., Inc., Kenilworth, NJ USA; <sup>2</sup>Becton, Dickinson & Company, Franklin Lakes, NJ USA; <sup>3</sup>Harvard Medical School, Boston, MA USA

eilish.mccann@merck.com, vikas.gupta@bd.com

## Abstract

**Background:** Carbapenem non-susceptibility (NS) in Gram-negative (GN) bacteria is recognized as a serious issue in the US, though regional data are limited.

**Methods:** Electronic data from a Becton, Dickinson & Company research database for 348 US hospitals were analyzed for July 2015 to June 2016. All inpatient, non-duplicate GN isolates (first isolate of a species per 30 day period) from all sources (urine, skin, blood, intra-abdominal, respiratory, other), that were reported, were classified as carbapenem NS if intermediate or resistant to: a) imipenem or meropenem for *Pseudomonas aeruginosa* (PsA) or b) imipenem, meropenem, or ertapenem for Enterobacteriaceae. Geographic regions were as per National Healthcare Safety Network categories.<sup>2</sup> Regions 1, 7, and 8 were grouped as “other” due to the low number of hospitals (n=13). Pairwise comparisons used the region with the lowest NS rate as the reference group.

**Results:** PsA, *Klebsiella pneumoniae* (KP), and *Escherichia coli* (EC) comprised the majority of tested isolates (168,022/214,224). The highest NS rates were in PsA, ranging from 11.9% (Region 10) to 27.0% (Region 2) (all regions 21.9%). KP NS rates ranged from 0.4% (“other”) to 13.6% (Region 2) (all regions 4.8%). EC isolates were the most numerous though NS rates were low: 0.4% (range 0.2% – 0.5%).

**Conclusions:** Carbapenem NS is primarily observed in PsA in US hospitals. Of the most common Enterobacteriaceae, KP has the highest rates of NS. Regional differences are considerable; accordingly, clinicians should be aware of their local antibiogram and reporting patterns when creating treatment protocols.

## Background

- Carbapenem non-susceptibility (NS) in Gram-negative (GN) bacteria is recognized as a serious issue in the US, though regional data are limited.<sup>1</sup>
- We sought to examine the regional differences in the carbapenem NS rate using electronically captured microbiological data.

## Methods

- Data Source:** Electronic data from a Becton, Dickinson & Company research database for 348 US hospitals (see Table 1 for hospital characteristics) were analyzed for July 2015 to June 2016.
- Patients and Isolates:** All inpatient, non-duplicate GN isolates (first isolate of a species per 30 day period) from all sources (urine, skin, blood, intra-abdominal, respiratory, other), that were reported, were classified as carbapenem NS if intermediate or resistant to:
  - imipenem or meropenem for *Pseudomonas aeruginosa* or
  - imipenem, meropenem, or ertapenem for Enterobacteriaceae.
- Definition of Geographic Region:** Regions were as per National Healthcare Safety Network categories (NHSN).<sup>2</sup> Regions 1, 7, and 8 were grouped due to the low number of hospitals (n=13).

## Results

- P. aeruginosa*, *Klebsiella pneumoniae*, and *Escherichia coli* comprised the majority of tested isolates (168,022/214,224).
- The highest NS rates were in *P. aeruginosa*, ranging from 11.9% (Region 10) to 27.0% (Region 2) (all regions 21.9%). Similarly, the NS rate of *P. aeruginosa*/1000 admissions was lowest for Region 10 (0.27/1000 admissions) and highest for Region 2 (2.67/1000 admissions).
- K. pneumoniae* NS rates ranged from 0.4% (Regions 1, 7, 8 combined) to 13.6% (Region 2) (all regions 4.8%). Similarly, Regions 1, 7, 8 combined have the lowest *K. pneumoniae* NS rates/1000 admissions (0.03/1000 admissions) and Region 2 has the highest (1.06/1000 admissions).
- E. coli* isolates were the most commonly reported (96,271) of 214,224 non-duplicate isolates tested though NS rates were low: all regions 0.4% (range 0.2% – 0.5%). The NS rates per 1000 admissions ranged from 0.02 (Region 10) to 0.10 (Regions 2 and 4).

## Strength of the Study

- Large data set with nearly 400 hospitals.
- Data were most current one year data available (July 2015 to June 2016).

## Limitations

- These data were collected from the laboratory information system feeds provided by participating hospitals and relied on interpretive results reported at each facility, thus potential suppressed results may affect the non-susceptible rate.

## Conclusion

- Carbapenem NS is primarily observed in *P. aeruginosa* in US hospitals. Of the most commonly reported Enterobacteriaceae, *K. pneumoniae* has the highest rates of carbapenem NS. Although the distribution of isolate sources and pathogens were similar across regions there were notable differences in the carbapenem NS rate and NS rate per 1000 admissions; accordingly, clinicians should be aware of their local antibiogram and reporting patterns when creating treatment protocols.

Table 1. Hospital characteristics

Region	States	Hospital N (%)
2	NJ, NY, PR, VI	28 (8.0%)
3	DE, DC, MD, PA, VA, WV	11 (3.2%)
4	AL, FL, GA, KY, MS, NC, SC, TN	101 (29.0%)
5	IL, IN, MI, MN, OH, WI	91 (26.2%)
6	AR, LA, NM, OK, TX	55 (15.8%)
9	AZ, CA, HI, Pacific Islands	27 (7.8%)
10	AK, ID, OR, WA	22 (6.3%)
1, 7, 8*	Other	13 (3.7%)
<b>Overall</b>		<b>348</b>
<b>Urban/Rural</b>		
Urban		75.9%
Rural		24.1%
<b>Medical School Affiliation</b>		
Major		12.9%
Limited		19.3%
Graduate		4.6%
No Affiliation		63.2%
<b>Bed size</b>		
<100		22.7%
100-300		40.2%
>300		37.1%

\*Regions were combined due to insufficient facility count within each individual region (CT, ME, MA, NH, RI, VT, IA, KS, MO, NE, CO, MT, ND, SD, UT, and WY)

Table 2: Regional differences in carbapenem non-susceptible rates in the most commonly reported pathogens

Region	States	Carb NS % (n/N) <i>P. aeruginosa</i>	Carb NS % (n/N) <i>K. pneumoniae</i>	Carb NS % (n/N) <i>E. coli</i>
2	NJ, NY, PR, VI	27.0% (1022/3789)	13.6% (406/2976)	0.5% (40/7677)
3	DE, DC, MD, PA, VA, WV	20.2% (209/1036)	5.8% (55/947)	0.4% (10/2713)
4	AL, FL, GA, KY, MS, NC, SC, TN	21.4% (2493/11,636)	2.4% (254/10,735)	0.5% (141/27,106)
5	IL, IN, MI, MN, OH, WI	22.1% (2005/9053)	7.1% (595/8361)	0.3% (79/23,950)
6	AR, LA, NM, OK, TX	20.6% (1387/6724)	1.5% (97/6559)	0.3% (63/19,850)
9	AZ, CA, HI, Pacific Islands	25.3% (929/3677)	7.7% (207/2671)	0.4% (37/8682)
10	AK, ID, OR, WA	11.9% (84/703)	1.4% (10/694)	0.3% (7/2607)
1, 7, 8	Other	13.7% (153/1115)	0.4% (4/1075)	0.2% (8/3686)
<b>Overall</b>		<b>21.9% (8282/37,733)</b>	<b>4.8% (1628/34,018)</b>	<b>0.4% (385/96,271)</b>

## References

- Centers for Disease Control: Antibiotic Resistance Threats in the United States, 2013. <http://www.cdc.gov/drugresistance/pdf/ar-threats-2013-508.pdf>. Accessed July 25, 2016.
- Sievert DM, Ricks P, Edwards JR, et al. Antimicrobial-resistant pathogens associated with healthcare-associated infections: summary of data reported to the National Healthcare Safety Network at the Centers for Disease Control and Prevention, 2009-2010. *Infect Control Hosp Epidemiol*. 2013;34(1):1-14.

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Table 3. Regional differences in carbapenem non-susceptible rates/1000 admissions in the most commonly reported pathogens

Region	States	Carb NS per 1000 Admissions (n/N) <i>P. aeruginosa</i>	Carb NS per 1000 Admissions (n/N) <i>K. pneumoniae</i>	Carb NS per 1000 Admissions (n/N) <i>E. coli</i>
2	NJ, NY, PR, VI	2.67 (1022/382,854)	1.06 (406/382,854)	0.10 (40/382,854)
3	DE, DC, MD, PA, VA, WV	1.35 (209/154,291)	0.36 (55/154,291)	0.06 (10/154,291)
4	AL, FL, GA, KY, MS, NC, SC, TN	1.79 (2493/1,393,715)	0.18 (254/1,393,715)	0.10 (141/1,393,715)
5	IL, IN, MI, MN, OH, WI	1.36 (2005/1,475,464)	0.40 (595/1,475,464)	0.05 (79/1,475,464)
6	AR, LA, NM, OK, TX	1.48 (1387/934,689)	0.10 (97/934,689)	0.07 (63/934,689)
9	AZ, CA, HI, Pacific Islands	2.03 (929/458,407)	0.45 (207/458,407)	0.08 (37/458,407)
10	AK, ID, OR, WA	0.27 (84/310,193)	0.03 (10/310,193)	0.02 (7/310,193)
1, 7, 8	Other	1.07 (153/143,178)	0.03 (4/143,178)	0.06 (8/143,178)
<b>Overall</b>		<b>1.58 (8282/5,252,791)</b>	<b>0.31 (1628/5,252,791)</b>	<b>0.07 (385/5,252,791)</b>

Table 4. Carbapenem non-susceptible rates and rates per 1000 admissions by pathogen

Pathogen	Carb NS % (n/N)	Carb NS per 1000 Admissions (n/N)
<i>P. aeruginosa</i>	21.9% (8282/37,733)	1.58 (8282/5,252,791)
<i>K. pneumoniae</i>	4.8% (1628/34,018)	0.31 (1628/5,252,791)
<i>P. mirabilis</i>	5.1% (847/16,545)	0.16 (847/5,252,791)
<i>E. cloacae</i>	6.0% (679/11,243)	0.13 (679/5,252,791)
<i>M. morgani</i>	15.9% (511/3209)	0.10 (511/5,252,791)
<i>E. coli</i>	0.4% (385/96,271)	0.07 (385/5,252,791)
<i>E. aerogenes</i>	7.6% (284/3755)	0.05 (284/5,252,791)
<i>S. marcescens</i>	3.5% (175/5013)	0.03 (175/5,252,791)
<i>C. freundii</i>	2.6% (95/3660)	0.02 (95/5,252,791)
Overall	6.1% (12,886/211,447)	2.71 / 1000 admissions (14,236/5,252,791)

Figure 1: Carbapenem non-susceptible isolate distribution by pathogen and region (n=12,866)

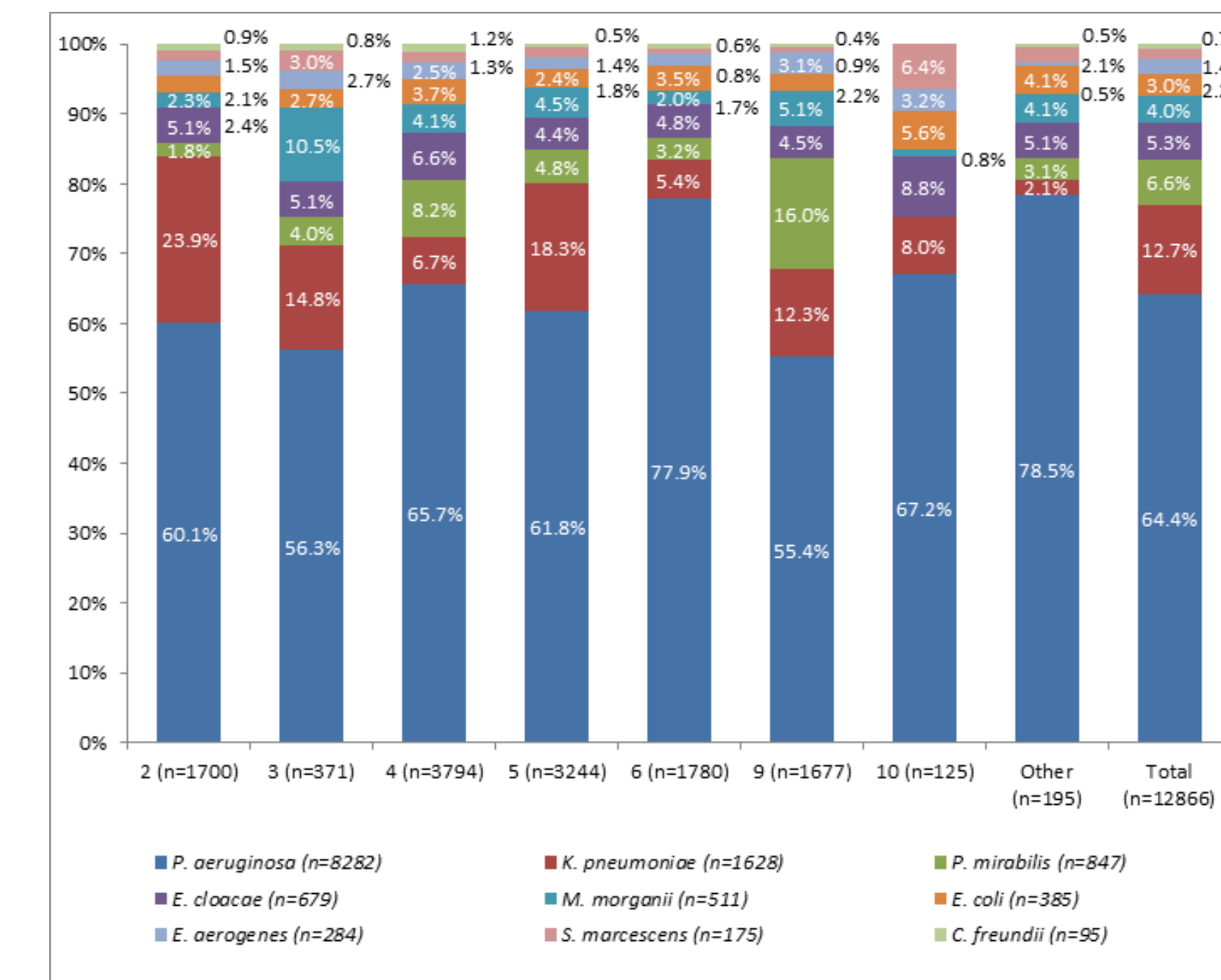


Figure 2: Carbapenem non-susceptible isolate distribution by source and region (n=12,866)

