

National Prevalence of Carbapenem-Resistant Enterobacteriaceae (CRE) in the Ambulatory and Acute Care Settings in the United States in 2015 -2016

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Abstract

BACKGROUND: In 2013 the CDC classified infections caused by CRE organisms as an urgent threat. The purpose of this study was to estimate the national prevalence of CRE events in the acute care and ambulatory settings based on a large database from Becton Dickinson & Company.

METHODS: Susceptibility data from non-duplicate *E. coli*, *K. pneumoniae*, and *P. mirabilis* cultures that were obtained from all sources were identified from 348 hospitals nationwide from July 2015 to June 2016. Organisms were classified into ambulatory, admission, and hospital-onset periods based on collection time. CRE isolates were identified per NHSN definitions. The raking method was applied per CMS national hospital distribution by location, teaching status, urban/rural status, and bed size to project the national prevalence estimates.

RESULTS: Of 878,777 isolates tested, 5,794 were CRE and the total number of nationally projected CRE events was 53,724 (see Table). The CRE rates were highest in the hospital onset period, followed by admission and ambulatory. Approximately 72% of all CRE events occurred in the ambulatory or admission settings. Overall CRE rates between the regions ranged from 0.6 to 0.8%, but there was more variability between the regions with admission (range 0.7 -1.5%) and hospital onset periods (range 1.4-2.9%).

Period Tested	Observed Events (348 hospitals)			National Projection		
	Isolates tested	Confirmed CRE	% CRE	Isolates tested	CRE Events	% CRE
Ambulatory	682,409	3,100	0.5%	6,319,175	30,601	0.5%
Admission	109,746	1,089	1.0%	912,212	9,462	1.0%
Hospital-onset	86,622	1,605	1.9%	736,300	13,662	1.9%
Total	878,777	5,794	0.7%	7,967,687	53,724	0.7%
Regions						
Midwest	242,065	1,465	0.6%	2,348,457	13,903	0.6%
NE	128,383	963	0.8%	1,146,354	9,729	0.8%
South	373,503	2,352	0.6%	3,002,689	19,546	0.7%
West	134,826	1,014	0.8%	1,470,187	10,546	0.7%
Total	878,777	5,794	0.7%	7,967,687	53,724	0.7%

CONCLUSION: These data estimate that the number of hospital onset CRE events nationally in July 2015 to June 2016 was higher than previously reported. Although the highest prevalence of CRE events occurred in the HO period, CRE events were highest in frequency in the ambulatory period. The highest rates of observed CRE were in the NE and South regions among all periods tested.

Introduction

Infection with carbapenem-resistant *Enterobacteriaceae* (CRE) or carbapenemase-producing *Enterobacteriaceae* is emerging as an important challenge in health-care settings. CDC laboratories have confirmed at least one type of CRE in healthcare facilities in 46 states and estimate ~7,900 and 1,400 HAIs caused by CRE *Klebsiella* spp. and *E. coli*, respectively, occur annually in the US.^{1,2}

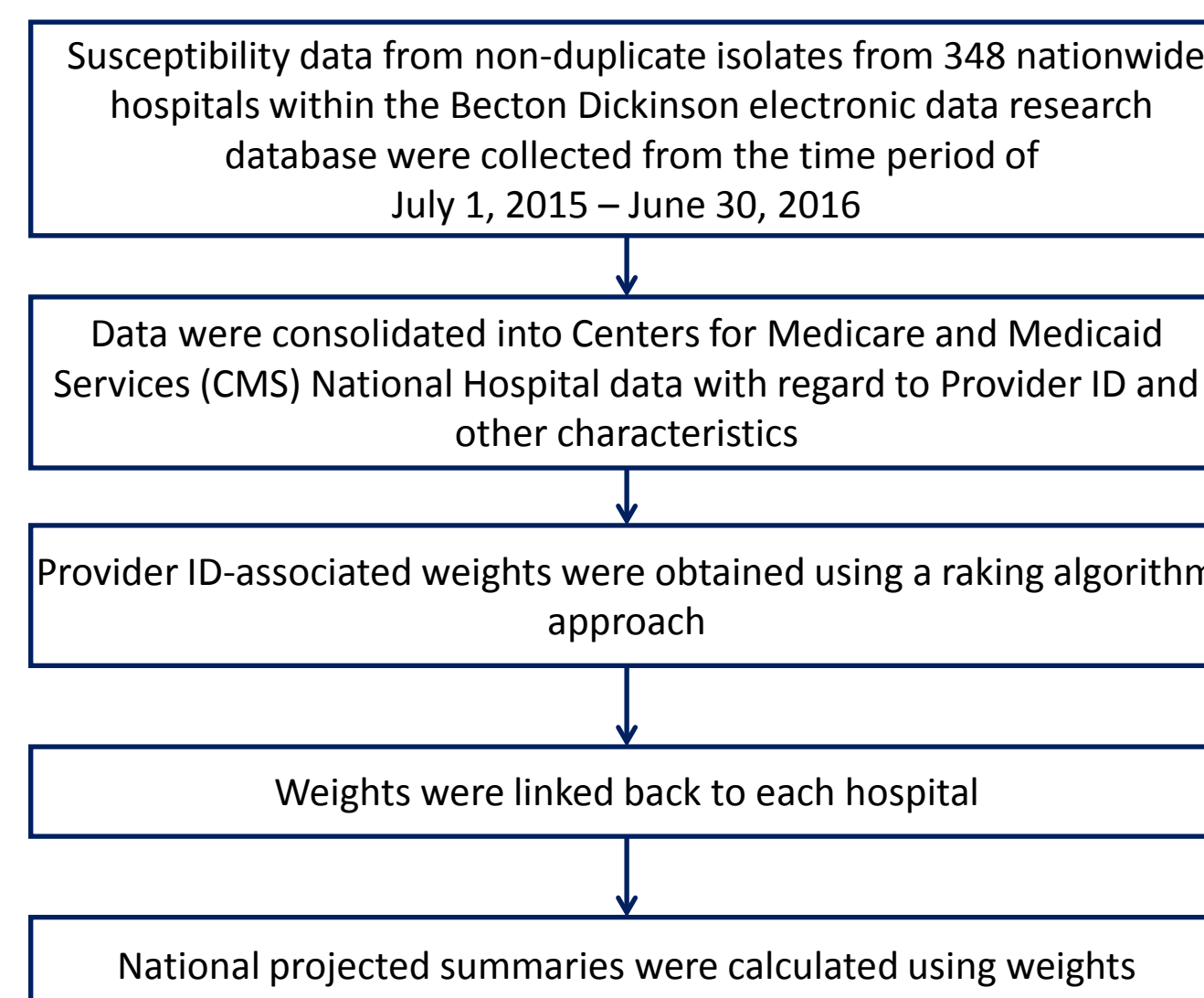
The purpose of this study was to estimate the national prevalence of carbapenem-resistant (CR) *E. coli*, *K. pneumoniae*, and *P. mirabilis* events in the acute care and ambulatory settings in the US from July 2015 to June 2016 based on a large database from Becton Dickinson & Company.

Methods

- Non-duplicate isolates (first isolate of a species per 30 day period) collected from 348 nationwide hospitals (Table 1) from respiratory, blood, urine, skin, intra-abdominal, and other sources were identified as CRE per the following:
 - E. coli*, *K. pneumoniae*, *P. mirabilis* confirmed intermediate or resistant to imipenem, meropenem, or ertapenem OR if flagged as CRE by the institution using National Healthcare Safety Network (NHSN) definitions.
- Isolates were categorized into three settings by the specimen collection time totals:
 - Admission:** Within 3 days of an inpatient admission and no previous admission within 14 days
 - Hospital-onset:** 3 days or more post-admission or within 14 days of discharge
 - Ambulatory:** Neither a or b.

- All data were linked with publicly available CMS (Centers for Medicare and Medicaid Services) National Hospital Data using Provider IDs
- The raking method was applied per CMS national hospital distribution by location, teaching status, urban/rural status, and bed size to project the national prevalence estimates. Raking has been borrowed from survey research methods. Raking uses an iterative proportional fitting algorithm to force estimates to match known underlying distribution totals.
- Figure 1 demonstrates the projection methodology for determining national prevalence estimates.

Figure 1. Projection Methodology for determining national prevalence estimates



Results

- For the 348 facilities 878,777 non-duplicate *E. coli*, *K. pneumoniae*, and *P. mirabilis* isolates were identified and tested for susceptibility in 745,182 patients
 - 5,794 (0.7%) of the isolates were determined to be CRE (Table 2) in 4,326 patients
 - The percentage of observed CRE events was highest in the hospital onset period (1.9%), followed by admission (1.0%) and ambulatory (0.5%) settings (Table 2)
- The top three sources identified as CR for *E. coli*, *K. pneumoniae*, and *P. mirabilis* isolates were: urine (64.2% of isolates), skin (16.7%) and respiratory (9.4% of isolates) (Figure 2)
- The national projected number of CR *E. coli*, *K. pneumoniae*, and *P. mirabilis* events was 53,724 (0.7%) (Table 2)
- National projections for CR *E. coli*, *K. pneumoniae*, and *P. mirabilis* for each region were: ambulatory (0.4%, 0.5%, 0.6%, & 0.5%), admission (1.2%, 1.3%, 0.7% & 1.5%) and hospital-onset (1.9%, 2.9%, 1.4% & 1.8%) for the Midwest, Northeast (NE), South & West regions, respectively (Table 3)

Table 1. Hospital Characteristics

Hospital Characteristics	BD Database N=348 Hospitals	CMS Database N=4,650 Hospitals
Teaching Status		
Major	12.9%	9.6%
Limited	19.3%	13.2%
Graduate	4.6%	2.8%
No Affiliation	63.2%	74.5%
Bed Size		
<100 beds	22.8%	50.8%
100-300 beds	41.3%	30.3%
≥300 beds	35.8%	19.0%
Urban/Rural Status		
Urban	75.9%	57.8%
Rural	24.1%	42.2%
Region		
Northeast	9.5%	8.9%
South	47.7%	41.1%
Midwest	27.0%	30.1%
West	15.8%	19.9%

BD= Becton Dickinson; CMS= Centers for Medicare and Medicaid Services

Figure 2: Source distribution for CRE *E. coli*, *K. pneumoniae*, and *P. mirabilis* (N=5,794) from 348 facilities

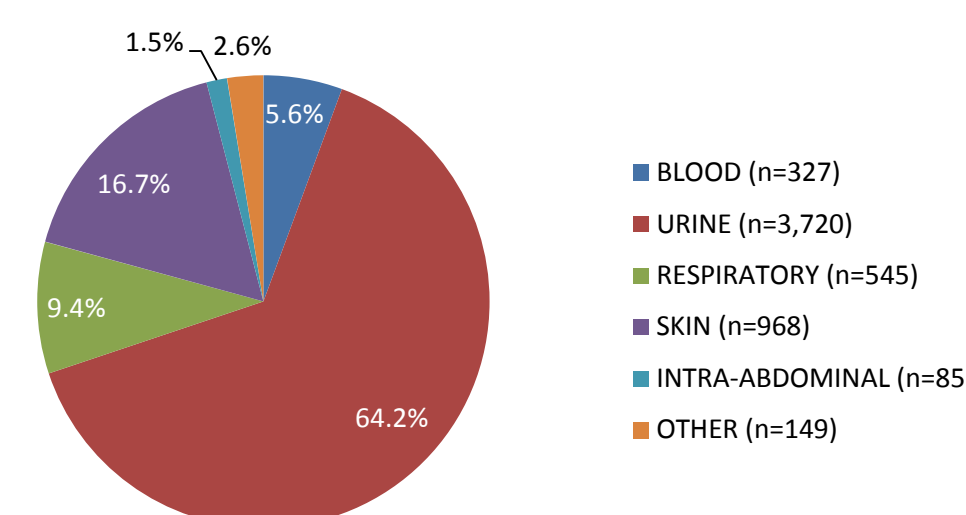


Figure 3: Source distribution of CR *E. coli*, *K. pneumoniae*, and *P. mirabilis* for projections of national prevalence by setting type

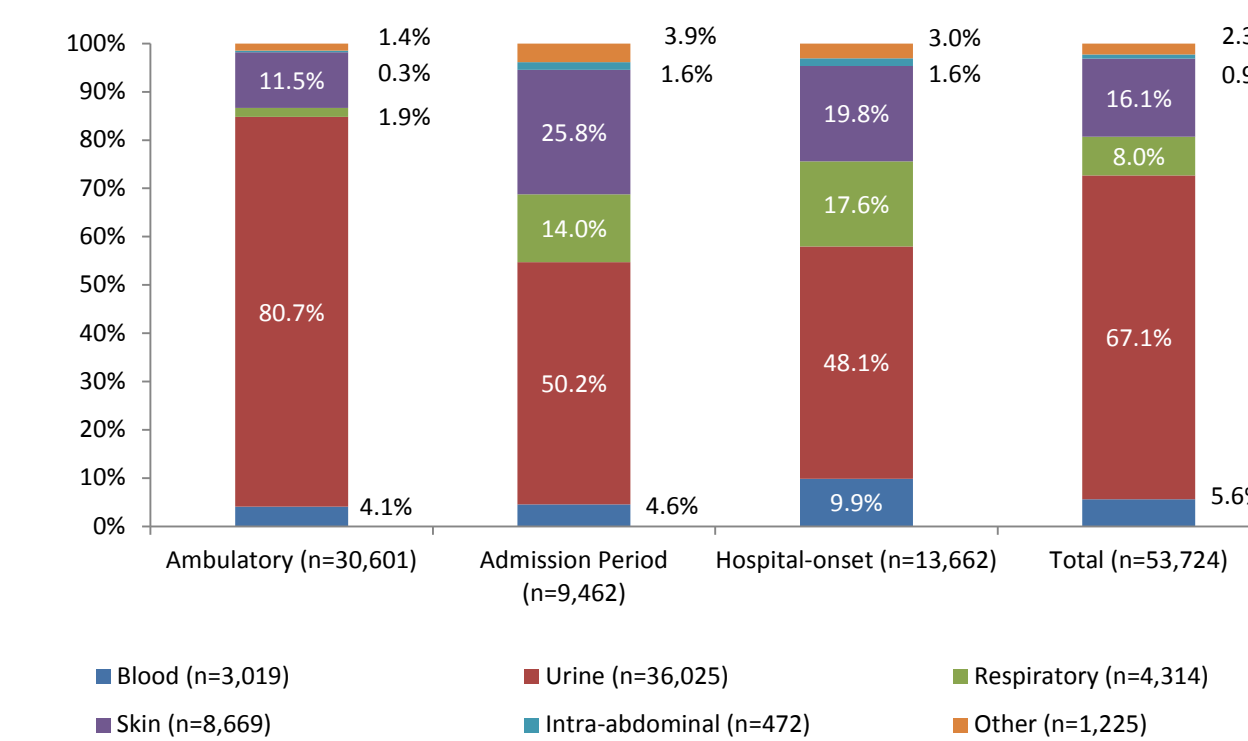


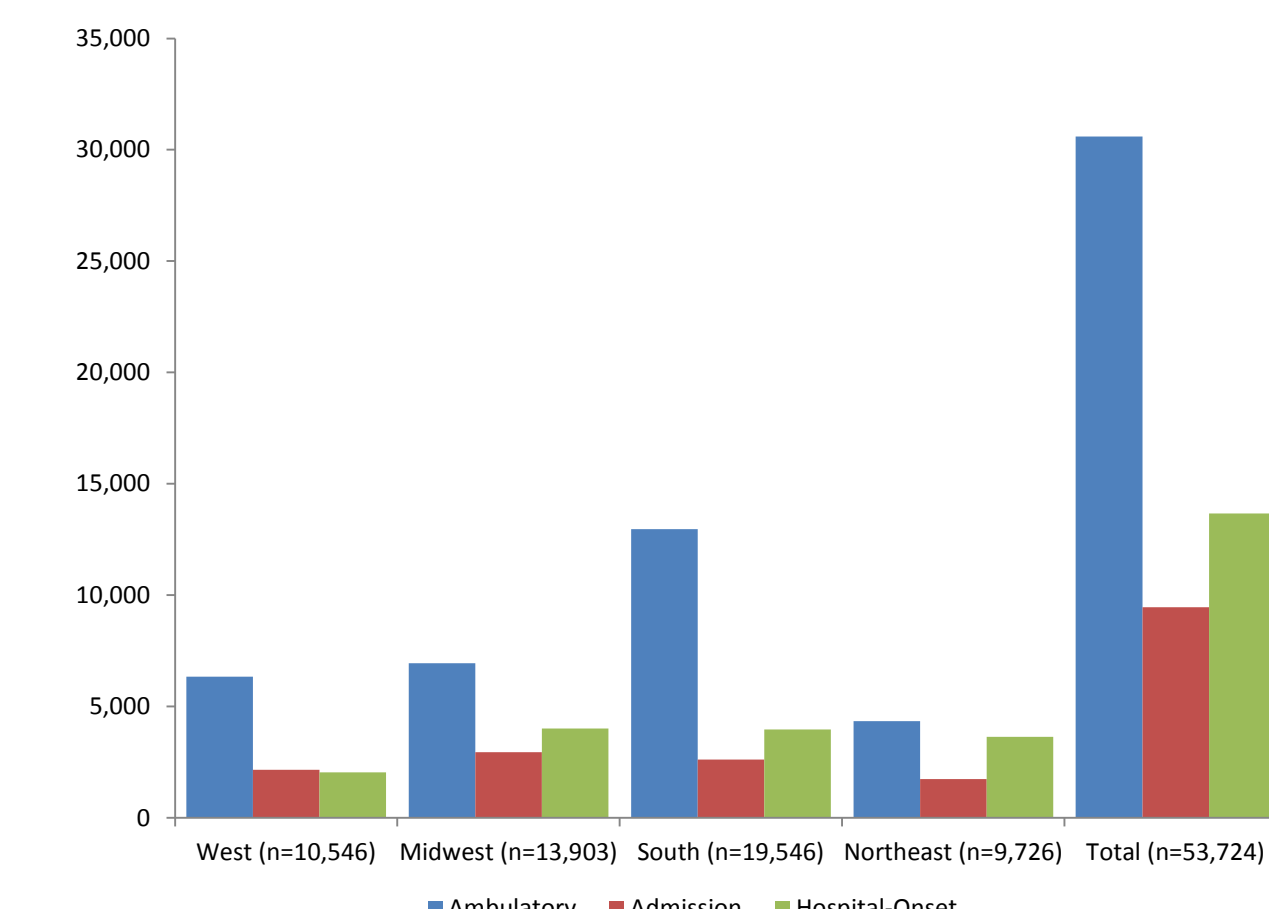
Table 2. National projection of CR *E. coli*, *K. pneumoniae*, and *P. mirabilis* events estimated from observed events from the 348 hospitals in the BD database

Period	348 Facilities Observed			NATIONAL PROJECTIONS		
	Total Tested, N	CRE, N	% CRE	Projected Org Tested, N	Projected CRE, N	Projected % CRE
Ambulatory	682,409	3,100	0.5%	6,319,175	30,601	0.5%
Admission	109,746	1,089	1.0%	912,212	9,462	1.0%
Hospital-Onset	86,622	1,605	1.9%	736,300	13,662	1.9%
Grand Total	878,777	5,794	0.7%	7,967,687	53,724	0.7%

Table 3. National projection of MDR AB events by region and setting

Region	Setting	CRE % (n)
West	Ambulatory	0.5% (6,344/1,211,156)
	Admission	1.5% (2,162/142,764)
	Hospital-Onset	1.8% (2,041/116,267)
Subtotal		0.7% (10,546/1,470,187)
Midwest	Ambulatory	0.4% (6,943/1,884,816)
	Admission	1.2% (2,948/252,003)
	Hospital-Onset	1.9% (4,012/211,637)
Subtotal		0.6% (13,903/2,348,457)
South	Ambulatory	0.6% (12,967/2,332,858)
	Admission	0.7% (2,611/386,125)
	Hospital-Onset	1.4% (3,968/283,707)
Subtotal		0.7% (19,546/3,002,689)
Northeast	Ambulatory	0.5% (4,347/890,346)
	Admission	1.3% (1,741/131,320)
	Hospital-Onset	2.9% (3,641/124,689)
Subtotal		0.8% (9,729/1,146,354)

Figure 4. National projections of CR *E. coli*, *K. pneumoniae*, and *P. mirabilis* events (n) by period tested and region.



Total "N" represents number of projected events

Conclusions

- These data estimate that national hospital onset CRE rates in the 12 months ending June 2016 to be higher than previously reported estimates²
- The highest rates of projected CRE occur in the hospital-onset period, however 57% of CRE events occur in the ambulatory period
- The highest rates of CRE were seen in the Northeast but the highest projected cases are in the Midwest and South regions
- The limitations to this study include that many methodologies are available to determine projections, and projections beyond the underlying data sample always have underlying assumptions and carry some risk

References

- <http://gis.cdc.gov/grasp/PSA/MapView.html> (last accessed October 13, 2016)
- 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.

Acknowledgements

This study is supported by Tetraphase Pharmaceuticals, Watertown, MA. We would like to thank Jason Till, MPH and John Murray, MPH for their efforts to create the dataset and analyses to support this work.

Author Disclosure Information

V. Gupta: D. Employee; Self; BD; M Olesky: D. Employee; Self; Tetraphase Pharmaceuticals; YP Tabak: D. Employee; Self; BD.; J Mohr: D. Employee; Self; Medical Affairs Strategic Solutions, LLC; H Hoffman-Roberts: D. Employee; Self; Theravance Biopharma; RS Johannes: D. Employee; Self; BD.