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Regional Difference of Extended-spectrum β-lactamases (ESBLs) Susceptibility in USA Hospitals in 2015-2016

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Abstract

Background: We examined the regional differences in susceptibility of ESBLs producing *E. coli* (EC), *K. pneumoniae* (KP), and *P. mirabilis* (PM) isolates in different settings.

Methods: We analyzed an electronic research dataset of Becton, Dickinson & Company from 348 USA hospitals from July 2015 to June 2016. All non-duplicate EC, KP, and PM isolates (first isolate of a species per 30 day period) from all sources were categorized as ESBLs if confirmed as ESBL-positive per commercial panels or intermediate/resistant to either ceftriaxone, cefotaxime, ceftazidime or cefepime. Positive isolates were categorized into 3 settings by the specimen collection time:

a) Admission: within 3 days of an inpatient admission and no previous admission within 14 days;
b) Hospital-onset: 3 or more days post-admission or within 14 days of discharge.
c) Ambulatory (neither a or b)

Geographic regions were classified into NHSN categories.[2] Region 1, 7, and 8 were grouped into "Other" due to the small number of hospitals. We conducted pairwise comparisons between regions using the region with the overall lowest ESBL rate as the reference group.

Results: The overall ESBL rate was 6.9% (60,932/878,777). The ESBL rates for ambulatory, admission, and hospital-onset settings were 5.8% (39,317/682,409), 9.2% (10,062/109,746), and 13.3% (11,553/86,622), respectively. Compared to Region 10, all regions, except for "Other", had significantly higher ESBL rates, ranging from 4.5% to 8.0% (all p<0.05) for ambulatory; from 7.1% to 11.8% (all p<0.01) for admission; and 11.2% to 17.5% (all p<0.01) for hospital-onset settings.

Conclusions: ESBL rates were highest in the hospital setting with significant regional differences. The highest ESBL region had a rate approximately twice that of the lowest region in all three settings. Regional and setting differences in ESBL epidemiology should be considered when making empiric antibiotic treatment decisions.

Background

Each year in the United States, at least 2 million people acquire serious infections with bacteria that are resistant to one or more of the antibiotics designed to treat those infections[1]. The CDC has categorized pathogens exhibiting extended-spectrum β-lactamases (ESBLs) of serious concern and requires prompt and sustained action to ensure the problem does not grow.

Purpose

We examined the regional differences in susceptibility of ESBL-producing *E. coli* (EC), *K. pneumoniae* (KP), and *P. mirabilis* (PM) isolates in different healthcare settings.

Methods

- We analyzed an electronic research dataset of Becton, Dickinson & Company from 348 USA hospitals from July 2015 to June 2016.
- All non-duplicate EC, KP, and PM isolates (first isolate of a species per 30 day period) from respiratory, blood, urine, skin, intra-abdominal, and other sources were categorized as ESBLs if confirmed as ESBL-positive per commercial panels or intermediate/resistant to either ceftriaxone, cefotaxime, ceftazidime, or cefepime (ESC4).
- Positive isolates were categorized into 3 settings by the specimen collection time:
  a) Admission: within 3 days of an inpatient admission and no previous admission within 14 days;
  b) Hospital-onset: 3 or more days post-admission or within 14 days of discharge;
  c) Ambulatory (neither a or b).
- Geographic regions were classified into National Healthcare Safety Network (NHSN) categories.[2] Region 1, 7, and 8 were grouped into "Other" due to small number of hospitals.
- We conducted pairwise comparisons between regions using the region with the overall lowest ESBL rate as the reference group.

Results

- The overall ESBL rate was 6.9% (60,932/878,777).
- The ESBL rates for ambulatory, admission, and hospital-onset settings were 5.8% (39,317/682,409), 9.2% (10,062/109,746), and 13.3% (11,553/86,622), respectively.
- Compared to Region 10, all regions, except for "Other", had significantly higher ESBL rates, ranging from 4.5% to 8.0% (all p<0.05) for ambulatory; from 7.1% to 11.8% (all p<0.01) for admission; and 11.2% to 17.5% (all p<0.01) for hospital-onset settings.

Conclusion

- ESBL rates were highest in the hospital-onset setting with significant regional differences.
- The highest ESBL region had a rate approximately twice that of the lowest region in all three settings.
- Regional and setting differences in ESBL epidemiology should be considered when making empiric antibiotic treatment decisions.

Limitations

- These data were collected from the laboratory information system feeds provided by participating hospitals and relied on interpretive results at each facility.
- The ESBL definition for this evaluation differed from CLSI recommendations in that we included intermediate or resistance to ESC4 (see Methods).
- These data were collected and analyzed from the perspective of unique non-duplicate collected cultures and not from the perspective of unique patients. The goal was to understand the volume and frequency of these organisms that were seen at the level of the hospital/microbiology laboratory across a large number of geographical diverse institutions.

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%)
Overall		**348**
Urban/Rural		
Urban	75.9%	
Rural	24.1%	
Medical School Affiliation		
Major	12.9%	
Limited	19.3%	
Graduate	4.6%	
No Affiliation	63.2%	
Bed size		
<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: ESBL rates by region and hospital setting

Region	States	Ambulatory	Admission period	Hospital-onset	Total
2	NJ, NY, PR, VI	7.0% (3,827/54,459)	11.8% (1,028/8,731)	17.1% (1,620/9,450)	8.9% (6,475/72,640)
3	DE, DC, MD, PA, VA, WV	5.1% (1,502/29,506)	7.1% (337/4,741)	11.2% (307/2,733)	5.8% (2,146/36,980)
4	AL, FL, GA, KY, MS, NC, SC, TN	6.2% (9,515/154,038)	9.0% (3,022/33,618)	13.1% (3,123/23,772)	7.4% (15,660/211,428)
5	IL, IN, MI, MN, OH, WI	4.5% (8,047/180,820)	8.3% (2,187/26,335)	11.5% (2,479/21,585)	5.6% (12,713/228,740)
6	AR, LA, NM, OK, TX	6.9% (8,759/127,664)	10.0% (1,838/18,451)	14.0% (2,098/15,027)	7.9% (12,695/161,142)
9	AZ, CA, HI, Pacific Islands	8.0% (4,076/50,868)	11.6% (1,184/10,177)	17.5% (1,352/7,727)	9.6% (6,612/68,772)
10	AK, ID, OR, WA	4.2% (2,077/48,871)	5.8% (181/3,134)	9.4% (345/3,660)	4.7% (2,603/55,665)
1, 7, 8	Other	4.2% (1,514/36,183)	6.3% (285/4,559)	8.6% (229/2,668)	4.7% (2,028/43,410)
Total		**5.8% (39,317/682,409)**	**9.2% (10,062/109,746)**	**13.3% (11,553/86,622)**	**6.9% (60,932/878,777)**

Table 3. ESBL rates by pathogen, setting and source

Source	Setting	ESBL *E. coli*	ESBL *K. pneumoniae*	ESBL *P. mirabilis*
All sources	Ambulatory	6.0% (31464/526929)	5.3% (5295/99734)	4.6% (2558/55746)
	Admission Period	9.6% (7216/75039)	8.8% (1949/22250)	7.2% (897/12457)
	Hospital-onset	14.1% (7494/53311)	14.3% (3228/22515)	7.7% (831/10796)
	Subtotal	7.0% (46174/655279)	7.2% (10472/144499)	5.4% (4286/78999)
Blood	Ambulatory	9.7% (1488/15344)	7.0% (269/3848)	5.8% (99/1704)
	Admission Period	11.7% (690/5896)	7.5% (130/1736)	7.6% (43/568)
	Hospital-onset	18.3% (618/3383)	16.4% (316/1926)	8.0% (31/386)
	Subtotal	11.4% (2796/24623)	9.5% (715/7510)	6.5% (173/2658)
Urine	Ambulatory	5.8% (28442/492743)	5.0% (4421/87945)	4.5% (1,921/43151)
	Admission Period	9.2% (5185/56145)	7.8% (1104/14197)	6.6% (448/6739)
	Hospital-onset	13.2% (4956/37449)	12.7% (1585/12474)	6.8% (423/6247)
	Subtotal	6.6% (38583/586337)	6.2% (7110/114616)	5.0% (2792/56,137)
Respiratory	Ambulatory	14.1% (172/1220)	9.7% (126/1305)	11.8% (67/568)
	Admission Period	15.0% (345/2305)	10.8% (271/2498)	13.3% (101/757)
	Hospital-onset	20.2% (640/3175)	16.1% (656/4,086)	15.1% (142/942)
	Subtotal	17.3% (1157/6700)	13.3% (1,053/7889)	13.7% (310/2267)
Skin	Ambulatory	8.7% (1000/11534)	8.1% (398/4932)	4.6% (423/9130)
	Admission Period	10.9% (697/6421)	13.9% (353/2541)	7.0% (276/3916)
	Hospital-onset	14.1% (911/6443)	18.4% (526/2862)	7.2% (202/2825)
	Subtotal	10.7% (2608/24398)	12.4% (1277/10335)	5.7% (901/15871)
Intra-abdominal	Ambulatory	4.4% (086/1973)	3.0% (15/498)	2.5% (3/118)
	Admission Period	5.9% (137/2317)	4.0% (30/758)	5.1% (005/098)
	Hospital-onset	12.0% (151/1256)	9.8% (58/591)	6.0% (5/084)
	Subtotal	6.7% (374/5546)	5.6% (103/1847)	4.3% (13/300)
Other	Ambulatory	6.7% (276/4115)	5.5% (066/1206)	4.2% (45/1075)
	Admission Period	8.3% (162/1955)	11.7% (61/520)	6.3% (24/379)
	Hospital-onset	13.6% (218/1605)	15.1% (87/576)	9.0% (28/312)
	Subtotal	8.5% (656/7675)	9.3% (214/2302)	5.5% (97/1766)

Figure 1: ESBL pathogen distribution by hospital setting

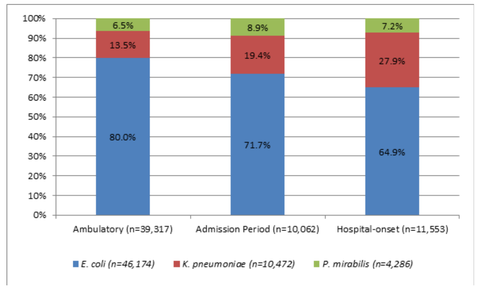
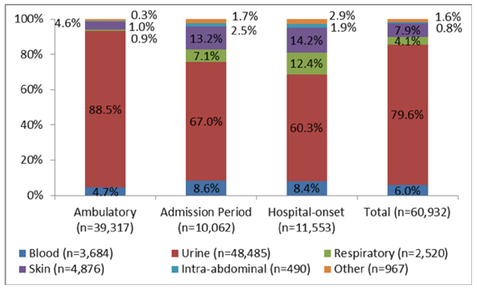


Figure 2: ESBL source distribution by hospital setting



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