Emerging Infections Program (EIP) Network Report
Healthcare-Associated Infections Community Interface Activity
Multi-site Gram-negative Surveillance Initiative
Extended-spectrum β-lactamase (ESBL)-producing Enterobacterales (ESBL-E) Surveillance, 2022

Case Definition:

An extended-spectrum beta-lactamase (ESBL)-producing Enterobacterales (ESBL-E) case was defined as isolation of *Escherichia coli*, *Klebsiella pneumoniae,* or *Klebsiella oxytoca* with the following criteria:

- Extended-spectrum cephalosporin-resistant (ceftazidime, cefotaxime, or ceftriaxone) using the current Clinical and Laboratory Standards Institute clinical breakpoints (1); and
- Carbapenem non-resistant (i.e., susceptible or intermediate) (doripenem, imipenem, meropenem, or ertapenem) using the current Clinical and Laboratory Standards Institute clinical breakpoints (1);
- Isolated from a normally sterile body specimen (e.g., blood, cerebrospinal fluid, pleural fluid, pericardial fluid, peritoneal fluid, joint/synovial fluid, bone, internal body site, muscle) or urine;
- Identified in residents of the surveillance area in 2022.

Surveillance Catchment Areas:

Colorado (1 county Denver area); Georgia (2 county Atlanta area); Maryland (1 county Baltimore area); New Mexico (1 county Albuquerque area); New York (1 county Rochester area); Tennessee (4 county Columbia area).

Population:

The surveillance area represents 2,939,124 persons.
Source: U.S. Census Bureau, Population Division, Vintage 2022 Special Tabulation.

Methods:

Case finding was active, laboratory-based, and population-based. Clinical laboratories that serve residents of the surveillance area were routinely contacted for case identification through a query of minimum inhibitory concentration (MIC) values from automated testing instruments. When possible, the MIC values obtained directly from the automated testing instruments were used to determine if an isolate met the phenotypic case definition. An incident ESBL-E case was defined as the first ESBL-E isolate meeting the case definition from a patient during a 30-day period.

Standardized case report forms were completed for incident cases through review of medical records. Inpatient and outpatient medical records were reviewed for information on patient demographics, clinical syndrome, outcome of illness, and relevant healthcare exposures.

A convenience sample of ESBL-E isolates (N=313) was collected from EIP sites and submitted to CDC for additional testing, including species confirmatory testing, reference antimicrobial susceptibility testing by using broth microdilution, phenotypic screening for ESBL production by using ceftazidime and cefotaxime alone and in combination with clavulanate, and molecular characterization.

Incidence rates for cases were calculated using the 2022 U.S. Census estimates of the surveillance area population as the denominator. Assessment of vital status in patients admitted to a hospital occurred at the time of discharge from the acute care hospital. For patients in a long-term care facility, long-term acute care facility, or in an outpatient dialysis center, vital status was assessed 30 days after culture collection. For all other patients, vital status was assessed using medical records from the healthcare facility encounter associated with the culture.

ESBL-E surveillance data underwent regular data cleaning to ensure accuracy and completeness. Patients with complete case report form data as of 8/21/2024 were included in this analysis. Because data can be updated as needed, analyses of datasets generated on a different date may yield slightly different results.

Results:

Note: The numbers of cases and denominators used for incidence rate calculations and case descriptions vary from table to table.

Tables 1 and 2a include all incident cases identified in 6 EIP sites (n=5065). Incidence rates were calculated using the total population in the 6-site surveillance area.

Table 2b includes all incident cases identified in 5 EIP sites (n=4066). Data on race were unavailable for most cases in the 6th EIP site, which was excluded. Incidence rates were calculated using the total population in the 5-site surveillance area.

Tables 3–8 include incident cases (n=3179) with completed case report forms (n=3137) or with unavailable charts (n=42) in 5 EIP sites. This number (n=3179) differs from the total number of incident cases (n=5065) for 2 reasons: 1) a case report form is completed for the first incident case per species per person during 2022 (except invasive cases, for which a case report form is always completed); and 2) case report forms were completed for cases in 5 EIP sites.

Table 1. Specimen Sources for ESBL-E Cases by Organism, 2022 (N=5065)

Organism	Total	Urine No.	Urine %	Blood[a] No.	Blood[a] %	Other sterile specimens No.	Other sterile specimens %
Escherichia coli	3974	3767	94.8	170	4.3	37	0.9
Klebsiella pneumoniae	950	848	89.3	80	8.4	22	2.3
Klebsiella oxytoca	141	127	90.1	13	9.2	1	0.7
Total	**5065**	**4742**	**93.6**	**263**	**5.2**	**60**	**1.2**

[a] Category may include cases with both a positive blood and urine specimen collected

Table 2a: Incidence Rates of ESBL-E Cases by Sex and Age, 2022 (N=5065)

Sex	No. of Cases	%	Incidence Rate[a]
Female	3706	73.2	244.4
Male	1353	26.7	95.1
Unknown	6	0.1	-

Age groups, years	No. of Cases	%	Incidence Rate[a]
0–18	138	2.7	21.0
19–49	1220	24.1	97.8
50–64	1076	21.2	196.6
65–79	1678	33.1	437.9
≥80	953	18.8	902.7
Invasive cases[b]	383	7.6	13.0
All cases	**5065**	**100.0**	**172.3**

[a] Cases per 100,000 population for EIP site surveillance areas (crude rates)

[b] Invasive cases include cases with a sterile incident specimen source or an incident urine specimen with a subsequent non-incident sterile specimen collected on the date of incident specimen collection or in the 29 days after

Table 2b: Incidence Rates of ESBL-E Cases by Race, 2022 (N=4066)

Race	No. of Cases	%	Incidence Rate[a]
White	2299	56.5	136.3
Black or African American	388	9.5	83.0
Another race[b]	214	5.3	99.2
Unknown	1165	28.7	-

Note: Table includes data from five EIP sites

[a] Cases per 100,000 population for EIP site surveillance areas (crude rates)

[b] Data for Asian, American Indian, Alaska Native, Native Hawaiian, and Pacific Islander, and multiple race case-patients were included in the another race category for privacy

Table 3. ESBL-E Cases by Race and Ethnicity, 2022 (N=3179)

Race/Ethnicity	No. of Cases	%
Hispanic or Latino, any race	632	19.9
Not known to be Hispanic or Latino[a] – White[b]	1838	57.8
Not known to be Hispanic or Latino[a] – Black or African American[c]	356	11.2
Not known to be Hispanic or Latino[a] – Asian[d]	135	4.2
Not known to be Hispanic or Latino[a] – Another race or multiracial[e]	83	2.6
Not known to be Hispanic or Latino[a]– Unknown race[f]	135	4.2

Note: Table includes data from five EIP sites

[a] Records either indicated ethnicity was non-Hispanic or Latino, or ethnicity was not known

[b] 85 ESBL-E cases with unknown ethnicity

[c] 10 ESBL-E cases with unknown ethnicity

[d] 15 ESBL-E cases with unknown ethnicity

[e] American Indian or Alaska Native, Native Hawaiian or Pacific Islander, or ≥2 races reported; 5 ESBL-E case with unknown ethnicity

[f] 96 ESBL-E cases had unknown ethnicity

Table 4. Selected Characteristics of ESBL-E Cases, 2022 (N=3179)

Location of patient on the 3rd calendar day before incident specimen collection	No. of Cases	%
Private residence	2659	83.6
Long-term care facility	302	9.5
Acute-care hospital (inpatient)	149	4.7
Homeless[a]	29	0.9
Long-term acute care hospital	8	0.3
Unknown or another location	32	1.0

[a]Includes patients documented as experiencing homelessness at the time of positive culture. A patient experiencing homelessness is defined as an individual who lacks permanent housing

Location of incident specimen collection	No. of Cases	%
Outpatient setting or emergency department	2666	83.9
Acute care hospital	331	10.4
Long-term care facility	145	4.6
Long-term acute care hospital	10	0.3
Unknown	27	0.8

Infection types[a]	No. of Cases	%
Urinary tract infection	2575	81.0
Bacteremia[b]	276	8.7
Pyelonephritis	136	4.3
Other	114	3.6
None[c]	276	8.7
Unknown	97	3.1

Note: Table includes data from five EIP sites

[a] Patients could have more than one type of infection reported

[b] Bacteremia includes cases with a positive blood specimen (incident or non-incident) or a documented diagnosis of sepsis, bacteremia, or blood stream infection

[c] No infection types reported

Table 5. Selected Clinical Characteristics of ESBL-E Cases, 2022 (N=3179)

Charlson comorbidity index	No. of Cases	%
0	1185	37.3
1	651	20.5
≥2	1314	41.3
Unknown	29	0.9
Median (IQR)	1	0–3

Underlying conditions[a]	No. of Cases	%
Neurologic condition, any	935	29.4
Urinary tract problems/abnormalities	932	29.3
Diabetes mellitus	931	29.3
Cardiovascular disease[b]	830	26.1
Chronic pulmonary disease[c]	657	20.7
Chronic renal disease	620	19.5
Gastrointestinal disease[d]	420	13.2
Skin condition	397	12.5
Malignancy (hematologic or solid organ)	321	10.1
Transplant (hematopoietic stem cell or solid organ)	45	1.4
Unknown	29	0.9

SARS-CoV-2 testing	No. of Cases	%
Positive test for SARS-CoV-2 during hospitalization and on or before the date of incident specimen collection[e]	67/713	9.4

Note: Table includes data from five EIP sites

[a] Patients could have more than one underlying condition reported

[b] Defined as myocardial infarction, congestive heart failure, congenital heart disease, stroke, transient ischemic attack, or peripheral vascular disease

[c] Defined as cystic fibrosis or any chronic respiratory condition resulting in symptomatic dyspnea

[d] Defined as diverticular disease, inflammatory bowel disease, peptic ulcer disease, short gut syndrome, or liver disease

[e] Among patients in the hospital on the date of incident specimen collection. Excludes patients who were admitted to the hospital after the date of incident specimen collection. A positive SARS-CoV-2 test was defined as any positive viral test for SARS-CoV-2, including antigen and nucleic acid amplification tests. Serologic tests were excluded

Table 6. Selected Healthcare Exposures or Risk Factors of ESBL-E Cases, 2022[a] (N=3179)

Exposure	No. of Cases	%
Healthcare facility stay in the year before the date of incident specimen collection – any healthcare facility stay	1190	37.4
Healthcare facility stay in the year before the date of incident specimen collection – acute care hospitalization	1093	34.4
Healthcare facility stay in the year before the date of incident specimen collection – long-term care facility residence	484	15.2
Healthcare facility stay in the year before the date of incident specimen collection – long-term acute care hospitalization	24	0.8
Surgery in the year before the date of incident specimen collection	508	16.0
Specimen collected ≥3 days after hospital admission	139	4.4
Chronic dialysis	59	1.9
Selected medical device(s) in place in the 2 calendar days before the date of incident specimen collection – urinary catheter	508	16.0
Selected medical device(s) in place in the 2 calendar days before the date of incident specimen collection – central venous catheter	132	4.2
Selected medical device(s) in place in the 2 calendar days before the date of incident specimen collection – other [b]	187	5.9
None of the above healthcare exposures [c]	1649	51.9
Healthcare exposures are unknown	82	2.6
International travel in the 12 months prior to date of incident specimen	101	3.2

Note: Table includes data from five EIP sites

[a] Patients could have more than one prior healthcare exposure or risk factor reported

[b] Other medical devices: endotracheal or nasotracheal tube, tracheostomy, gastrostomy tube, nephrostomy tube, nasogastric tube

[c] Defined as having no healthcare exposures in the year before specimen collection, no selected medical devices in place in the 2 days before specimen collection, and specimen collected before calendar day 3 after hospital admission if hospitalized

Table 7. Outcomes of Incident ESBL-E Cases, 2022 (N=3179)

Outcomes	No. of Cases	%
Outcomes – hospitalized on the day of or in the 29 days after the date of incident specimen collection[a,b]	901	28.3
Outcomes – ICU admission in the 6 days after the date of incident specimen collection[a]	102	3.2
Hospitalized patient discharged to – private residence	528/901	58.6
Hospitalized patient discharged to – long-term care facility	274/901	30.4
Hospitalized patient discharged to – died during hospitalization	67/901	7.4
Hospitalized patient discharged to – long-term acute care hospital	8/901	0.9
Hospitalized patient discharged to – other/unknown	24/901	2.7
Died within 30 days of incident specimen collection date	68	2.1
Cases with an incident sterile site specimen	20/176	11.4
Cases with an incident urine specimen[c]	48/3003	1.6

Note: Table includes data from five EIP sites

[a] Patients could have more than one outcome

[b] Data include 149 cases considered to be hospital-onset

[c] Two incident ESBL-E cases had a subsequent non-incident blood specimen collected on the date of incident specimen collection or in the 29 days after

Table 8. Prior Antimicrobial Use among ESBL-E Cases, 2022[a] (N=3179)

Antimicrobial class	Antimicrobial agent [b, c]	No. of Cases	%
Any antimicrobial class	Any antimicrobial agent	941	29.6
Cephems	Cefadroxil, cefazolin, cefdinir, cefepime, cefixime, cefotaxime, cefoxitin, cefpodoxime, ceftaroline, ceftazidime, ceftizoxime, ceftriaxone, cefuroxime, cephalexin	471	14.8
Fluoroquinolones	Ciprofloxacin, delafloxacin, levofloxacin, moxifloxacin, nalidixic acid	162	5.1
Glycopeptides	Dalbavancin,[d] oritavancin, telavancin,[d] vancomycin (intravenous or oral)	122	3.8
Penicillins	Amoxicillin, ampicillin, penicillin, nafcillin, oxacillin	87	2.7
ß-lactam combination agents	Amoxicillin/clavulanic acid, ampicillin/sulbactam, ceftazidime/avibactam, ceftolozane/tazobactam,[d] meropenem/vaborbactam	83	2.6
Tetracyclines	Doxycycline, eravacycline[d], minocycline, omadacycline[d], tetracycline, tigecycline	86	2.7
Carbapenems	Doripenem,[d] ertapenem, meropenem, imipenem/cilastatin	53	1.7
Lincosamides	Clindamycin	19	0.6
Ansamycins	Rifaximin, rifampin	13	0.4
Aminoglycosides	Amikacin, gentamicin, tobramycin	22	0.7
Fosfomycins	Fosfomycin	10	0.3
Macrolides	Azithromycin, clarithromycin, erythromycin	5	0.2
Folate pathway antagonists	Trimethoprim, trimethoprim/sulfamethoxazole	10	0.3
Lipopeptides	Daptomycin, polymyxin B,[d] polymyxin E[d]	8	0.3
Monobactams	Aztreonam	0	-

Note: Table includes data from five EIP sites

[a] Antimicrobial use was reported in the 30 days before the date of incident specimen collection

[b] Patients could have more than one antimicrobial reported

[c] 20 (0.6%) were methenamine, unknown, unspecified (reported as other and not shown in table)

[d] No prior antimicrobial use reported

Laboratory Characterization:

Table 9. Antimicrobial Susceptibility and Molecular Characteristics of ESBL-E Isolates Based on Testing Performed at CDC, 2022 (N=313)

Organism	Isolates Submitted to CDC	Isolates meeting case definition, No.	Isolates meeting case definition, %	ESBL-producing organisms,[a] No.	ESBL-producing organisms,[a] %
Escherichia coli	228	224	98.2	211	92.5
Klebsiella pneumoniae [b]	84	79	94.0	75	89.3
Klebsiella oxytoca	1	1	100	1	100
Total	**313**	**304**	**97.1**	**287**	**91.7**

[a] Phenotypic screening for ESBL production was performed by using ceftazidime and cefotaxime alone and in combination with clavulanate according to CDC guidelines

[b] Includes *Klebsiella pneumoniae* and *Klebsiella variicola*

Summary:

Surveillance data from 2022 represent the fourth calendar year and third full year of population-based surveillance for ESBL-E through the Emerging Infections Program (surveillance was conducted for six months in 2019). The crude annual incidence rate of ESBL-E in 2022 was 172.3 cases per 100,000 persons. This is a 6.8% increase in the crude ESBL-E incidence rate reported in 2021 (2). The incidence rate increased with increasing age, was higher in females than in males and higher in persons of White race than in persons of other races. More ESBL-E were isolated from a urine source than from normally sterile body sites. Prior healthcare exposures were reported for half of the cases, with the most common exposures being an admission to a healthcare setting in the prior year, surgery in the prior year, and presence of an indwelling medical device in the two days prior to the date of incident specimen collection. Approximately one-third of the ESBL-E cases were hospitalized, and overall crude 30-day mortality was 2.1%, with a higher 30-day mortality observed in cases with a sterile site specimen source compared to those with a urine specimen source. Nine percent of patients in the hospital on the date of incident specimen collection had a positive viral test for SARS-CoV-2 during their hospitalization and on or before the date of incident ESBL-E specimen collection. Among the 313 isolates submitted to CDC, 91.7% were ESBL-producing.

References:

1. CLSI. *Performance Standards for Antimicrobial Susceptibility Testing.* 32nd ed. CLSI supplement M100. Wayne, PA: Clinical and Laboratory Standards Institute; 2022.

2. Centers for Disease Control and Prevention. 2023. Emerging Infections Program, Healthcare-Associated Infections – Community Interface Surveillance Report, Multi-site Gram-negative Surveillance Initiative (MuGSI), Extended-spectrum β-lactamase -producing Enterobacterales Surveillance, 2021. Available at: https://www.cdc.gov/hai/eip/pdf/mugsi/2021-ESBL-Report-508.pdf

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For more information, visit our web sites:

- Multi-site Gram-negative Surveillance Initiative (MuGSI) (https://www.cdc.gov/healthcare-associated-infections/php/haic-eip/mugsi.html)
- Healthcare-Associated Infections - Community Interface Data Visualization (HAICViz) (https://www.cdc.gov/healthcare-associated-infections/php/haic-eip/haicviz.html)