THE FIRST YEAR OF MANDATED CARBAPENEM-RESISTANT *ENTEROBACTERIACEAE* AND ANTIBIOGRAM REPORTING IN LOS ANGELES COUNTY: 2017

BACKGROUND

Carbapenem-resistant *Enterobacteriaceae* (CRE)[1] are a family of gram-negative bacteria that can be resistant to most antibiotics including the carbapenem class of drugs which are used to treat severe infections. The majority of CRE infections are associated with patients in an acute care hospital or skilled nursing facility (SNF) who are immunocompromised or have invasive devices such as intravenous catheters or are ventilator dependent. The Centers for Disease Control and Prevention (CDC) is concerned about the rapid spread of CRE and has recommended aggressive approaches for identifying and preventing further spread [1].

Using data from 2010–2012, the Los Angeles County Department of Public Health (LAC DPH) assessed the prevalence of CRE in LAC[2] and received over 2,000 laboratory reports of carbapenem-resistant *Klebsiella pneumoniae*, one type of CRE. Prior work by the CDC suggested only sporadic cases of CRE were identified in LAC hospitals and prevalence was unknown. The large number of cases received was substantially higher than anticipated, providing justification for further surveillance.

CDC's National Healthcare Safety Network (NHSN)[3] is an electronic healthcare-associated infection (HAI) tracking system. In California, all acute care hospitals are mandated to report select HAIs to the California Department of Public Health via this system. The NHSN includes an option to report the three most common CRE infections (*Escherichia coli, Enterobacter sp., Klebsiella sp.)* as part of the system's LabID Event module. In April 2010, LAC DPH requested and received voluntary conferral of rights to the NHSN data submitted to California Department of Public Health. On January 19, 2017 a Health Officer Order (HOO)[4] was issued requiring all acute care hospitals and SNFs report CRE infections as well as a facility-specific annual antibiogram to LAC DPH. Antibiogram data provide a comprehensive summary of antimicrobial resistance organisms isolated in healthcare facilities. LAC DPH will use data submitted from healthcare facilities to compile a regional antibiogram to assess resistance and detect new trends in LAC.

METHODS

In California, general acute care hospitals (GACH) and long term acute care hospitals (LTACH) mandatorily report HAI data into NHSN. LAC DPH decided to build CRE reporting into this already established system and expand the data captured by creating a LAC CRE Group which added patient information and key variables needed to assess and describe the epidemiology of CRE in LAC. For surveillance purposes in this study, CRE infections were defined using the NHSN Safety Component Manual[5] as *Enterobacteriaceae* (*E. coli, Enterobacter sp., Klebsiella sp*.) resistant to carbapenem antibiotics or that produce carbapenemases.

[1] https://www.cdc.gov/hai/organisms/cre/definition.html
[2] http://publichealth.lacounty.gov/acd/docs/CRKP_ICHE.pdf
[3] https://www.cdc.gov/nhsn/index.html
[4] http://publichealth.lacounty.gov/acd/docs/CREorder.pdf
[5] https://www.cdc.gov/nhsn/pdfs/pscmanual/pcsmanual_current.pdf

LAC DPH sent detailed instructions for this new reporting requirement to all LAC facilities mandated to report. In addition, a webinar was created to provide step by step guidance on how to join the LAC CRE Group, as well as how to confer rights to LAC DPH and create custom variables. In contrast to GACHs and LTACHs, because most SNFs are not enrolled in the NHSN, a paper reporting form was created for these locations.

The NHSN LAC CRE group was used as the data source for analysis to calculate hospital and community onset rates as well as for descriptive epidemiology statistics. All SNF reports were submitted via paper case report forms and were entered into an Access database by ACDC staff.

For GACHs and LTACHs, CRE rates were analyzed using NHSN calculations of number of infections reported for the numerator and admissions for community-onset (CO) and patient days for healthcare-onset (HO) for the denominator. CO infections were identified within 3 days of admission and HO after 3 days of admission in both GACHs and LTACHs. Stratification of data by onset type in SNFs was not possible since most admission date information was either missing or filled out incorrectly.

According to the Centers for Medicare and Medicaid services (CMS) requirements, GACHs and LTACHs submitted final reports to NHSN by May 15, 2018. Data analysis was performed in May and June 2018. Additional analysis was done comparing CRE case counts between the two NHSN LAC groups; the general LAC group and the LAC CRE Group containing patient information and custom variables.

RESULTS

Out of 83 GACHs and 8 LTACHs in LAC, 72 (86.7%) GACHs and all LTACHs reported at least one CRE event. Pooled LTACH HO rates were higher than GACHs at 1.22 (range 0.50–2.18) infections compared to 0.66

Figure 1.
Boxplots of HO Infection Rate Distribution
GACHs and LTACHs
where >0 cases reported, LAC 2017

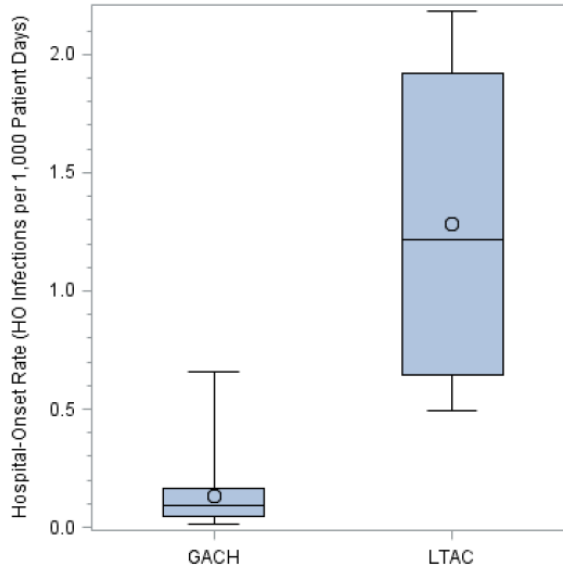
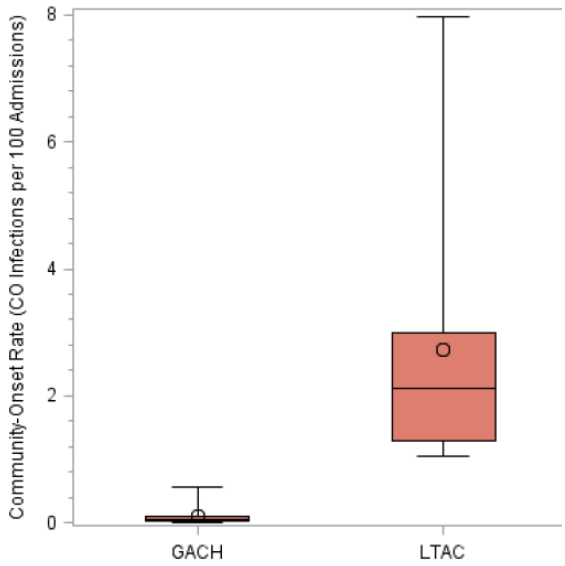


Figure 2.
Boxplots of CO Infection Rate Distribution
GACHs and LTACHs
where >0 cases reported, LAC 2017



(range 0.01–0.66) per 1,000 patient days respectively (**Figure 1**). The pooled CO CRE rates reported from LTACHs were also higher than GACHs, 2.11 (range 1.04–7.97) infections and 0.35 per 100 admissions, respectively (**Figure 2**).

GACH

In GACHs, the majority of healthcare-onset CRE reported was *Klebsiella* (64.9%), followed by *Enterobacter* (22.4%) and *E. coli* (12.7%) (**Table 1**). *Klebsiella* (75.6%) was also the most commonly reported community onset CRE followed by *E. coli* (13.5%) and *Enterobacter* (10.9%).

Table 1.
CRE Organism Type by Healthcare or Community Onset, GACH
LAC, 2017 (N=1280)

	HO		CO		
Organism Type	No.	%	No.	%	**TOTAL**
E. coli	63	12.7	106	13.5	169
Enterobacter	112	22.4	85	10.9	197
Klebsiella	323	64.9	591	75.6	914
TOTAL	**498**	**38.9**	**782**	**61.1**	**1280**

Across the three CRE organisms that were assessed, the most common type of CRE infections reported from GACH were CO genitourinary tract infections, followed by HO respiratory infections (**Table 2**).

Table 2.
CRE Organism by Specimen Source by Healthcare or Community Onset, GACH
LAC, 2017 (N=1280)

	E. coli				Enterobacter				Klebsiella			
	HO		CO		HO		CO		HO		CO	
Specimen Source	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Cardiovascular	7	11.1	10	9.4	6	5.4	3	3.5	38	11.8	43	7.3
Digestive System	7	11.1	1	0.9	6	5.4	3	3.5	7	2.2	25	4.2
Ear, Eye, Nose, Throat	0	0	0	0	0	0	0	0	0	0.0	2	0.3
Genitourinary	14	22.2	69	65.1	14	12.5	44	51.8	73	22.6	312	52.8
Musculoskeletal	0	0.0	0	0.0	0	0.0	2	2.4	1	0.3	0	0.0
Reproductive Male	0	0.0	0	0.0	0	0.0	0	0.0	1	0.3	0	0.0
Respiratory	16	25.4	7	6.6	65	58.0	10	11.8	120	37.2	70	11.8
Skin/Soft tissue	11	17.5	11	10.4	14	12.5	17	20.0	67	20.7	122	20.6
Unspecified	8	12.7	8	7.6	7	6.3	6	7.1	16	5.0	17	2.9
TOTAL	**63**	**4.9**	**106**	**8.3**	**112**	**8.8**	**85**	**6.6**	**323**	**25.2**	**591**	**46.2**

The mean age of CRE HO and CO infections reported from GACH were 63.5 and 67.4 years respectively. Although data on race and ethnicity was collected, much of this data was missing (**Table 3**).

Table 3.
CRE Infections Demographic Data by Healthcare or Community Onset, GACH LAC, 2017 (N=1280)

	HO		CO	
Demographics	No.	%	No.	%
Gender				
Female	187	37.6	371	47.4
Male	311	62.4	411	52.6
Ethnicity* (N=176)				
Hispanic	19	29.2	33	29.7
Non-Hispanic	46	70.8	78	70.3
Mean Age (Median, Range)	63.5	(65, 0–97)	67.4	(70, 0–102)

* Missing 1104; not a required field.

Information on fatalities related to CRE infections was requested; however, a large proportion of these data were missing. Of the 283 CRE events where death data was completed, 38 reported a fatal outcome.

LTACH

In LTACHs, the majority of HO CRE reported was *Klebsiella* (93%), followed by *E. Coli* (4.5%) and *Enterobacter* (2.5%) (**Table 4**). *Klebsiella* (86.2%) was also the most commonly reported CO CRE followed by *Enterobacter* (7.6%) and *E. Coli* (6.3%).

Table 4.
CRE Organism Type by Healthcare or Community Onset, LATCH LAC, 2017 (N=517)

	HO		CO		
Organism Type	No.	%	No.	%	**TOTAL**
E. coli	16	4.5	10	6.3	26
Enterobacter	9	2.5	12	7.6	21
Klebsiella	333	93.0	137	86.2	470
TOTAL	**358**	**69.2**	**159**	**30.8**	**517**

The most common type of CO CRE infections across all three organisms and HO *E. Coli* reported from LTACHs were identified from urine specimens. HO *Enterobacter* and *Klebsiella* were most commonly reported from respiratory sources (**Table 5**).

Table 5.
CRE Specimen Source by Organism by Healthcare or Community Onset, LTACH
LAC, 2017 (N=517)

	E. coli				Enterobacter				Klebsiella			
	HO		CO		HO		CO		HO		CO	
Specimen Source	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Cardiovascular	0	0.0	0	0.0	2	22.2	1	8.3	28	8.4	1	0.7
Digestive System	0	0.0	0	0.0	0	0.0	2	16.7	5	1.5	39	28.5
Genitourinary	9	56.3	9	90.0	0	0.0	6	50.0	117	35.1	62	45.3
Respiratory	3	18.8	1	10.0	6	66.7	2	16.7	141	42.3	24	17.5
Skin/Soft tissue	4	25.0	0	0.0	1	11.1	0	0.0	38	11.4	9	6.6
Unspecified	0	0.0	0	0.0	0	0.0	1	8.3	4	1.2	2	1.5
TOTAL	**16**	**3.1**	**10**	**1.9**	**9**	**1.7**	**12**	**2.3**	**333**	**64.4**	**137**	**26.5**

The mean age of CRE HO and CO infections reported from LTACHs were 69.9 and 66.8 years respectively. Although data on race and ethnicity was collected, because this was not a required field, much of this data was missing and could not be analyzed and reported (**Table 6**).

Table 6.
CRE Infections Demographic Data by Healthcare or Community Onset, LTACH
LAC, 2017 (N=517)

	HO		CO	
Demographics	No.	%	No.	%
Gender				
Female	185	51.7	78	49.0
Male	173	48.3	81	51
Mean Age (Median, Range)	69.9	(72, 0–100)	66.8	(71, 0–96)

Information on fatalities at LTACH hospitals related to CRE infections, like the GACH, was requested, however a large proportion of these data were missing. Of the 59 CRE events where death data was completed, 15 reported a fatal outcome.

SNFs

A total of 56 CRE events were reported by 33 SNFs in 2017. No deaths were reported.

Table 7.
CRE Organism Type, SNF
LAC, 2017 (N=56)

	No.	%
E. coli	9	16.1
Enterobacter	7	12.5
Klebsiella	40	71.4
TOTAL	**56**	

The mean age of SNF CRE infections was 68.8 years, which was similar to both GACHs and LTACHs. CRE in females was more commonly reported from SNFs.

Table 8.
CRE Infections Demographic Data, SNF
LAC, 2017 (N=56)

Demographics	No.	%
Gender (N=56)		
Female	30	53.6
Male	26	46.4
Ethnicity* (N=32)		
Hispanic	14	43.8
Non-Hispanic	18	56.2
Race* (N=50)		
African American	8	16.0
Asian	11	22.0
White	31	62.0
Mean Age (Median, Range)	68.8	(69, 24–94)

* Missing data

The most common specimen source reported in *Klebsiella* and *E. Coli* infections was urine. Sputum was the most common specimen source for *Enterobacter* infections.

Table 9.
CRE Specimen Source by Organism, SNF
LAC, 2017 (N=56)

	E. coli		Enterobacter		Klebsiella	
Specimen Source[1]	No.	%	No.	%	No.	%
Blood	0	0.0	1	14.3	1	2.5
Sputum	1	11.1	5	71.4	7	17.5
Wound	3	33.3	0	0.0	0	0
Urine	5	55.6	0	0.0	24	60
Rectal	0	0.0	0	0.0	3	7.5
Other[2]	0	0.0	0	0.0	3	7.5
No Source	0	0.0	1	14.3	3	7.5
TOTAL[3]	**9**	**16.1**	**7**	**12.5**	**40**	**71.4**

1. Multiple specimen source listed for some cases.
2. Tracheal and gastrostomy tube.
3. No organism specified for 3 cases.

The majority of CRE events reported by SNFs list the patient was admitted from a GACH (60.7%).

Table 10.
Admissions from Facility Type, SNFs
LAC, 2017 (N=56)

	Admissions	
Facility Type	No.	%
Hospital	34	60.7
LTACH	5	8.9
SNF	2	3.6
Home	0	0
Missing	15	26.8
TOTAL	**56**	

Data Analysis

For GACHs and LTACHs, 19 hospitals were found to have reporting issues in the CRE Group including not joining or conferring rights, incorrect reporting plans, or a lag in data entry. Communication addressing the specific issue identified for each hospital was generated and sent via email to the hospital infection preventionist by the respective LAC DPH liaison public health nurse and an epidemiologist. If additional troubleshooting or technical assistance was required, the assigned epidemiologist would follow-up with the infection preventionist. By May 2018, all 19 with reporting issues had corrected the problems. In addition, 2018 reporting plans were checked to ensure the corrections had carried over to the new year.

Forty duplicates were identified within NHSN data. Efforts were made to reach out to NHSN to troubleshoot how this occurred and make appropriate corrections to avoid future duplicate event entry.

SNF data was merged with the GACH and LTACH data to check for duplicate reporting. Multiple errors were identified including CRE reported by a SNF that should have or had already been reported by the ordering acute care hospital, incorrect date of current admission to the SNF, reporting a history of CRE (no current lab), and reporting on different organisms (i.e. *Pseudomonas*) not covered by the HOO. Analysis of SNF reports resulted in identification of two CRE reports that should have been reported by the acute care hospital but were missed. Five cases had already been reported in NHSN by the acute care hospital. These errors were communicated to the appropriate facilities.

Antibiogram

All 92 acute care hospitals (including LTACHs) in LAC submitted antibiograms during the first year of the HOO. With this information, the first LAC regional antibiogram[6] was completed, published, and distributed in January 2018 and is posted on the ACDC website. Data entry and analysis is currently underway for 2017 data.

DISCUSSION

Overall the first year of CRE reporting in LAC generated valuable data and identified high rates of CRE in healthcare facilities, especially among LTACHs. This information will help guide targeted prevention efforts moving forward. Reporting errors were identified from GACHs, LTACHs, and SNFs and efforts have been made to correct discrepancies both retrospectively and going forward.

LIMITATIONS

All the custom variables that LAC DPH requested in NHSN reporting plans exhibited low response rates resulting in missing data. We plan to address these reporting gaps by identifying facilities that did not complete the custom variable fields and reaching out to them to notify them and provide additional assistance as needed.

There was no NHSN data validation done to ensure that hospitals are reporting CRE accurately and thoroughly. Historically, the California Department of Public Health has performed hospital data entry validation for other diseases, however this verification has not been conducted as CRE is not reportable at the state level. Currently, data validation in SNFs is not feasible as there are over 300 SNFs in LAC.

REFERENCES

1. Centers for Disease Control and Prevention (CDC). Healthcare-associated Infections: FAQs about Choosing and Implementing a CRE Definition. https://www.cdc.gov/hai/organisms/cre/definition.html Accessed August 2018.
2. Marquez P, Terashita D, Dassey D, Mascola L. Population-based incidence of carbapenem-resistant Klebsiella pneumoniae along the continuum of care, Los Angeles County. Infect Control Hosp Epidemiol. 2013;34(2):144–150. http://publichealth.lacounty.gov/acd/docs/CRKP_ICHE.pdf

[6] http://publichealth.lacounty.gov/acd/AntibiogramData.htm