Emerging Infections Program
Healthcare-Associated Infections

Community Interface Report
Invasive *Staphylococcus aureus*, 2018

Last Updated: September 5, 2024

Erratum: The rates among people on dialysis were corrected. The previous version of this report used an incorrect denominator for calculating these rates.

Emerging Infections Program (EIP) Surveillance Catchment Areas

Methicillin-resistant *Staphylococcus aureus* (MRSA): California (3 county San Francisco Bay area); Connecticut; Georgia (8 county Atlanta area); Maryland (Baltimore City and County); Minnesota (2 county Minneapolis–Saint Paul area); New York (1 Rochester county); Tennessee (1 Nashville county).

Methicillin-sensitive *Staphylococcus aureus* (MSSA): California (3 county San Francisco Bay area); Connecticut (New Haven County); Georgia (1 Atlanta county); Maryland (Baltimore City and County); Minnesota (2 county Minneapolis–Saint Paul area); New York (1 Rochester county); Tennessee (1 Nashville county).

Population

The MRSA surveillance areas represent 16,074,962 persons. The MSSA surveillance areas represent 10,283,632 persons.

Source: National Center for Health Statistics bridged-race vintage 2018 postcensal file.

Case Definition

Invasive *Staphylococcus aureus* (SA) infection: isolation of SA from a normally sterile site in a resident of the surveillance area in 2018. Cases of infection are classified into one of three epidemiologic classifications.

A case is classified as

- hospital-onset (HO) if the SA culture was obtained on or after the third calendar day of hospitalization, where admission is hospital day 0[a];
- healthcare-associated community-onset (HACO) if the culture was obtained in an outpatient setting or before the third[1] calendar day of hospitalization and had one or more of the following:
    1. a history of hospitalization, surgery, dialysis, or residence in a long-term care facility in the previous year, or
    2. the presence of a central vascular catheter (CVC) within 2 days prior to SA culture;
- community-associated (CA) if none of the previously mentioned criteria are met.

Cases were classified as MRSA or MSSA based on results from local clinical microbiology laboratory testing.

[a] This case definition represents an update in nomenclature from previous years, but not a change to the case definition

Methods

Case finding was active, laboratory-based and population-based. EIP personnel routinely contacted microbiology laboratories serving healthcare facilities in their area to identify cases. Laboratories serving the surveillance catchment areas were routinely audited to ensure complete case ascertainment.

A standardized case report form was completed for each incident case through review of medical records. Medical records were reviewed for information on demographic characteristics, clinical syndrome, and outcome of illness.

Convenience samples of MRSA isolates were collected and sent to CDC for routine testing, including antimicrobial susceptibility testing using reference broth microdilution, detection of toxin genes, *SCCmec* typing, and *spa* typing. Pulsed-field gel electrophoresis (PFGE) of all isolates was discontinued in 2008; up until 2012, PFGE was inferred based on a validated algorithm[1]. Starting in 2012, *spa* typing was added to routine laboratory testing. Through 2016, PFGE type was inferred based on *spa* type, inferred multilocus sequence typing (MLST) clonal complex, and molecular characteristics of the isolates[2]; isolates identified as USA300 were confirmed using an single-nucleotide polymorphism (SNP) assay[3]. Currently, whole genome sequencing and analysis is used to determine MLST clonal complexes, with PFGE types assigned based on phylogenetic relatedness and molecular characteristics of the isolates. In 2018, isolates were collected in five sites (California, Georgia, Minnesota, New York, and Tennessee).

In 2018, some sites collected limited data from most MRSA hospital-onset cases, with full case report forms data collected only for a random sample of 8–91% of hospital-onset cases. Data not collected because of sampling were estimated based on the distribution of collected data to calculate incidence. Detailed case data below only reflect data from full case report forms unless otherwise specified. Rates of invasive SA infection among all patients were calculated using population estimates for 2018. Cases with unknown race were assigned race based on the distribution of known age, race, and sex by EIP site.

Rates of invasive SA infection among patients who were undergoing chronic dialysis treatment were calculated using December 31, 2017, point prevalent counts of patients on dialysis from the United States Renal Data System (USRDS) (https://www.niddk.nih.gov/about-niddk/strategic-plans-reports/usrds). The figures depicting the overall invasive MRSA incidence by epidemiologic class and incidence of invasive HACO MRSA among persons on dialysis, 2009–2018 are restricted to the continuous catchment area (California [3 county San Francisco Bay area]; Connecticut; Georgia [8 county Atlanta area]; Minnesota [2 county Minneapolis–Saint Paul area]; New York [1 Rochester county]; and Tennessee [1 Nashville county]) for comparison of trends over time.

Invasive SA surveillance data undergo regular data cleaning to ensure accuracy and completeness. Patients with complete case report form data as of June 5, 2021, 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.

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[1] Use of an Inferred PFGE Algorithm, Emerging Infections Program/Active Bacterial Core (ABCs) Surveillance Invasive MRSA Project (https://archive.cdc.gov/#/details?url=https://www.cdc.gov/hai/settings/lab/inferred-pfge-algorithm.html)

[2] Inferred Identification of Pulsed Field Types based on MLST clonal complex (CC) (https://archive.cdc.gov/#/details?url=https://www.cdc.gov/hai/settings/lab/ccalgorithm.html)

[3] Improved Subtyping of *Staphylococcus aureus* Clonal Complex 8 Strains Based on Whole-Genome Phylogenetic Analysis [PDF - 15 pages] (https://msphere.asm.org/content/msph/3/3/e00464-17.full.pdf)

Results

Table 1. MSSA (N=3748) and MRSA (N=3391) Cases by Race, Emerging Infections Program, 2018

Race	MSSA No. (Rate[a])	MRSA No. (Rate[a])
White	2344 (36.7)	2073 (20.5)
Black	1024 (46.0)	1170 (30.3)
Other	380 (22.7)	148 (7.1)
TOTAL	3748 (36.5)	3319 (21.1)

Unknown race (n= 358 MSSA, n=372 MRSA) distributed amongst known

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

Table 2. MSSA (N=3748) and MRSA (N=3391) Case and Death Rate by Epidemiological Classification, Emerging Infections Program, 2018

Class	MSSA Cases No. (Rate[a])	MSSA Deaths No. (Rate[a])	MRSA Cases No. (Rate[a])	MRSA Deaths No. (Rate[a])
CA	1340 (13.0)	116 (1.1)	790 (4.9)	72 (0.5)
HCA[b]	2378 (23.2)	271 (2.7)	2575 (16.0)	361 (2.2)
HCA - HO[c]	458 (4.5)	78 (0.8)	486 (3.0)	81 (0.5)
HCA - HACO	1920 (18.7)	193 (1.9)	2089 (13.0)	280 (1.7)
Unknown	30 (0.3)	7 (0.03)	26 (0.2)	4 (0.02)

[a] Cases per 100,000 population for EIP areas (crude rates) calculated using 2018 U.S. Census Data

[b] HCA: Healthcare-associated invasive SA infection; sum of patients that are classified as either the HO or HACO classes

[c] HO MRSA rate imputed from a sample of cases.

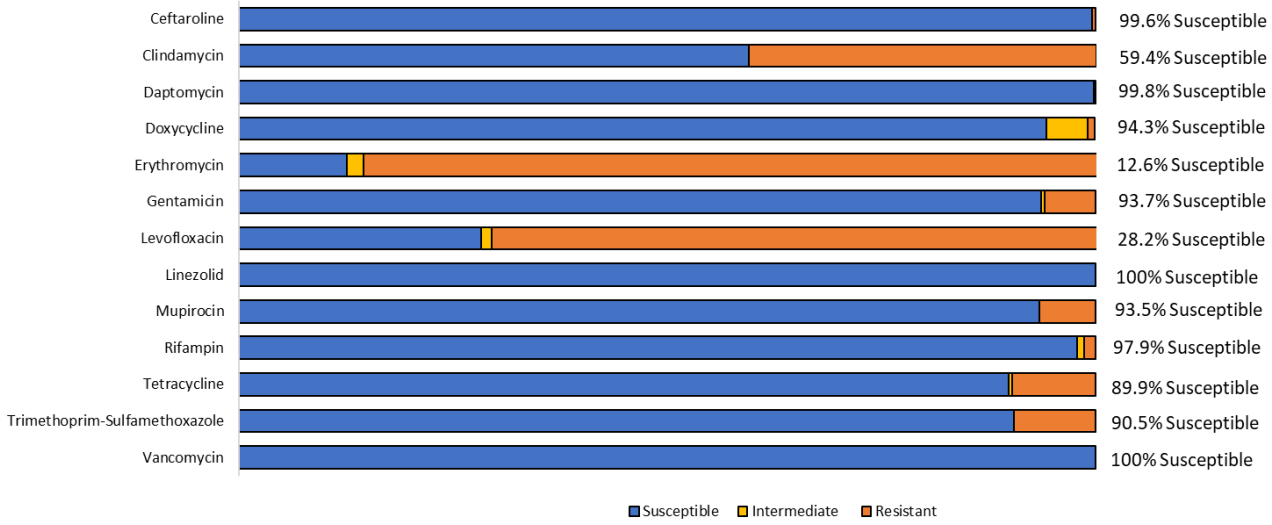
Table 3. MRSA Inferred PFGE Type by Epidemiological Classification, Isolates Tested at CDC, Emerging Infections Program, 2018

Class	Total	CC5 USA100 No. (%)	Other CC5 No. (%)	CC8 USA300 No. (%)	Other CC8 No. (%)	Other (not CC5 or CC8) No. (%)
CA	92	9 (9.8)	3 (3.3)	67 (72.8)	3 (3.3)	10 (10.9)
HCA[a]	379	110 (29.0)	20 (5.3)	175 (46.2)	42 (11.1)	32 (8.4)
HCA - HO	74	24 (32.4)	7 (9.5)	33 (44.6)	2 (2.7)	8 (10.8)
HCA - HACO	305	86 (28.2)	13 (4.3)	142 (46.6)	40 (13.1)	24 (7.9)
Total[b]	474	119 (25.1)	23 (4.9)	244 (51.5)	45 (9.5)	43 (9.1)

[a] HCA: Healthcare-associated invasive SA infection; sum of patients that are classified as either the HO or HACO classes

[b] Results for all isolates, including those with an unknown epidemiologic category (n=3), are included in the total.

Figure 1. MRSA Antimicrobial Susceptibility Testing Results by Agent[a,b,c,d] (N=476 Isolates Tested at CDC), Emerging Infections Program, 2018



[a] High level mupirocin resistance depicted in the figure as resistant; non-high level mupirocin resistance shown as susceptible.

[b] Ceftaroline Susceptible Dose Dependent is reported as resistant

[c] Daptomycin non-susceptible isolates are depicted in the figure as resistant

[d] Isolates with inducible resistance to clindamycin are considered resistant

Table 4. MSSA (N=3748) and MRSA (N=3391) Cases by Race/Ethnicity, Emerging Infections Program, 2018

Race/Ethnicity	MSSA No. (%)	MRSA No. (%)
Hispanic, any race	295 (7.9)	180 (5.3)
Not known to be Hispanic[a] - White[b]	2021 (53.9)	1701 (50.2)
Not known to be Hispanic[a] - Black or African American[c]	908 (24.2)	977 (28.8)
Not known to be Hispanic[a] - Asian[d]	236 (6.3)	92 (2.7)
Not known to be Hispanic[a] - Other or multiple races[e]	92 (2.5)	32 (0.9)
Not known to be Hispanic[a] - Unknown race, non-Hispanic	75 (2.0)	185 (5.5)
Unknown race and ethnicity	121 (3.2)	224 (6.6)

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

[b] 254 MSSA cases and 159 MRSA cases with unknown ethnicity

[c] 107 MSSA cases and 90 MRSA cases with unknown ethnicity

[d] 56 MSSA cases and 16 MRSA cases with unknown ethnicity

[e] American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander, or ≥2 races reported; 17 MSSA cases and 4 MRSA cases with unknown ethnicity

Figure 2. Incidence[a,b] of Invasive *Staphylococcus aureus*, by Epidemiologic Class, Pediatric Age Groups, and Methicillin-Resistance Status, Emerging Infections Program, 2018

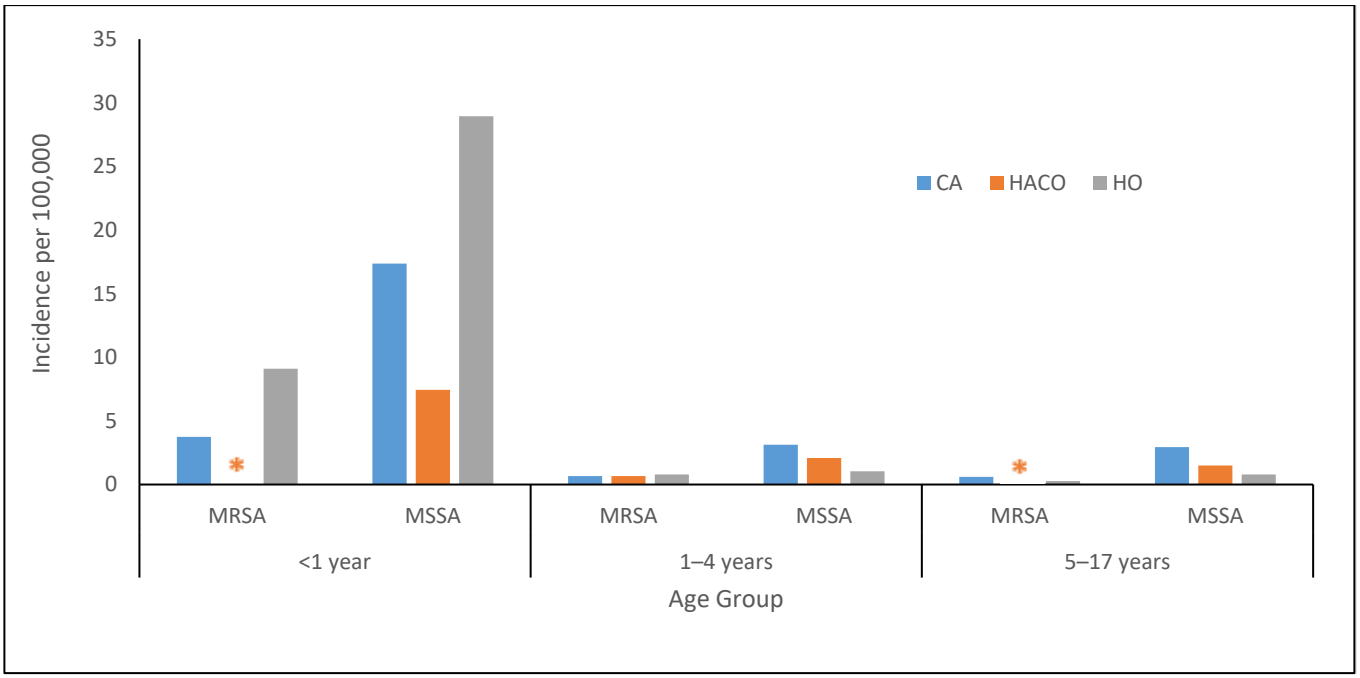
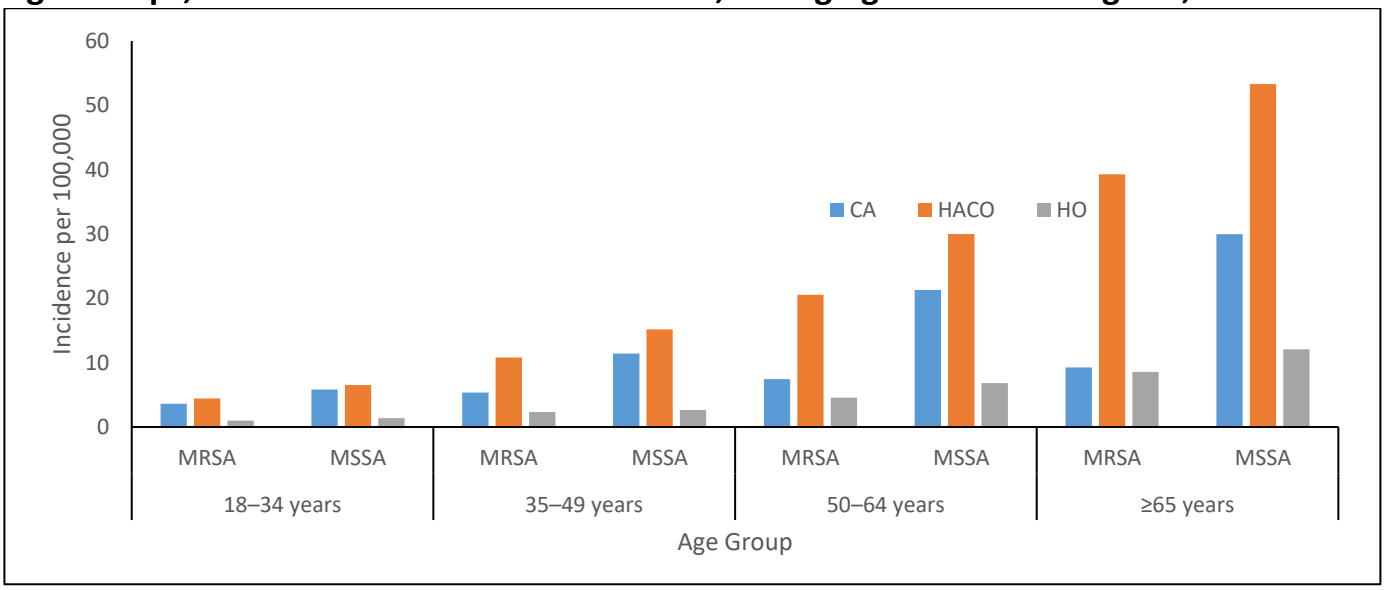


Figure 3. Incidence[a] of Invasive *Staphylococcus aureus*, by Epidemiologic Class, Adult Age Groups, and Methicillin-Resistance Status, Emerging Infections Program, 2018



[a] Incidence (no. per 100,000 population per year) calculated using 2018 U.S. Census Data
[b] An asterisk represents a case count of <5; rates for these groups have been suppressed

Table 5. Location of Invasive MSSA (N=3748) and MRSA (N=3196[a]) Cases Before Incident Specimen Collection, Emerging Infections Program, 2018

Location of patient before incident specimen collection[b]	MSSA No. (%)	MRSA[a] No. (%)
Private residence	2822 (75.3)	2139 (66.9)
Long-term care facility	232 (6.2)	514 (16.1)
Acute-care hospital (inpatient)	488 (13.0)	323 (10.1)
Long-term acute care hospital	0 (0.0)	18 (0.6)
Homeless	167 (4.5)	172 (5.4)
Incarcerated	11 (0.3)	14 (0.4)
Other	0 (0.0)	0 (0.0)
Unknown	28 (0.7)	16 (0.5)

[a] Represents a subset of HO MRSA cases due to sampling

[b] Represents location of the patient three days before incident specimen collection, where initial culture is day 0

Location of Invasive MSSA (N=3748) and MRSA (N=3196[a]) Cases at Time of Incident Specimen Collection, Emerging Infections Program, 2018

Location of incident specimen collection	MSSA No. (%)	MRSA[a] No. (%)
Outpatient setting or emergency department	2659 (70.9)	2417 (75.6)
Acute care hospital	1030 (27.5)	706 (22.1)
Long-term care facility	12 (0.3)	40 (1.3)
Long-term acute care hospital	0 (0.0)	14 (0.4)
Other	29 (0.8)	7 (0.2)
Unknown	18 (0.5)	12 (0.4)

[a] Represents a subset of HO MRSA cases due to sampling

Table 6. Selected Clinical Characteristics of Invasive MSSA (N=3718[a]) and MRSA (N=3170[a,b]) Cases by Epidemiological Class, Emerging Infections Program, 2018

Characteristics	CA MSSA (n=1340) No. (%)	CA MRSA (n=790) No. (%)	HACO MSSA (n=1920) No. (%)	HACO MRSA (n=2089) No. (%)	HO MSSA (n=458) No. (%)	HO MRSA[b] (n=291) No. (%)
Underlying conditions[c] - Abscess/boil (recurrent)	10 (0.7)	16 (2.0)	19 (1.0)	28 (1.3)	0 (0.0)	2 (0.7)
Underlying conditions[c] - Chronic pulmonary disease	212 (15.9)	143 (18.1)	369 (19.3)	545 (26.2)	97 (21.2)	99 (34.3)
Underlying conditions[c] - Chronic kidney disease	155 (11.6)	84 (10.6)	732 (38.3)	832 (40.0)	114 (24.9)	81 (28.0)
Underlying conditions[c] - Chronic skin breakdown	208 (15.6)	107 (13.6)	275 (14.4)	412 (19.8)	40 (8.7)	33 (11.4)
Underlying conditions[c] - Decubitus/pressure ulcer	44 (3.3)	30 (3.8)	98 (5.1)	270 (13.0)	10 (2.2)	17 (5.9)
Underlying conditions[c] - Diabetes mellitus	385 (28.9)	234 (29.7)	758 (39.6)	984 (47.3)	132 (28.8)	109 (37.7)
Underlying conditions[c] - Hemiplegia/paraplegia	23 (1.7)	15 (1.9)	46 (2.4)	111 (5.3)	9 (2.0)	5 (1.7)
Underlying conditions[c] - Intravenous drug use	179 (13.4)	211 (26.7)	179 (9.4)	248 (11.9)	18 (3.9)	30 (10.4)
Underlying conditions[c] - Obesity or morbid obesity	185 (13.9)	92 (11.7)	327 (17.1)	300 (14.4)	69 (15.1)	47 (16.3)
Underlying conditions[c] - Pregnancy	6 (<0.01)	4 (<0.01)	1 (<0.01)	3 (<0.01)	0 (0.0)	0 (0.0)
Syndrome[d] - Bloodstream infection[e] with other syndrome	738 (55.1)	527 (66.7)	1007 (52.4)	1265 (60.6)	169 (36.9)	120 (41.2)
Syndrome[d] - Bloodstream infection with other syndrome	312 (23.3)	146 (18.5)	642 (33.4)	626 (30.0)	185 (40.4)	96 (33.0)

Characteristics	CA MSSA (n=1340) No. (%)	CA MRSA (n=790) No. (%)	HACO MSSA (n=1920) No. (%)	HACO MRSA (n=2089) No. (%)	HO MSSA (n=458) No. (%)	HO MRSA[b] (n=291) No. (%)
Syndrome[d] - Pneumonia	136 (10.2)	132 (16.7)	219 (11.4)	270 (12.9)	77 (16.8)	50 (17.2)
Syndrome[d] - Osteomyelitis	187 (14.0)	99 (12.5)	216 (11.3)	301 (14.4)	39 (8.5)	31 (10.7)
Syndrome[d] - Endocarditis	114 (8.5)	117 (14.8)	158 (8.2)	225 (10.8)	11 (2.4)	21 (7.2)
Syndrome[d] - Cellulitis	230 (17.2)	168 (21.3)	181 (9.4)	222 (10.6)	36 (7.9)	25 (8.6)
Syndrome[d] - Surgical wound[f]	11 (0.8)	8 (1.0)	112 (5.8)	97 (4.6)	25 (5.5)	12 (4.1)
Syndrome[d] - Decubitus/pressure ulcer	17 (1.3)	5 (0.6)	34 (1.8)	68 (3.3)	5 (1.1)	2 (0.7)
Syndrome[d] - Skin abscess[g]	76 (5.7)	54 (6.8)	78 (4.1)	83 (4.0)	18 (3.9)	10 (3.4)
Syndrome[d] - Other wound[h]	59 (4.4)	18 (2.3)	95 (4.9)	102 (4.9)	12 (2.6)	7 (2.4)
Syndrome[d] - Traumatic wound	13 (1.0)	8 (1.0)	11 (0.6)	7 (0.3)	3 (0.7)	3 (1.0)

[a] Excludes 30 MSSA and 26 MRSA cases with unknown epidemiological class

[b] Represents a subset of HO MRSA cases due to sampling

[c] Some case patients had more than one underlying condition. Excludes 6 CA MSSA, 1 CA MRSA, 7 HACO MSSA, 7 HACO MRSA, 0 HO MSSA, and 2 HO MRSA cases with unknown underlying conditions; Pregnancy status was unknown for 147 CA MSSA, 158 CA MRSA, 169 HACO MSSA, 355 HACO MRSA, 45 HO MSSA, and 70 HO MRSA cases

[d] Some case patients had more than one syndrome

[e] Catheter site infection or AV fistula infection only are included in BSI with other syndrome

[f] Combines deep tissue/organ infection and infection of a surgical wound, post-operatively

[g] Category includes skin abscess, necrotizing fasciitis, gangrene

[h] Category includes non-traumatic and other chronic wound infections

Table 7. Selected Healthcare Exposures or Risk Factors for Invasive MSSA (N=3748) and MRSA (N=3196[a]), Emerging Infections Program, 2018

Exposures	MSSA No. (%)	MRSA[a] No. (%)
Healthcare facility stay in the year before incident specimen collection - Any	1879 (50.1)	2114 (66.1)
Healthcare facility stay in the year before incident specimen collection - Acute care hospitalization	1791 (47.8)	1974 (61.8)
Healthcare facility stay in the year before incident specimen collection - Long-term care facility residence	400 (10.7)	791 (24.7)
Healthcare facility stay in the year before incident specimen collection - Long-term acute care hospitalization	12 (0.3)	35 (1.1)
Surgery in the year before the date of incident specimen collection	701 (18.7)	861 (26.9)
Chronic dialysis - Any Modality	506 (13.5)	521 (16.3)
Chronic dialysis – Modality - Peritoneal	31 (6.1)	15 (2.9)
Chronic dialysis – Modality - Hemodialysis	472 (93.3)	506 (97.1)
Chronic dialysis – Hemodialysis vascular access type - AV Fistula/Graft[b]	240 (50.9)	237 (46.8)
Chronic dialysis – Hemodialysis vascular access type - CVC[b]	229 (48.5)	253 (50.0)
Chronic dialysis – Hemodialysis vascular access type - Unknown	8 (1.7)	16 (3.2)
Chronic dialysis – Modality - Unknown	3 (0.6)	0 (0.0)
Central vascular catheter in place at any time in the 2 calendar days incident specimen collection	453 (12.1)	469 (14.7)
Unknown	32 (0.9)	28 (0.9)

[a] Represents a subset of HO MRSA cases due to sampling

[b] 5 MSSA cases had both AV Fistula/Graft and CVC

Table 8. Number and Incidence Rates of Invasive MRSA and MSSA Infections by Dialysis Status and Epidemiologic Class, Emerging Infections Program, 2018

Epidemiologic Class	MSSA Dialysis Patients No. (Rate[a])	MRSA Dialysis Patients No. (Rate[a])	MSSA Non-Dialysis Patients No. (Rate[b])	MRSA Non-Dialysis Patients No. (Rate[b])	MSSA Total No. (Rate[b])	MRSA Total No. (Rate[b])
CA	NA	NA	1340 (13.1)	790 (4.9)	1340 (13.0)	790 (4.9)
HCA[c]	506 (2762.6)	541 (1936.7)	1872 (18.2)	2034 (12.7)	2378 (23.1)	2575 (16.0)
HCA- HO[d]	40 (218.4)	57 (204.1)	418 (4.1)	429 (2.7)	458 (4.5)	486 (3.0)
HCA - HACO	466 (2544.2)	484 (1732.7)	1454 (14.2)	1605 (10.0)	1920 (18.7)	2089 (13.0)
Overall[e]	506 (2762.6)	541 (1936.7)	3242 (31.6)	2850 (17.8)	3748 (36.4)	3391 (21.1)

[a] Incidence (no. per 100,000 population per year) for dialysis patients calculated using 2017 USRDS point prevalence data

[b] Incidence (no. per 100,000 population per year) calculated using 2018 U.S. Census Data

[c] HCA: Healthcare-associated invasive MRSA infection; sum of patients that are classified as either the HO or HACO classes

[d] Dialysis and non-dialysis estimated number and incidence based on data from a sample of HO MRSA cases

[e] The overall counts and rates include 30 MSSA and 26 MRSA cases with unknown epidemiological class

Figure 4. Incidence of Invasive MRSA by Epidemiologic Class, Emerging Infections Program, 2009–2018[a]

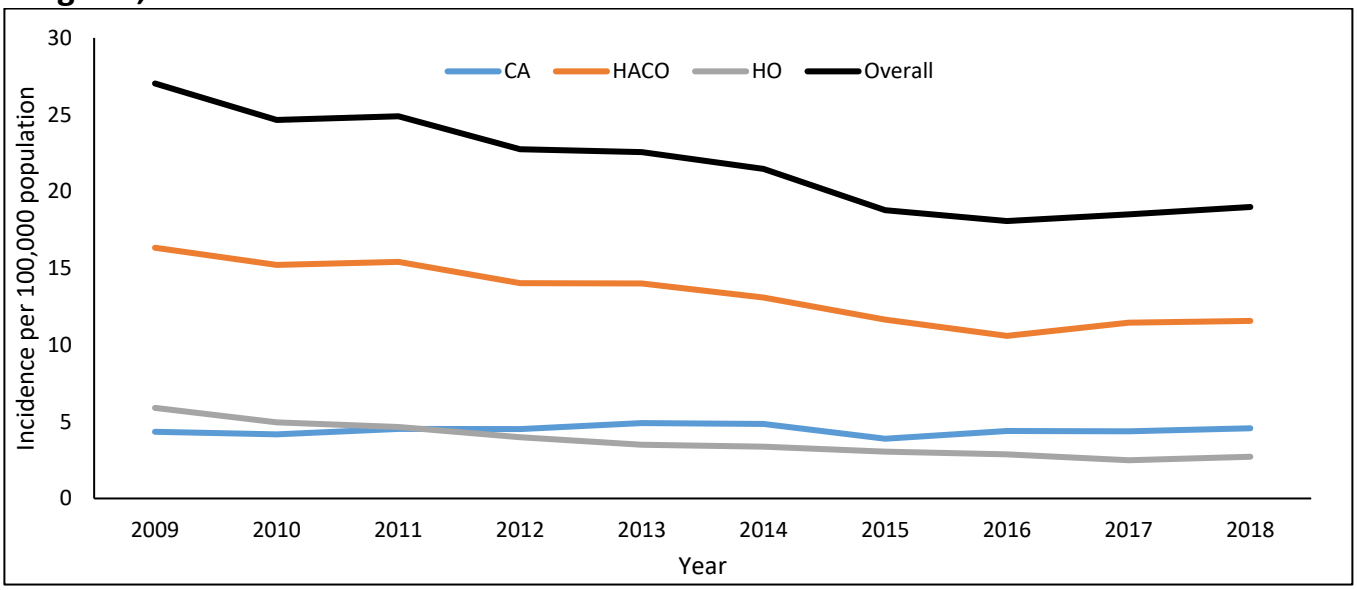
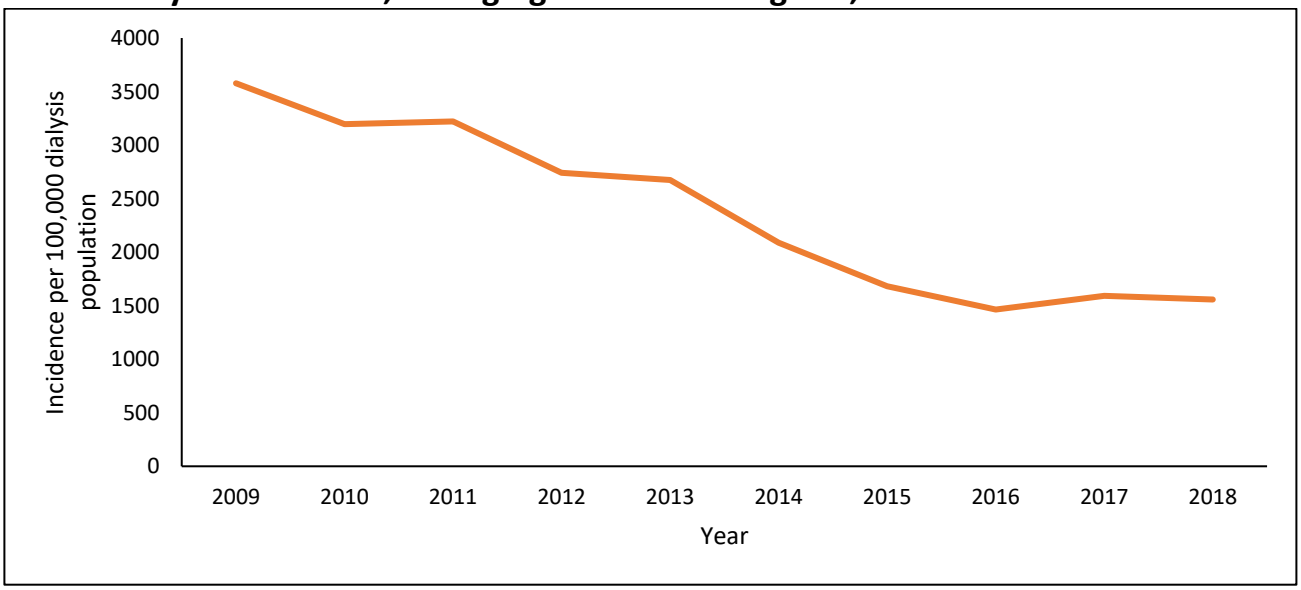


Figure 5. Incidence of Invasive MRSA among Persons on Dialysis, Healthcare-Associated Community-Onset Cases, Emerging Infections Program, 2009–2018[a]



[a] Restricted to the continuous catchment area (California [3 county San Francisco Bay area]; Connecticut; Georgia [8 county Atlanta area]; Minnesota [2 county Minneapolis -Saint Paul counties]; New York [1 Rochester county]; and Tennessee [1 Nashville county]) for comparison of trends over time.

Table 9. Outcomes of Invasive MSSA (N=3748[a]) and MRSA (N=3196[a,b]) Cases by Epidemiologic Class, Emerging Infections Program, 2018

Outcomes	CA MSSA (n=1340) No. (%)	CA MRSA (n=790) No. (%)	HACO MSSA (n=1920) No. (%)	HACO MRSA (n=2089) No. (%)	HO MSSA (n=458) No. (%)	HO MRSA[b] (n=291) No. (%)
Died	116 (8.6)	72 (9.1)	193 (10.1)	280 (13.4)	78 (17.0)	56 (19.2)
Survived - All	1223 (91.3)	717 (90.8)	1719 (89.5)	1804 (86.4)	379 (82.8)	235 (80.8)
Survived - discharged to long-term care facility after acute-care hospitalization	354 (28.9)	216 (30.1)	602 (35.0)	818 (45.3)	148 (39.1)	108 (46.0)
Survived - discharged to long-term acute care hospital after acute-care hospitalization	15 (1.2)	10 (1.4)	31 (1.8)	53 (2.9)	17 (4.5)	12 (5.1)
Survived – discharged to other[c] type of facility after acute-care hospitalization	847 (69.2)	491 (68.5)	1084 (63.1)	929 (51.5)	214 (56.5)	115 (48.9)
Survived - discharged to unknown type of facility after acute-care hospitalization	7 (0.6)	0 (0.0)	2 (0.1)	4 (0.2)	0 (0.0)	0 (0.0)
Unknown	1 (0.1)	1 (0.1)	8 (0.4)	5 (0.2)	1 (0.2)	0 (0.0)

[a] Excludes 30 MSSA and 26 MRSA cases with unknown epidemiological class

[b] Represents a subset of HO MRSA cases due to sampling

[c] Examples include private residence, correctional facility, homeless shelter, and drug rehabilitation program

Summary

Surveillance data from 2018 represent the fourteenth full year of population-based surveillance for invasive MRSA infections through the Emerging Infections Program, and the third for MSSA. Incidence of invasive HO and HACO MRSA has decreased since 2009, but has increased for CA, HO, and HACO MRSA since 2017. The rate of HACO MRSA among persons on dialysis has increased since 2016. MSSA incidence was greater in 2018 than in 2017 for every epidemiologic class. Incidence of invasive MRSA and MSSA continued to be highest among persons with Black race compared to White or Other races. Since 2017, USA300 continued to be the most common strain type among isolates tested for every epidemiologic classification, and in 2018, USA300 comprised the majority of isolates received.

Citation

1. Centers for Disease Control and Prevention. 2021. Emerging Infections Program, Healthcare-Associated Infections – Community Interface Surveillance Report, Invasive *Staphylococcus aureus*, 2018. Available at: https://www.cdc.gov/healthcare-associated-infections/media/pdfs/2018-MRSA-Report-508.pdf

For more information, visit our web sites:

- Invasive *Staphylococcus aureus* (MRSA/MSSA) Infection Tracking (https://www.cdc.gov/healthcare-associated-infections/php/haic-eip/invasive-staphylococcus.html)
  Methicillin-resistant *Staphylococcus aureus* (MRSA) (http://www.cdc.gov/mrsa/about/index.html)