



Annual Surveillance Summary: Methicillin-resistant *Staphylococcus aureus* (MRSA) Infections in the Military Health System (MHS), 2017

NMCPHC-EDC-TR-369-2018

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14. ABSTRACT The EpiData Center conducts routine surveillance of methicillin-resistant Staphylococcus aureus (MRSA) incidence and prevalence among all beneficiaries seeking care within the Military Health System (MHS). This report describes demographics, clinical characteristics, prescription practices, and antibiotic resistance patterns observed for MRSA infections in calendar year 2017. Overall, incidence rates in the MHS beneficiary and DOD AD populations are decreasing. Inducible clindamycin resistance is slowly increasing in the MHS; no additional changes in antibiotic susceptibility emerged in 2017. Clindamycin should be used cautiously in the inpatient setting due to reduced susceptibility (less than 85%).					
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Abstract

The EpiData Center (EDC) conducts routine surveillance of methicillin-resistant *Staphylococcus aureus* (MRSA) incidence and prevalence among all beneficiaries seeking care within the Military Health System (MHS). This report describes demographics, clinical characteristics, prescription practices, and antibiotic resistance patterns observed for MRSA infections in calendar year (CY) 2017.

Multiple data sources were linked to assess descriptive and clinical factors related to MRSA. Health Level 7 (HL7)-formatted Composite Health Care System (CHCS) microbiology data identified *S. aureus* infections resistant to oxacillin, cefoxitin, or methicillin. These infections were matched to HL7-formatted CHCS pharmacy data to assess prescription practices, the Standard Inpatient Data Record (SIDR) to determine healthcare-associated exposures, and the Defense Manpower Data Center (DMDC) rosters to determine burden among Department of Defense (DOD) active duty (AD) service members.

Overall, incidence rates (IRs) of MRSA in the MHS beneficiary and DOD AD populations are decreasing. Inducible clindamycin resistance (ICR) is slowly increasing in the MHS, with a 3.7% increase from the weighted historic ICR; no additional changes in antibiotic susceptibility emerged in 2017. Clindamycin, trimethoprim/sulfamethoxazole, doxycycline, and vancomycin remain viable treatments for MRSA, although clindamycin should be used cautiously in the inpatient setting due to reduced susceptibility (less than 85%). Current infection control practices appear effective, and continued surveillance is recommended.



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Background, Methods, and Limitations

The EpiData Center (EDC) at the Navy and Marine Corps Public Health Center (NMCPHC) prepares a retrospective report each calendar year (CY) that summarizes the demographics, clinical characteristics, prescription practices, and antibiotic susceptibility patterns for methicillin-resistant *Staphylococcus aureus* (MRSA) infections among Military Health System (MHS) beneficiaries. This report presents analytical results and discussion of CY 2017 data for MRSA infections in the MHS.

The background, methods, and limitations relevant to this analysis have been discussed in previous reports (CY 2015 and 2016 annual reports for MRSA^{1,2}). The CY 2017 report does not include an analysis of burden associated with deployment-related infections using Contingency Tracking System (CTS) data; all other methods and limitations are the same as in recent years. Recent literature reviews did not present any relevant developments in MRSA research since CY 2016 analyses.

The EDC also monitors other multidrug-resistant organisms (MDROs) of interest in the MHS.^{3,4}



Results

Section A – Descriptive Epidemiology

Incidence of MRSA

In 2017, the annual incidence rate (IR) for MRSA infections among MHS beneficiaries treated at a military treatment facility (MTF) was 47.7 per 100,000 persons per year. This reflects a 19.9% change below the weighted historic IR. Incidence rates across all services and the Department of Defense (DOD) active duty (AD) population in 2017 were also below the weighted historic IRs. A change greater than 20% below the weighted historic IRs occurred in the Air Force and Navy populations. The 2017 IRs are more than two standard deviations below the weighted historic IRs of MRSA in the MHS, service-specific, and the DOD AD populations, reflecting notably lower incidence rates of MRSA in 2017 (Table 1).

Table 1. Incidence Rate (IR) for MRSA Infections in the MHS, CY 2017

Population	2017 IR	Weighted Historic ^a IR 2014 - 2016	Two Standard Deviations: Weighted Historic ^a IR	2017	
				Direction	Percent Change ^b
MHS Beneficiaries	47.7	59.5	7.0	↓	19.9%
Air Force	26.4	35.9	3.2	↓	26.6%
Army	52.7	64.9	10.0	↓	18.9%
Marine Corps	81.0	99.7	13.5	↓	18.8%
Navy	42.7	53.8	4.2	↓	20.7%
DOD Active Duty	127.2	156.5	19.0	↓	18.7%

Rates are presented as the rate per 100,000 persons per year.

A green arrow indicates an increasing percent change and a blue arrow indicates a decreasing percent change.

^a Historic IR reflects the weighted average of the three years prior to the analysis year.

^b This reflects the percent change from the weighted historic IR to the IR of the current analysis year.

Data Source: NMCPHC HL7-formatted CHCS microbiology and MHS M2 databases.

Prepared by the EpiData Center, Navy and Marine Corps Public Health Center, on 01 May 2018.



Demographic Distribution of MRSA

In 2017, there were 4,479 incident MRSA infections identified among all MHS beneficiaries. The highest incidence rates among each demographic category occurred in 18-24 year-olds, males, and AD service members (Table 2).

Table 2. Demographic Characteristics of MRSA Infections in the MHS, CY 2017

	N = 4,479	
	Count	Rate
Gender		
Female	1,578	34.2
Male	2,901	60.6
Age Group (in Years)		
0-17	784	40.2
18-24	1,302	115.1
25-34	745	62.9
35-44	399	47.1
45-64	687	33.6
65+	562	25.1
Beneficiary Type		
Active Duty	1,729	127.2
Family Members	1,608	29.4
Retired	570	25.9
Other ^a	572	--

^a Rate is not reported due to variation in population denominator.

Rates are presented as the rate per 100,000 persons per year.

Data Source: NMCPHC HL7-formatted CHCS microbiology and MHS M2 databases.

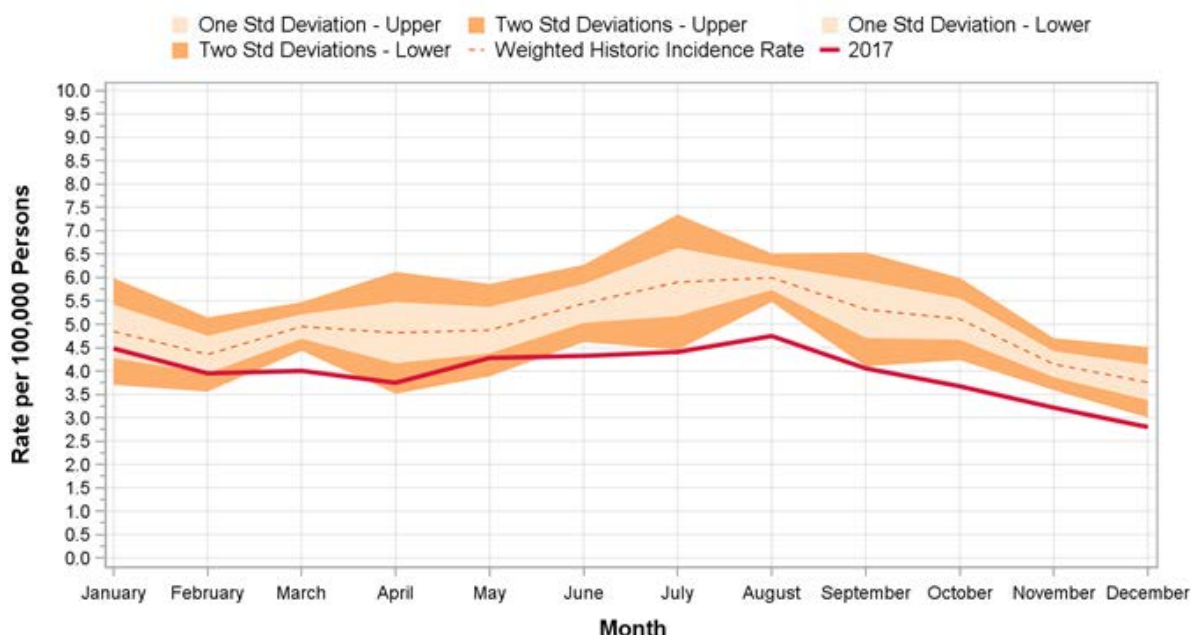
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Seasonality

Monthly incidence rates of MRSA infections in 2017 were lower than the weighted historic IR for the calendar year and exceeded two standard deviations below the weighted historic IR during March, June, August, and October through December. Other monthly incidence rates (January and February) for MRSA infections were below the weighted historic monthly IR and within one standard deviation (Figure 1). A seasonal component to MRSA infections was observed in 2017, with an increase in infections in May, a peak in monthly incidence in August, and then descending rates throughout the remainder of the year.

Figure 1. Monthly Incidence of MRSA Infections and Weighted Historic Incidence Rate (IR) Comparisons in the MHS, CY 2017



Rates are presented as the rate per 100,000 persons per year.
 Bands indicate one and two standard deviations above and below the weighted historic monthly IRs.
 The weighted historic monthly IR is a weighted average of the three years prior to the analysis year.
 Data Source: NMCPHC HL7-formatted CHCS microbiology and MHS M2 databases.
 Prepared by the EpiData Center, Navy and Marine Corps Public Health Center, on 01 May 2018.



MRSA Clinical Characteristics

There were 4,800 prevalent MRSA infections identified among all MHS beneficiaries treated at an MTF in 2017. The infection burden was higher in the outpatient setting (88.6%) and generally consisted of non-invasive infections (94.2%). Seventy-two percent of MRSA infections were collected from a skin or soft tissue infection (SSTI) or wound.

Table 3. Clinical Characteristics of MRSA Prevalent Infections in the MHS, CY 2017

	N = 4,800	
	Count	Percent
Specimen Collection Location		
Inpatient	545	11.4
Outpatient	4,255	88.6
Infection Type		
Invasive	278	5.8
Non-Invasive	4,522	94.2
Body Collection Site		
Blood	114	2.4
Respiratory	351	7.3
SSTI/Wound	3,479	72.5
Urine	259	5.4
Other	597	12.4

Data Source: NMCPHC HL7-formatted CHCS microbiology database.

Prepared by the EpiData Center, Navy and Marine Corps Public Health Center, on 01 May 2018.



Exposure Burden Metrics

In 2017, there were 226,808 direct care inpatient admissions across all MHS MTFs. Table 4 details two MRSA infection metrics related to community and healthcare exposures.

The admission multidrug-resistant organism (MDRO) prevalence rate measures the rate of MRSA importation into the MHS and includes 1) hospitalized patients in 2017 that tested positive for the infection within the first three days of admission and 2) all other hospitalized patients in 2017 that tested positive for the infection or colonization in 2016. The 2016 samples are included in the calculation of the admission prevalence rate to estimate the reservoir of MRSA impacting the MHS. In 2017, the admission MDRO prevalence rate for MRSA infection was 5.3 per 1,000 inpatient admissions. Within the MHS, the US West region had the highest admission MDRO prevalence rate (5.9 per 1,000 inpatient admissions) and regions outside the continental United States (OCONUS), as a group, had the lowest rates (3.0 per 1,000 inpatient admissions).

The overall MDRO prevalence rate measures the cumulative community reservoir and healthcare-associated exposure burden for MRSA and includes 1) hospitalized patients in 2017 that tested positive for the infection at any time during the admission and 2) all other hospitalized patients in 2017 that tested positive for the infection or colonization in 2016. The 2016 samples are included in the calculation of the overall prevalence rate to estimate the reservoir of MRSA impacting the MHS. In 2017, the overall MDRO prevalence rate for MRSA infection was 5.7 per 1,000 inpatient admissions. The US South, US South Atlantic, and US West regions demonstrated an overall MDRO prevalence rate between 3.4 and 6.3 per 1,000 inpatient admissions.

By definition, admission MDRO prevalence infections are included in the calculation of the overall MDRO prevalence rate. In 2017, the admission prevalence rate comprised 92.5% of the overall prevalence rate of MRSA in the MHS (5.3 of the 5.7 per 1,000 inpatient admissions). This suggests that the majority of MRSA infections were imported into the MHS from the community reservoir.



Table 4. MDRO Community- and Healthcare-Associated Exposure Burden Metrics among MRSA in the MHS, CY 2017

	Admission MDRO Prevalence ^a		Overall MDRO Prevalence ^b		Percentage ^d of Admission (Imported) Prevalent Infections among Overall Prevalent Infections
	Count	Rate ^c	Count	Rate ^c	
Region					
OCONUS	49	3.0	54	3.4	90.7
US Midwest	45	5.2	48	5.6	93.8
US Northeast	6	3.6	6	3.6	100
US South	275	5.2	306	5.8	89.9
US South Atlantic	409	5.3	438	5.6	93.4
US West	411	5.9	440	6.3	93.4
Total	1,195	5.3	1,292	5.7	92.5

^a Admission MDRO prevalence included hospitalized patients in 2017 that tested positive for the infection within the first three days of admission and all other hospitalized patients in 2017 that tested positive for the infection or colonization in 2016.

^b Overall MDRO prevalence included hospitalized patients in 2017 that tested positive for the infection at any time during the admission and all other hospitalized patients in 2017 that tested positive for the infection or colonization in 2016.

^c Rates are presented as the rate per 1,000 inpatient admissions per year. Rates are not provided when the prevalence count is less than or equal to 5.

^d Percentage reflects the proportion of MDRO infections that were imported into the healthcare system in the calendar year.

Data Source: NMCPHC HL7-formatted CHCS microbiology and SIDR databases. Prepared by the EpiData Center, Navy and Marine Corps Public Health Center, on 01 May 2018.



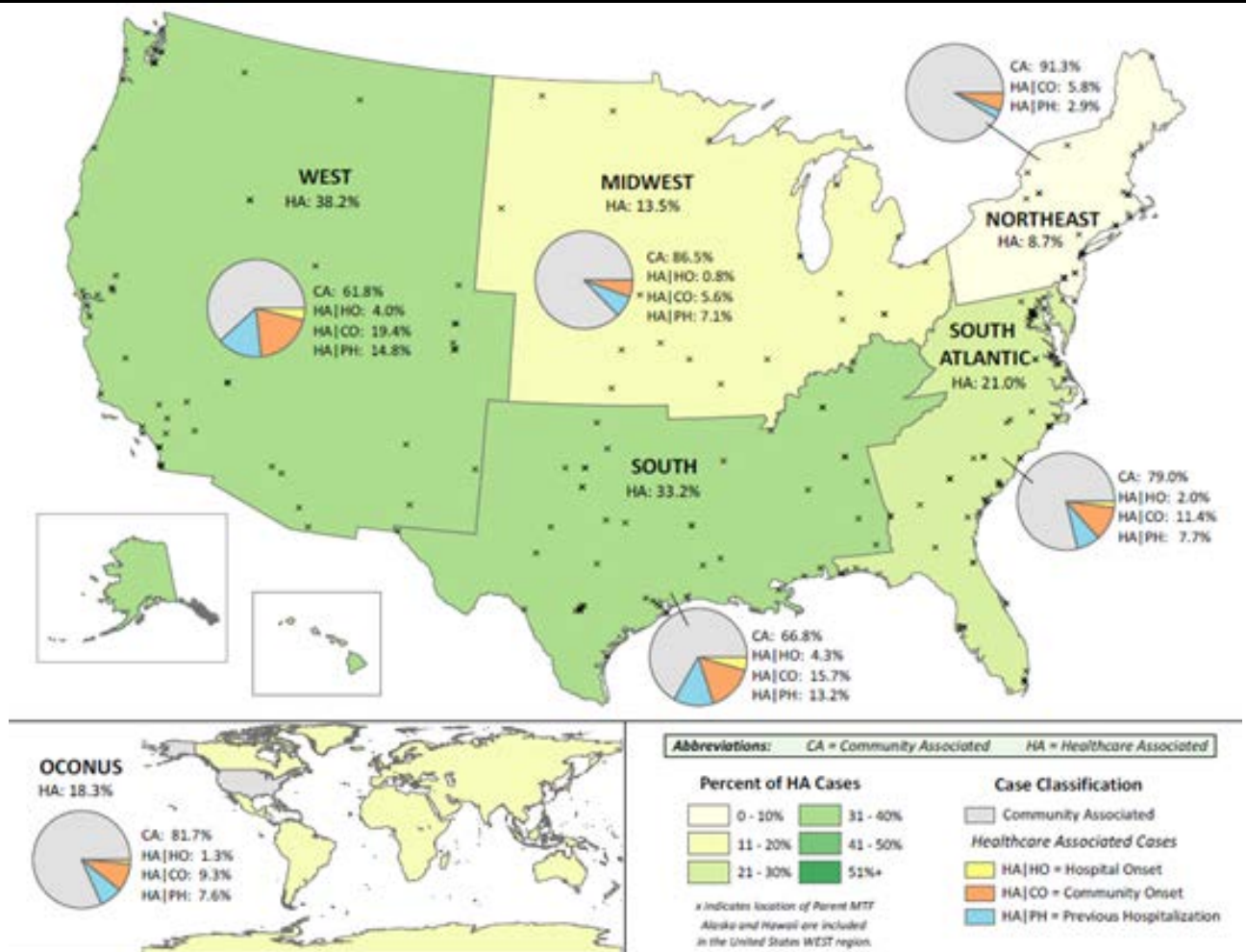
Regional Epidemiologic Infection Classifications

Among all prevalent MRSA infections identified in the MHS in 2017, 73.5% were community-associated (CA) cases, and 26.5% were healthcare-associated (HA) cases. Regionally, the US West reported the highest proportion of HA MRSA cases (38.2%), followed by the US South (33.2%), US South Atlantic (21.0%), OCONUS (18.3%), US Midwest, (13.5%), and the US Northeast (8.7%) (Figure 2).

HA cases were further categorized into hospital-onset (HO), community-onset (CO), or previous hospitalization (PH) groupings. Of all prevalent MRSA infections (regardless of HA or CA classification or region), 13.4% were CO cases, which indicates that the infection most likely originated from the community. Only 2.8% of all prevalent MRSA infections were HO, indicating that the infection was most likely acquired during the current hospitalization. Regionally, in the US Northeast, US West, US South, US South Atlantic, and OCONUS locations, the same overall pattern was observed, with CO cases accounting for the majority of HA MRSA cases (Figure 2). However, in the US Midwest region, PH cases comprised the largest proportion of HA MRSA cases (7.1%), which indicates that the specimens were not associated with a current admission but that the patient had a prior hospitalization in the previous 12 months.



Figure 2. Proportion of Healthcare- and Community-Associated Cases among MRSA Infection in the MHS by Region, CY 2017



Data Source: NMCPHC HL7-formatted CHCS microbiology, SIDR, and MHS M2 databases.
 Prepared by the EpiData Center, Navy and Marine Corps Public Health Center, on 01 May 2018.

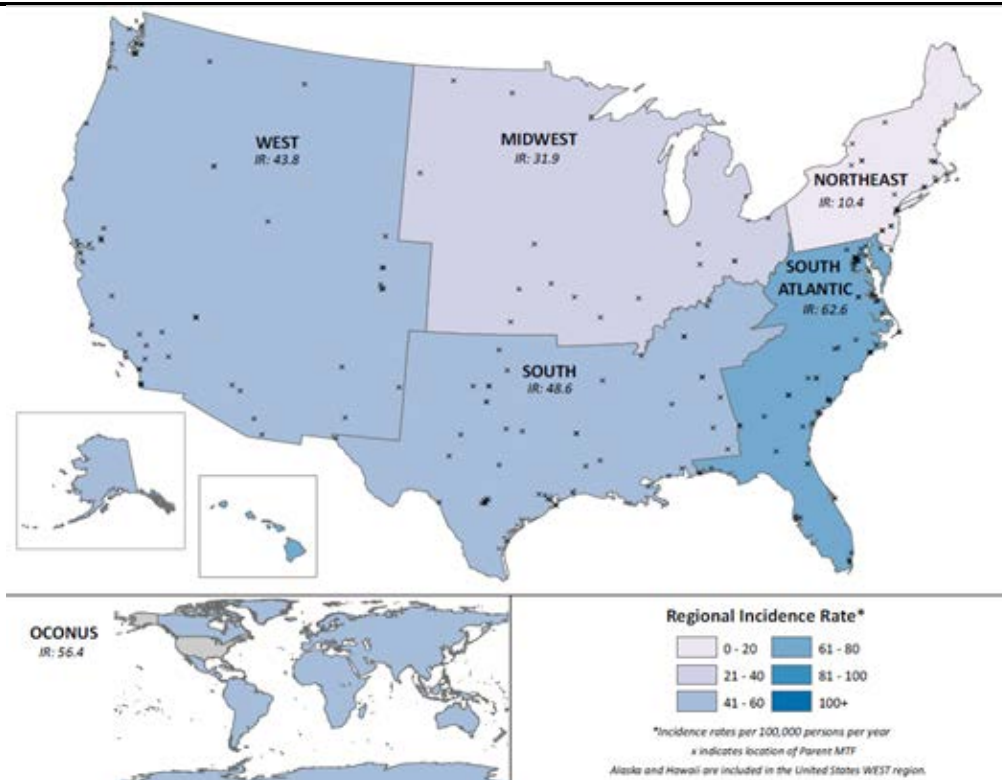


Section B – Antimicrobial Resistance and Use

Regional Multidrug Resistance

The 2017 annual incidence rate of MRSA among all MHS beneficiaries was 47.7 per 100,000 persons per year. Regionally, the highest incidence rates occurred in the US South Atlantic region (62.6 per 100,000 persons per year), followed by OCONUS locations (56.4) and the US South region (48.6) (Figure 3). The lowest incidence rate was observed in the US Northeast region at 10.4 per 100,000 persons per year.

Figure 3. Annual Incidence Rate (IR) and Percentage of Multidrug Resistance among MRSA Infections in the MHS by Region, CY 2017



Rates are presented as the rate per 100,000 persons per year.

Data Source: NMCPHC HL7-formatted CHCS microbiology, SIDR, and MHS M2 databases.

Prepared by the EpiData Center, Navy and Marine Corps Public Health Center, on 01 May 2018.



Emerging Resistance Patterns

In 2017, 16.4% of all MRSA prevalent infections in the MHS were resistant to both erythromycin and clindamycin, also known as inducible clindamycin resistance (ICR). This reflects a 3.7% change above the weighted historic ICR percentage among MRSA infections in the MHS (Table 5). The 2017 percentage of ICR in the Marine Corps and DOD AD service members was more than two standard deviations above the weighted historic ICR and thus higher than historical observations. The Air Force and Navy had a 2017 ICR percentage below the weighted historic ICR. The percentage ICR is within two standard deviations of the weighted historic ICR for the overall MHS beneficiary and Army populations, which indicates that an expected level of variation for ICR existed in these populations. The Marine Corps had the highest percent change (47.6%). DOD AD service members had a 12.2% change above the weighted historic ICR among MRSA infections in this population.

Table 5. Percentage of MRSA Infections with ICR^a in the MHS, CY 2016

Population	2017 ICR Percentage	Weighted Historic ^b ICR 2014 - 2016	Two Standard Deviations: Weighted Historic ^b ICR	2017	
				Direction	Percent Change ^c
MHS Beneficiaries	16.4	15.8	2.0	↑	3.7%
Air Force	17.8	18.0	1.6	↓	1.0%
Army	14.6	13.6	1.2	↑	7.3%
Marine Corps	13.8	9.3	1.7	↑	47.6%
Navy	16.3	17.0	2.8	↓	4.1%
DOD Active Duty	9.9	8.9	1.0	↑	12.2%

^a Specimen must be resistant to both erythromycin and clindamycin to meet criteria for inducible clindamycin resistance (ICR).

^b Historic ICR reflects the weighted average of the three years prior to the current analysis year's data.

^c This reflects the percent change from the weighted historic ICR to the ICR of the current analysis year.

A green arrow indicates an increasing percent change and a blue arrow indicates a decreasing percent change.

Data Source: NMCPHC HL7-formatted CHCS microbiology database.







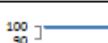


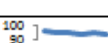

Prepared by the EpiData Center Department, Navy and Marine Corps Public Health Center, on 01 May 2018.



Antibiogram

Table 6 displays an antibiogram of MRSA incident infections for all MHS beneficiaries from 2012-2017. In 2017, MRSA infections were most susceptible to daptomycin (100.0%), vancomycin (99.8%), linezolid (99.8%), and quinupristin/dalfopristin (99.3%). Infections were least susceptible to erythromycin (18.4%) and clindamycin (82.0%). Statistically significant trends in susceptibility were observed for clindamycin, doxycycline, erythromycin, rifampin, tetracycline, and trimethoprim/sulfamethoxazole; all of these antibiotics displayed a decrease in susceptibility, except for erythromycin.

Table 6. Antibiogram of MRSA Infections Identified in the MHS, CY 2012-2017

Antibiotics	2012	2013	2014	2015	2016	2017	Susceptibility Trend ^a	Comment ^b
Ceftaroline	--	--	--	--	--	--		
Clindamycin	85.9	84.9	84.9	84.1	82.5	82.0		↓
Daptomycin	99.8	100.0	100.0	100.0	99.5	100.0		
Doxycycline	99.4	95.5	95.3	95.8	96.5	94.9		↓
Erythromycin	14.5	16.3	17.0	17.2	17.7	18.4		↑
Linezolid	99.8	99.4	99.8	99.6	99.8	99.8		
Minocycline	97.4	98.0	96.7	96.2	97.6	98.0		
Quinupristin/ Dalfopristin	99.5	99.4	99.8	99.4	99.8	99.3		
Rifampin	99.3	99.0	98.8	98.6	99.1	98.5		↓
Telavancin	--	--	--	--	--	--		
Tetracycline	96.0	95.6	95.7	94.3	94.8	93.8		↓
Trimethoprim/ Sulfamethoxazole	98.5	98.2	98.0	97.2	96.6	96.1		↓
Vancomycin	99.9	99.9	99.9	99.8	99.9	99.8		

'--' indicates that fewer than 30 isolates were tested.

^a Susceptibility trends are displayed only for antibiotics with susceptibility data for at least five consecutive years.

^b Arrow indicates the antibiotics with a significant change in direction of trend for significant two-tailed Cochrane-Armitage tests for trend established for a single antibiotic over time. A significant increase in susceptibility is denoted by a green upward arrow and a significant decrease in susceptibility is denoted by a blue downward arrow.

Data Source: NMCPHC HL7-formatted CHCS microbiology database.

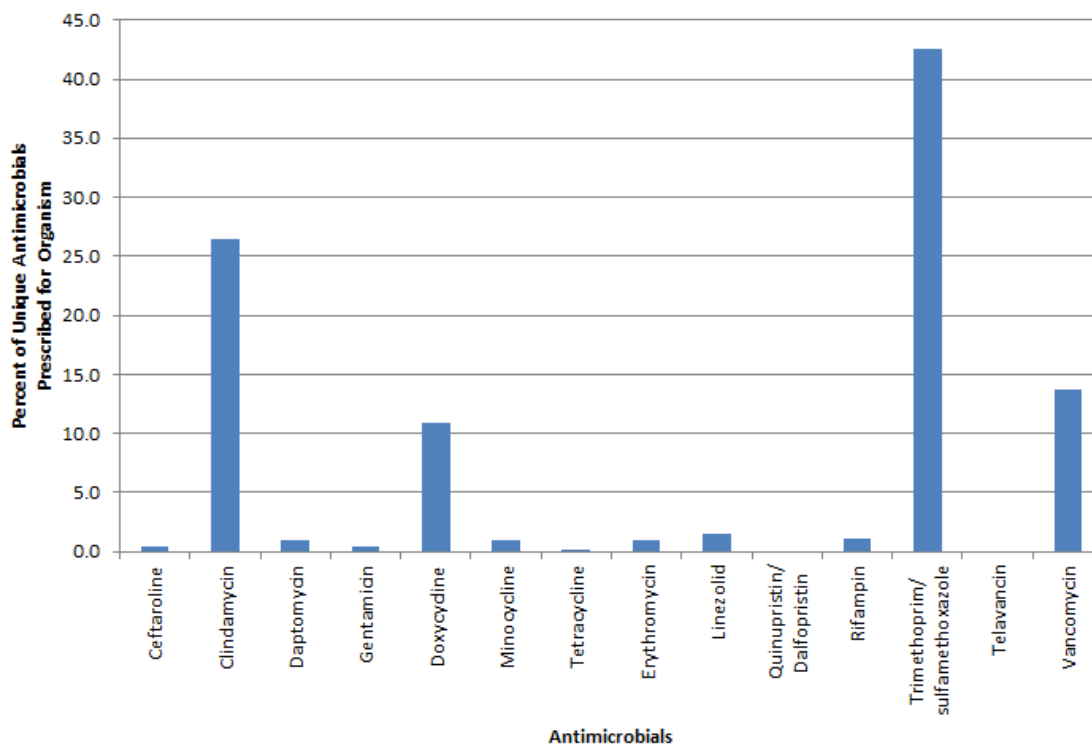
Prepared by the EpiData Center, Navy and Marine Corps Public Health Center, on 01 May 2018.



Antimicrobial Consumption/Prescription Practices

Among all MHS beneficiaries, the most commonly prescribed antibiotics associated with prevalent MRSA infections in 2017 were trimethoprim/sulfamethoxazole (42.5%), clindamycin (26.4%), and vancomycin (13.7%) (Figure 4). Doxycycline was also commonly prescribed (10.9%). The remaining antibiotics were prescribed for less than 2% of infections in 2017.

Figure 4. MRSA Infection and Prescription Practices in the MHS, CY 2017



Only the first occurrence of a unique antibiotic was counted per person per infection, regardless of administration route.

Data Source: NMCPHC HL7-formatted CHCS microbiology and HL7-formatted pharmacy databases.
Prepared by the EpiData Center, Navy and Marine Corps Public Health Center, on 01 May 2018.



Discussion

MRSA incidence rates in the general US population and the MHS have been declining in recent years; this decrease continued in 2017.^{2,5} Overall, the MRSA incidence rates in the MHS surveillance population remained low in 2017 with an overall descending trend observed among incident MRSA infections. All services (Army, Air Force, Marine Corps, and Navy) and the DOD AD population experienced a decline in incidence rates in 2017 as well. These trends, along with other indicators in this report, suggest that increased awareness, greater adherence to infection control and prevention strategies, and improved antimicrobial stewardship practices are proving effective in both the civilian and military healthcare communities.

Although overall MRSA incidence rates are declining, it is important to remain vigilant due to the bacteria's changing epidemiology.^{6,7} Recent literature shows that CA MRSA has disproportionately affected groups without typical risk factors, such as children or young adults.⁸⁻¹⁰ Within the MHS, the majority of MRSA prevalent infections in 2017 were classified as CA cases (73.5%) and followed typical patterns generally observed in the US for CA MRSA. The shift to predominately CA MRSA infections is likely multi-faceted, but it may be attributed to the trends toward shorter hospital stays, inappropriate outpatient antibiotic use, and the difficulty in implementing community-based infection control interventions. However, this shift is not likely due to surveillance screening programs in use within the MHS, as these types of surveillance samples have been excluded from analysis. Interventions that support antimicrobial stewardship and infection control are more easily implemented and enforced in the healthcare setting than the community setting, which may explain the difference between community-associated and healthcare-associated rates.

MRSA displayed low susceptibility to clindamycin and erythromycin in the MHS in 2017. Trends of clindamycin susceptibility since 2012 display a statistically significant descending trend, while erythromycin susceptibilities display a statistically significant ascending trend. Since the early 2000s, experts have been concerned about ICR, a type of resistance among *S. aureus* organisms that has been documented in the recent literature.^{2,11} Within the MHS in 2017, prevalent MRSA infections identified with inducible resistance to clindamycin were among the highest proportions seen since surveillance began in 2005, with ICR identified among 16.4% of MRSA infections in the MHS. The percentage of ICR in the MHS decreased slightly in 2017 (16.4% compared to 16.7% in 2016), which may indicate a stabilization of this type of resistance. Regardless, the proportion remains below that observed in the general US population (range 18 – 52%).¹¹⁻¹⁴ Further analysis of ICR by branch of DOD service identified that select services, namely the Air Force and Navy, are nearing the lower end of the threshold of ICR seen among the general US population; however, both service branches reported a decreasing percent change in ICR infections in CY2017. Close monitoring of clindamycin susceptibility patterns of MRSA is needed to ensure optimal disease prevention and treatment measures. It is also recommended that military laboratories routinely utilize the D-test (agar disk diffusion) in the Clinical and Laboratory Standards Institute (CLSI) guidelines to identify isolates susceptible to clindamycin despite erythromycin resistance.^{15,16} Additional analyses may also be warranted of ICR infections observed among the different DOD services to determine if enhanced prevention measures are needed among select services.



This annual report summarized MRSA incidence and prevalence in the MHS beneficiary population in 2017 and reported changes from previously identified trends. Given the possible change in MRSA's epidemiology, the shifting viability of treatment options, and increasing proportions of ICR among select DOD services, it is important to monitor and manage the risk to the MHS population at large. Continued surveillance is warranted to monitor any changes in burden, susceptibility, and treatment options and to guide targeted prevention efforts.

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Appendix A: Acronym and Abbreviation List

Acronym/Abbreviation	Definition
AD	active duty
CA	community-associated
CHCS	Composite Health Care System
CLSI	Clinical and Laboratory Standards Institute
CO	community-onset
CTS	Contingency Tracking System
CY	calendar year
DMDC	Defense Manpower Data Center
DOD	Department of Defense
DON	Department of the Navy
EDC	EpiData Center Department
HA	healthcare-associated
HL7	Health Level 7 format
HO	hospital-onset
ICR	inducible clindamycin resistance
IR	incidence rate
MDRO	multidrug-resistant organism
MHS	Military Health System
MRSA	methicillin-resistant <i>Staphylococcus aureus</i>
MTF	military treatment facility
NMCPHC	Navy and Marine Corps Public Health Center
OCONUS	outside the continental United States
PH	previous hospitalization
SIDR	Standard Inpatient Data Record
SSTI	skin and soft tissue infection
US	United States

