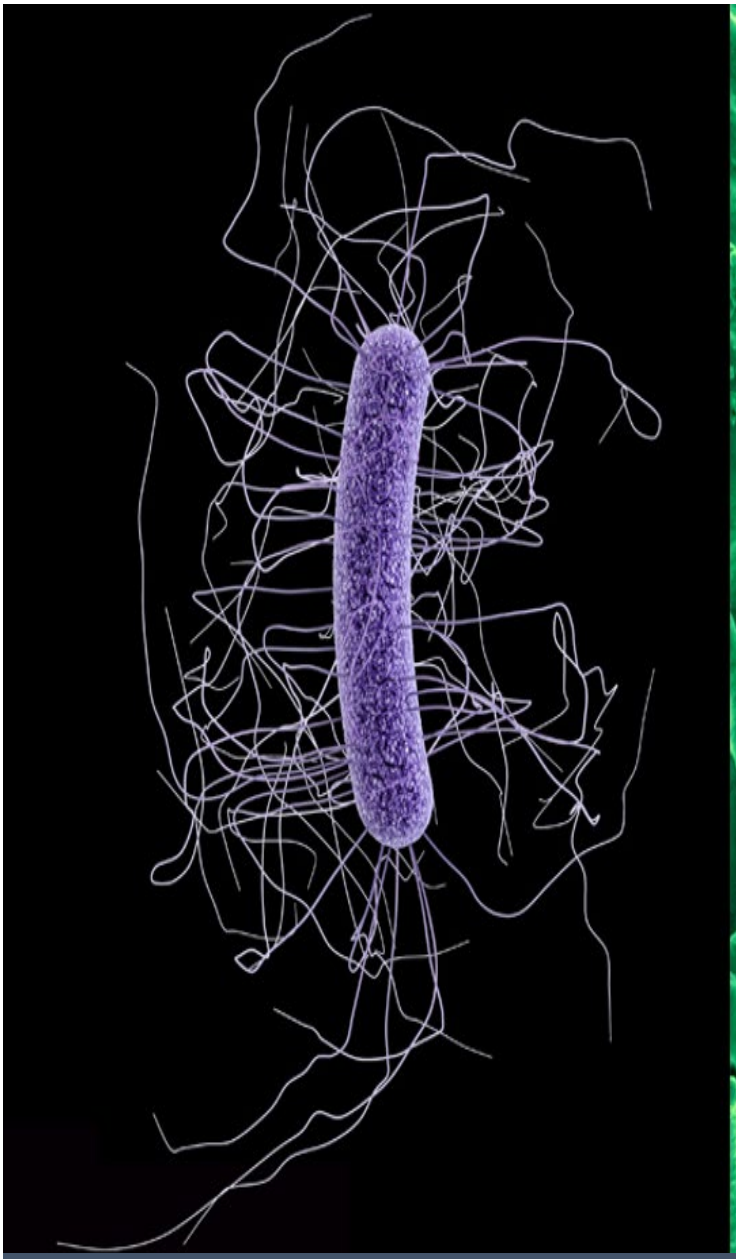

Healthcare-Associated Infections and Antimicrobial Use in Michigan

2018 Annual Report

Michigan Department of Health and Human Services

Michigan Healthcare Associated Infections and Antimicrobial Use

Annual Report 2018

Prepared by the Michigan Department of Health and Human Services

Division of Communicable Disease

Surveillance for Healthcare-Associated and Resistant Pathogens (SHARP) Unit

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Common Acronyms and Phrases

Below is an alphabetized list of commonly used acronyms and phrases throughout this report to facilitate ease in reading.

AMR	Antimicrobial Resistance
AMS	Antimicrobial Stewardship
APIC	Association for Professionals in Infection Control and Epidemiology
AST	Antimicrobial Susceptibility Testing
C. auris	*Candida auris*
CAD	Cumulative Attributable Difference
CAUTI	Catheter-Associated Urinary Tract Infection
CCU	Critical Care Unit
CDC	Centers for Disease Control & Prevention
CDI	*Clostridioides difficile* Infection
CI	Confidence Interval
CL	Central Line
CLABSI	Central Line-Associated Bloodstream Infection
CMS	Centers for Medicare and Medicaid Services
COLO	Colon Surgical Site Infection
CO	Community-Onset
CO-HCFA	Community-Onset Healthcare Facility-Associated
CP-CRE	Carbapenemase-Producing Carbapenem-Resistant *Enterobacteriaceae*
CRAB	Carbapenem-Resistant *Acinetobacter baumannii*
CRE	Carbapenem-Resistant *Enterobacteriaceae*
CRPA	Carbapenem-Resistant *Pseudomonas aeruginosa*
DU	Device Utilization
DUA	Data Use Agreement
E. coli	*Escherichia coli*
ELR	Electronic Laboratory Report
ESBL	Extended Spectrum Beta-Lactamase
FDA	Food and Drug Administration
HAI	Healthcare-Associated Infection
HAV	Hepatitis A Virus
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HHS	U.S. Department of Health & Human Services
HIV	Human Immunodeficiency Virus
HO	Healthcare Facility-Onset
HPRO	Hip Arthroplasty Surgical Site Infection

HYST	Abdominal Hysterectomy Surgical Site Infection
ICU	Intensive Care Unit
IMP	Imipenemase Metallo-Beta-Lactamase
IVAC	Infection-Related Ventilator-Associated Complication
KPC	*Klebsiella pneumoniae* Carbapenemase
KPRO	Knee Arthroplasty Surgical Site Infection
LabID	Laboratory-Identified Event
LTAC	Long-Term Acute Care
LTC	Long-Term Care
MBI-CLABSI	Mucosal Barrier Injury-Central Line Associated Blood Stream Infection
mCIM	Modified Carbapenem Inactivation Method
MCR	Mobile Colistin Resistance
MDHHS	Michigan Department of Health and Human Services
MDRO	Multidrug-Resistant Organism
MERS	Middle East Respiratory Syndrome
MHA	Michigan Health & Hospital Association
MHT	Modified Hodge Test
MRSA	Methicillin-Resistant *Staphylococcus aureus*
NDM	New Delhi Metallo-Beta-Lactamase
NHSN	National Healthcare Safety Network
OXA	Oxacillinase-Type Carbapenemases
PICC	Peripherally Inserted Central Catheter
PPE	Personal Protective Equipment
SCA	Specialty Care Area
SHARP	Surveillance of Healthcare-Associated & Resistant Pathogens
SIR	Standardized Infection Ratio
SNF	Skilled Nursing Facility
SSI	Surgical Site Infection
SUR	Standardized Utilization Ratio
TB	Tuberculosis
UC	Urinary Catheters
VAE	Ventilator-Associated Event
VAP	Ventilator-Associated Pneumonia
VE	Ventilators
VIM	Verona Integron-Mediated Metallo-Beta-Lactamase
VISA	Vancomycin-Intermediate *Staphylococcus aureus*
VRE	Vancomycin-Resistant *Enterococcus*
VRSA	Vancomycin-Resistant *Staphylococcus aureus*
vSNF	Skilled Nursing Facility Caring for Ventilated Patients
WHO	World Health Organization

Introduction

This report includes statewide healthcare-associated infection (HAI) counts, rates, and standardized ratios in Michigan from January through December 2018. Surveillance data was collected from Michigan facilities which voluntarily agreed to share their National Healthcare Safety Network (NHSN) data with the Michigan Department of Health and Human Services (MDHHS) Surveillance for Healthcare-Associated and Resistant Pathogens (SHARP) Unit. NHSN is a secure online surveillance system developed by the Centers for Disease Control and Prevention (CDC). Facilities sign a MDHHS SHARP data use and confidentiality agreement (DUA), confer rights to MDHHS SHARP and enroll in the Michigan NHSN Group to make their NHSN HAI data available to SHARP. As of the data access date (September 5, 2019) 116 out of 169 Michigan hospitals were participating in the Michigan NHSN Group and had a reporting plan in place for at least one month during the inclusive time period. The data from these hospitals were used for development of this report; however, not all participating hospitals provided data for every module. The number of hospitals providing data for analysis is indicated in each table throughout this report and reflects the number of hospitals contributing data to NHSN and sharing that data with MDHHS SHARP. As a requirement of some Centers for Medicare & Medicaid Services (CMS) programs, acute care hospitals (ACH), Long term Acute Care (LTAC), and inpatient rehabilitation (rehab) facilities must report certain infections to NHSN; critical access hospitals had no such requirements in 2018. More information regarding CMS reporting requirements can be found on the CMS website at CMS.gov.

The SHARP Unit collects data from all NHSN Patient Safety Component modules, which include Device-Associated Infections, Procedure-Associated Infections, Multi-drug Resistant Organisms (MRDO)/*Clostridioidies difficile* (C. difficile/CDI) laboratory identified (LabID) Infections, and Antimicrobial Use (AU). All NHSN data collected from participating facilities have been aggregated and facility de-identified in this report. Data are displayed only when five or more facilities are included in the analyses. This annual report, previous quarterly reports and 2015 annual report are posted on the MDHHS HAI website at Michigan.gov/HAI. When available, Michigan data may be compared to 2018 national HAI data through the Antibiotic Resistance & Patient Safety Portal.

Standardized Infection Ratios (SIRs) are the most widely used summary measure in NHSN. The SIR is the ratio of observed events compared to the number of predicted events, accounting for unit type, procedure and etcetera. An SIR of 1 can be interpreted as having the same number of events that were predicted. A SIR that is between 0 and 1 represents **fewer** events than predicted, while a SIR of greater than 1 represents **more** events than expected. SIR p-values are used to determine if the SIR is significantly different than expected. A SIR p-value of <0.05 is considered significantly different than expected, also referred to as statistically significant. It can show either significantly more infections (if the SIR is greater than 1 and the p-value is <0.05) or significantly fewer infections (if the SIR is less than 1 and the p-value is <0.05). Furthermore, the 95 percent confidence interval (CI) indicates that 95 percent of the time, the actual SIR will fall within this interval. The Cumulative Attributable Difference, or CAD, is a measure used to describe the number of infections needing to be prevented (**positive value**) or the number of infections prevented in excess (**negative value**) of the HHS 2020 Reduction goals.

Please note that, for the purpose of this report, “hospital”, “healthcare facility” and “facility” are used interchangeably and may include ACHs, critical access hospitals (CAHs), rehabs, and LTACs, unless otherwise noted. Long-term care facilities, or skilled nursing facilities, are excluded from this report.

Description of Hospitals and Surveillance Overview

Table 1 includes characteristics of the facilities enrolled in the Michigan NHSN Group. The number of hospitals enrolled in the SHARP NHSN Group includes acute care hospitals, critical access hospitals, long-term acute care, and rehab facilities. Acute Care Hospitals and Critical Access Hospitals represent most of the group (79 percent and 26 percent, respectively). To characterize the geographic distribution of the participating hospitals, hospital locations were categorized according to Public Health Emergency Preparedness Regions. Medical School Affiliation and bed size data were obtained from NHSN 2018 Annual Survey data and therefore only includes counts of hospitals who completed an annual survey (n=110). Among these, more facilities are teaching hospitals (71 percent) than non-teaching hospitals (29 percent). Forty-five percent of facilities in the group have less than 100 beds.

Table 1. *Facility Characteristics of the Michigan NHSN Group*

Facility Type	**Number**	**Percent (n= 116[1])**
Acute Care	92	79
Critical Access	19	26
Long Term Acute Care	3	3
Rehab	2	2
Region	**Number**	**Percent (n= 116)**
1	12	10
2N	17	15
2S	20	17
3	16	14
5	14	12
6	22	19
7	7	6
8	8	7
Medical School Affiliation	**Number**	**Percent (n= 110[2])**
Teaching[3]	78	71
Non-teaching	32	29
Bed size	**Number**	**Percent (n= 110)**
≤100	49	45
101–200	19	17
201–500	31	28
≥501	11	10

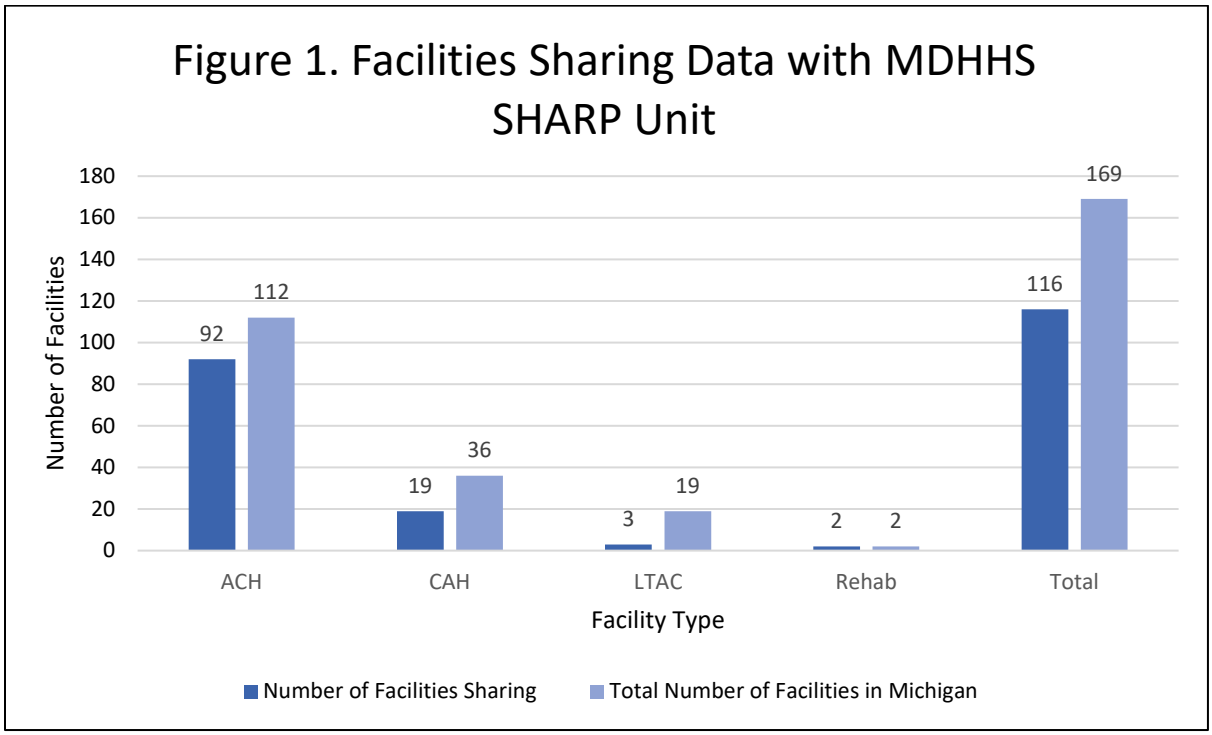
[1]Hospitals who have had a reporting plan in place for at least one month in 2018

[2]Hospitals who have filled out a 2018 facility survey

[3]Teaching includes major, graduate, and limited affiliation with medical schools as indicated on their facility survey

Figure 1 reflects the number of hospitals participating in the Michigan NHSN Group by hospital type compared to the total of each hospital type in Michigan. Sixty-eight percent of Michigan hospitals

shared data with the SHARP Unit as of the data access date (n = 116, N = 169). Hospital licensure data were obtained from a list generated by the Michigan Department of Licensing and Regulatory Affairs (LARA) on August 12, 2019.



[1]Definitions: ACH = Acute Care Hospital, CAH = Critical Access Hospital, LTAC = Long Term Acute Care

Figure 2 is a map indicating the percentage of SHARP-participating facilities by Public Health Preparedness Region. These facilities include acute care, critical access, long-term acute care, and inpatient rehab. More than 50 percent of facilities in each region are participating.

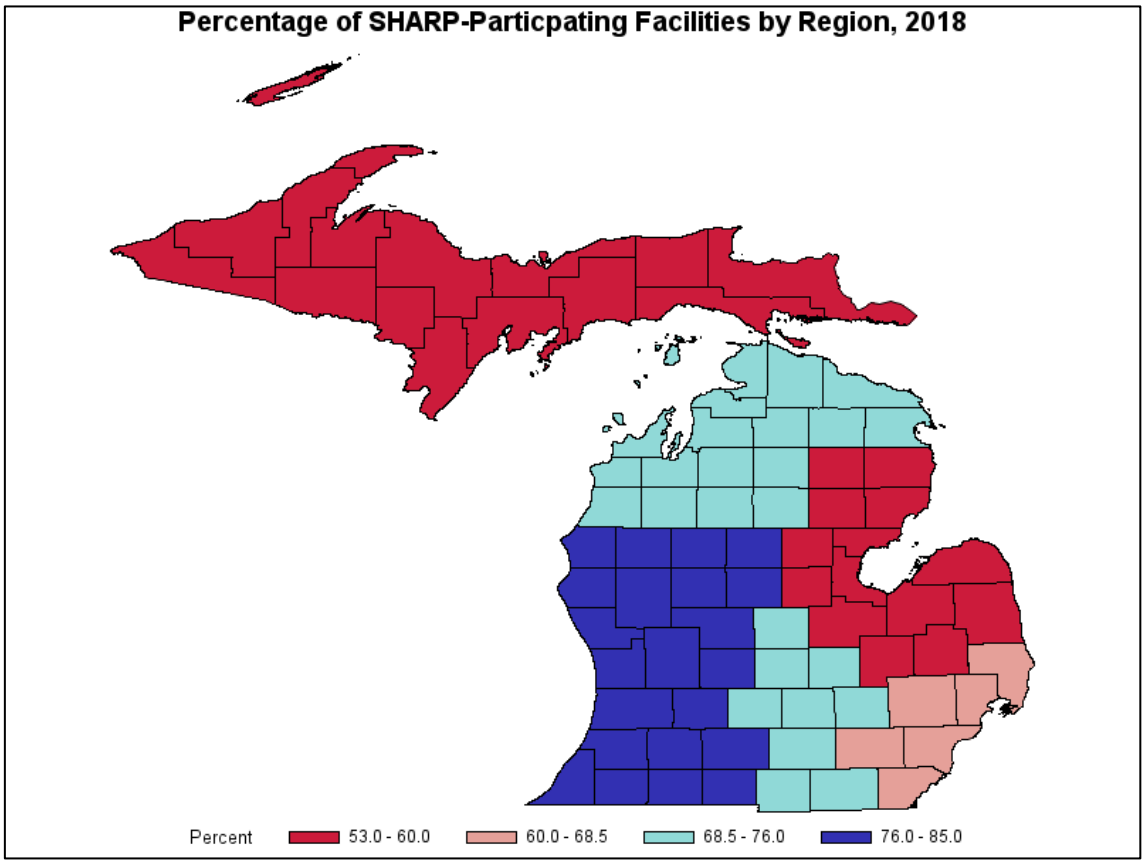


Table 2 indicates that most hospitals participating in SHARP NHSN surveillance are conducting NHSN surveillance facility-wide and in their intensive care units (ICUs). The ICU type is not specified in this report. Most hospitals are also conducting surveillance on one or more patient wards. MDRO/CDI module surveillance is typically conducted facility-wide, while surveillance for device-associated infections is typically conducted in ICUs and wards.

Table 2. *Types of Units in Reporting Plan*

Unit Type	FacWideIn[1]	ICU/CCU[2]	NICU[3]	STEP[4]	Wards[5]	Other Inpatient[6]	Outpatient[7]
Number of Facilities[8]	115	94	20	27	110	28	105

[1]FacWideIn: All Facility-Wide Inpatient locations
[2]ICU/CCU: Intensive Care Unit/Critical Care Unit
[3]NICU: Neonatal Intensive Care Unit
[4]STEP: Step-Down Unit
[5]Wards: Inpatient wards
[6]Other: All other inpatient locations, including inpatient rehab facilities, operating rooms, and locations designated as "other"
[7]Outpatient: All outpatient locations
[8]These numbers are not mutually exclusive

Table 3 indicates the NHSN module(s) in use, as indicated by monthly reporting plans developed by each participating hospital. A monthly reporting plan identifies which NHSN modules and surveillance activities a hospital will be participating in during a given month. Because surveillance targets and monthly reporting plans may vary by hospital and month, hospitals may not report to NHSN each month. From month to month, the type of module(s) being used can change as some modules require varying periods of use. According to data shared with MDHHS SHARP, the most commonly used modules during this reporting period were the CAUTI, laboratory identified (LabID) and CLABSI modules.

The column in Table 3 titled "Number of Facilities Using Module" displays the number of hospitals that have indicated module use in their reporting plans for at least one month during this report time period. The column titled "Number of Facilities Sharing Data" displays the number of hospitals that have shared data for this report time period as of the data access date. There is a discrepancy between these two columns in some instances because not all hospitals that indicate module use necessarily report data and some hospitals report out-of-plan data which cannot be excluded from certain calculations. The SHARP Unit excludes out-of-plan data when possible because it may not follow NHSN definitions as closely as in-plan data.

Table 3. *NHSN Modules in use*

NHSN Module	Number of Facilities Using Module[1]	Number of Facilities Sharing Data[2]
Catheter-Associated Urinary Tract Infection (CAUTI)	116	110
***Clostridioides difficile* Infection (CDI) Laboratory-identified (LabID) Event**	116	113
Methicillin-Resistant *Staphylococcus aureus* (MRSA) LabID[3]	115	113
Central Line-Associated Bloodstream Infection (CLABSI)	114	110
Surgical Site Infection (SSI)	103	96
Ventilator-Associated Events (VAE)	89	87
Vancomycin-Resistant Enterococcus (VRE) LabID	15	16
Acinetobacter LabID	12	7
Carbapenem-Resistant Enterobacteriaceae (CRE) LabID	12	5
Cephalosporin-Resistant *Klebsiella* LabID	7	3

[1]This is the number of hospitals that have indicated module use in each of their reporting plans for at least one month.
[2]This is the number of hospitals sharing data for the report period, as of the data access date, taken from those hospitals contributing to the SIR when available.
[3]MRSA LabID all specimens or blood (bld) only specimens
[4]In some instances, the number of hospitals sharing data is greater than the number of hospitals using the module. The option to 'view in-plan only data' is not available for all modules. Therefore, some out-of-plan data have been included when impossible to remove.

Multidrug Resistant Organism and Clostridioides difficile Infection Module

The NHSN definition for MDRO LabID Event is 'all non-duplicate MDRO from any specimen source and unique blood source MDRO isolates.' A unique blood source is defined as 'A MDRO isolate from blood in a patient with no prior positive blood culture for the same MDRO and location in ≤14 days, even across calendar months and different facility admissions.' The specimens must be obtained for clinical decision-making purposes to be considered a LabID Event; thus, isolates obtained for 'surveillance purposes only' are not reflected in this data. Additionally, testing protocol and type of test used (i.e. PCR, assay, culture) vary by facility and are not recorded here.

NHSN defines healthcare-onset (HO) as a 'LabID Event specimen collected >3 days after admission to the facility (i.e., on or after day 4).' Community-onset (CO) is defined by NHSN as a 'LabID Event specimen collected as an outpatient or an inpatient ≤3 days after admission to the facility (i.e., days 1, 2, or 3 of admission).' It should also be noted that LabID Event data do not necessarily indicate infection but denote a positive lab test result from a specimen collected for clinical purposes. Community-onset healthcare facility-associated (CO-HCFA) is defined as a 'CO LabID Event specimen collected from a patient who was discharged from the facility ≤4 weeks prior to specimen collection.' Further information on the MDRO/CDI Module Definitions can be found in the 2019 NHSN Patient Safety Manual, Chapter 12.

MRSA Annual Aggregate Reports

Tables 4 shows aggregate MRSA LabID Event cumulative data for 2018.

Table 4. *Cumulative Aggregate Methicillin-Resistant Staphylococcus aureus (MRSA) LabID Data*

Frequency, Number	
Aggregated LabID Events	**5738**
Onset, Number (percent)	
Healthcare Facility-Onset (HO)	**905 (16)**
Community-Onset (CO)	**4833 (84)**
Specimen Source, Number (percent, percentHO)[1]	
Blood	**2996 (52, 17)**
Sputum	**248 (4, 35)**
Wound	**989 (17, 10)**
Abscess	**522 (9, 7)**
Urine	**225 (4, 8)**
Skin	**18 (0, 6)**
Other	**740 (13, 20)**
Surveillance Location, Number (percent, percentHO)[2]	

Intensive/Critical Care Unit	**714 (12, 41)**
Specialty Care Area	**15 (0, 40)**
STEP Unit	**205 (4, 34)**
Wards	**1851 (32, 25)**
Other (Mixed, Emergency Dept, Clinics, etc.)	**2953 (51, 2)**

[1]The numbers in parentheses under "Specimen Source" are the percent of isolates from each specimen source, followed by the percent of isolates from each specimen source which are healthcare-onset.
[2]The numbers in parentheses under "Surveillance Location" are the percent of isolates from each location, followed by the percent of isolates from each location which are healthcare-onset.

In 2018, 16 percent of MRSA LabID events were considered HO, and 84 percent were determined to be CO. Most specimens were from blood sources (52 percent), followed by wound (17 percent), and then other (13 percent). Seventeen percent of the blood specimens were healthcare facility-onset. Fifty-one percent of MRSA LabID events came from locations categorized as "other", although only 2 percent of these were HO. The location with the greatest percentage of HO events was ICU/CCU (41 percent), followed by Specialty Care Areas (40 percent).

Table 5 provides the 2018 annual Michigan MRSA inpatient LabID rates, MRSA bacteremia inpatient LabID rates, outpatient LabID rates and rehab LabID rates.

Table 5. *Cumulative Michigan MRSA Rate*

	Facilities	Number of MRSA Events	Number of Patient Days	Number of Patient Admits/Encounters	MRSA Rate[1]	MRSA Prevalence Rate[2]
MRSA Inpatient LabID	113	2,488	5,201,108	1,258,029 Admits	0.478 ↓	0.198 ↓
MRSA Bacteremia LabID[3]	113	1,086	5,201,108	1,258,029 Admits	0.209	0.087
MRSA Outpatient LabID[4]	105	2,853	----	4,485,279 Encounters	----	0.064 ↑
MRSA Rehab LabID[5]	35	16	456,720	23,268 Admits	0.035	0.004 ↓

↓ or ↑ Indicates statistically significantly less than or greater than previous year (respectively)
[1]MRSA Rate: This is the number of MRSA LabID Events or surveillance infections per 1,000 patient days.
[2]MRSA Prevalence Rate. This is the number of MRSA LabID Events per 100 patients admitted or 100 encounters.
[3]MRSA bacteremia LabID: MRSA LabID event from a blood specimen
[4]MRSA outpatient LabID: MRSA LabID event taken in an outpatient location and reported only if the hospital is reporting outpatient events. These events are also reported in inpatient location and are attributed to the admitting location.
[5]MRSA rehab LabID: MRSA LabID event taken in rehab locations reported under a differing CCN number from a facility's inpatient location.

The 2018 annual Michigan MRSA inpatient LabID rate was 0.478 events per 1,000 patient-days, which showed a significant decrease from the 2017 LabID rate of 0.545 ($p<0.001$). The MRSA inpatient LabID prevalence rate was 0.198 per 100 patient admissions, significantly less than the previous annual inpatient MRSA prevalence rate of 0.216 per 100 patient days ($p=0.0017$). The outpatient MRSA prevalence rate significantly increased from 0.059 to 0.064 ($p=0.0032$).

Figure 3 is a graphical demonstration of the MRSA inpatient LabID and MRSA bacteremia LabID event rates from 2015 to 2018.

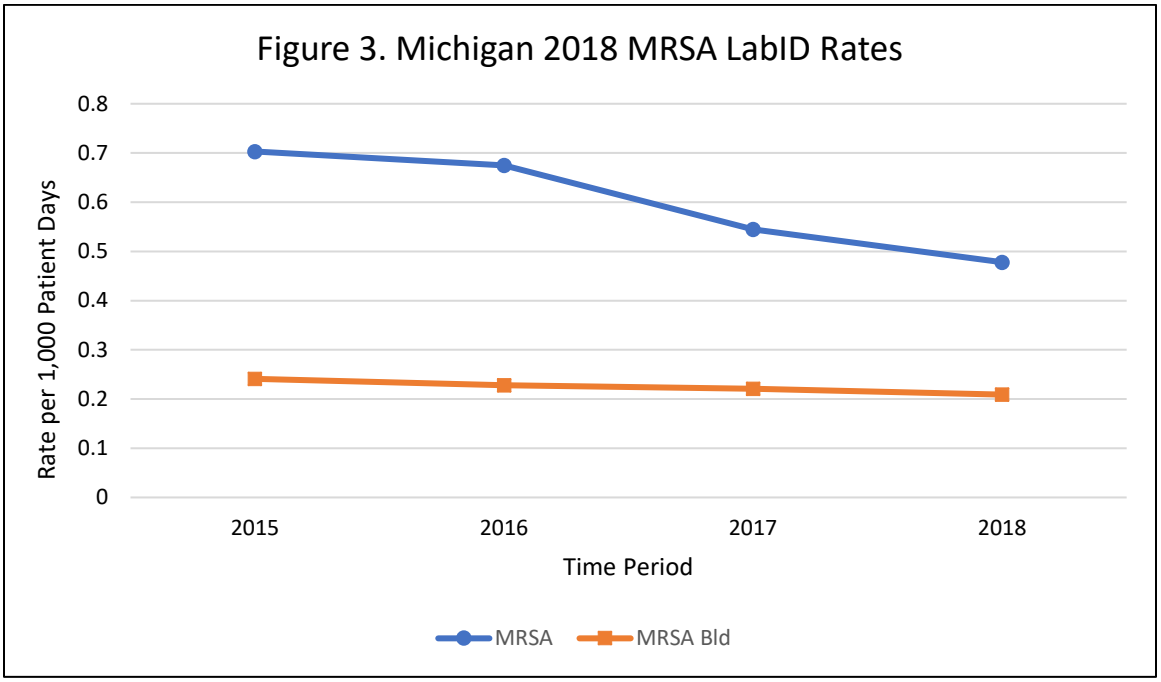


Table 6 stratifies Michigan inpatient MRSA LabID rates by onset for all specimens as well as bacteremia specimens. HO events occur when the LabID specimen was collected on or after day 4 of admission to the facility. Because they are incident events, only a MRSA incidence rate can be calculated (HO Incidence Rate). CO events occur when the LabID specimen was collected ≤3 days after admission to the facility. These are prevalent events, so a MRSA prevalence rate is calculated (CO Prevalence Rate).

Table 6. *Michigan Inpatient MRSA LabID[1] Rate by Onset*

Number of Facilities	Onset	Number of Inpatient MRSA LabID Events	Number of Patient Days	Number of Patient Admits	HO Incidence Rate	CO Prevalence Rate
90	HO	556 Lab ID	5,201,108	-----	0.107	-----
		302 Bld LabID[1]	5,201,108	-----	0.058	-----
90	CO	1,789 LabID	-----	1,258,029	-----	0.142
		634 Bld LabID	-----	1,258,029	-----	0.050

↓ or ↑ Indicates statistically significantly less than or greater than previous year (respectively)
[1]Bld LabID: MRSA bacteremia LabID events (LabID events from a blood specimen)

As in previous years, 2016-2017, the number of CO event onsets is greater than that of HO event onsets. The annual HO incidence rate was 0.107 per 1,000 patient days and the annual HO bacteremia incidence rate was 0.058 per 1,000 patient days; neither of these were a significant change from 2017. The CO

prevalence rate was 0.142 per 100 admissions, and the annual CO bacteremia prevalence rate was 0.050 per 100 admissions; neither of these were a significant change from 2017.

CDI Annual Aggregate Reports

Tables 7 shows aggregate CDI LabID Event cumulative data for 2018.

Table 7. *Cumulative Aggregate Clostridioides difficile Infection (CDI)[1] LabID[2] Data*

Frequency, Number	
Aggregated LabID Events	9,470
Onset, Number (percent)	
Healthcare Facility-Onset (HO)	2,791 (29)
Community-Onset Healthcare Facility-Associated (CO-HCFA)	1,562 (16)
Community-Onset (CO)	5,117 (54)
Previous CDI, Number (percent)	
Previously Positive	1,426 (15)
CDI Assay, Recurrent	535 (6)
Surveillance Location, Number (percent, percentHO)[1]	
Intensive/Critical Care Unit	1,362 (13, 54)
Specialty Care Area	26 (0, 42)
STEP Unit	668 (7, 45)
Wards	5,740 (56, 33)
Other (Emergency Dept and Outpatient locations)	2,441 (24, 4)

[1]The numbers in parentheses under "Surveillance Location" are the percent of isolates from each location, followed by the percent of isolates from each location which are healthcare-onset.

In 2018, 29 percent of CDI events were HO, 16 percent CO-HCFA, and 54 percent CO. Fifteen percent of events were previously positive, and 6 percent were considered recurrent. The greatest percentage of events came from wards (56 percent); however, only 36 percent of these events were HO. As with MRSA LabID events, the surveillance location with the greatest percentage (54 percent) of HO events was the ICU/CCU.

Table 8 provides the annual Michigan inpatient CDI rate and CDI prevalence rate along with the CDI outpatient LabID rate and the CDI surveillance rate

Table 8. *Cumulative Michigan CDI Rate*

	Facilities	Number of CDI Events[4]	Number of Patient Days	Number of Patient Admits/Encounters	CDI Rate[1]	CDI Prevalence Rate[2]
CDI Inpatient LabID	113	6,736	4,870,254	1,161,433 Admits	13.83 ↓	0.580 ↓
CDI Outpatient LabID[3]	105	2,400	-----	4,501,715 Encounters	-----	0.053
CDI Rehab LabID[4]	35	100	456,720	23,268 Admits	2.19	0.430 ↓

↓ or ↑ Indicates statistically significantly less than or greater than previous year (respectively)
[1]CDI Rate: *Clostridioides difficile* rate. This is the number of CDI LabID or surveillance events per 10,000 patient days.
[2]CDI Prevalence Rate. This is the number of *C. diff* LabID events per 100 patients admitted or per 100 encounters.
[3]CDI Outpatient LabID: CDI LabID event specimen collected in an outpatient location and reported only if the hospital is reporting outpatient events. If a patient is then admitted as an inpatient, these events are also reported as inpatient events, and are attributed to the admitting location.
[4]CDI rehab LabID: MRSA LabID event taken in rehab locations reported under a differing CCN number from a facility's inpatient location.

The 2018 annual CDI rate significantly decreased from 2017 annual rate of 15.82 to 13.83 ($p<0.001$) per 10,000 patient days, and the prevalence rate significantly decreased from 0.628 to 0.580 ($p<0.001$) per 100 admissions, respectively. The CDI rehab prevalence rate decreased significantly from 0.617 to 0.430 per 100 admissions ($p=0.008$).

Figure 5 shows the overall CDI LabID event rate trends from the last four years. The overall rate of CDI LabID events has been steadily decreasing.

Figure 5. Michigan SHARP-Participating Acute Care Hospital CDI LabID Event Rates

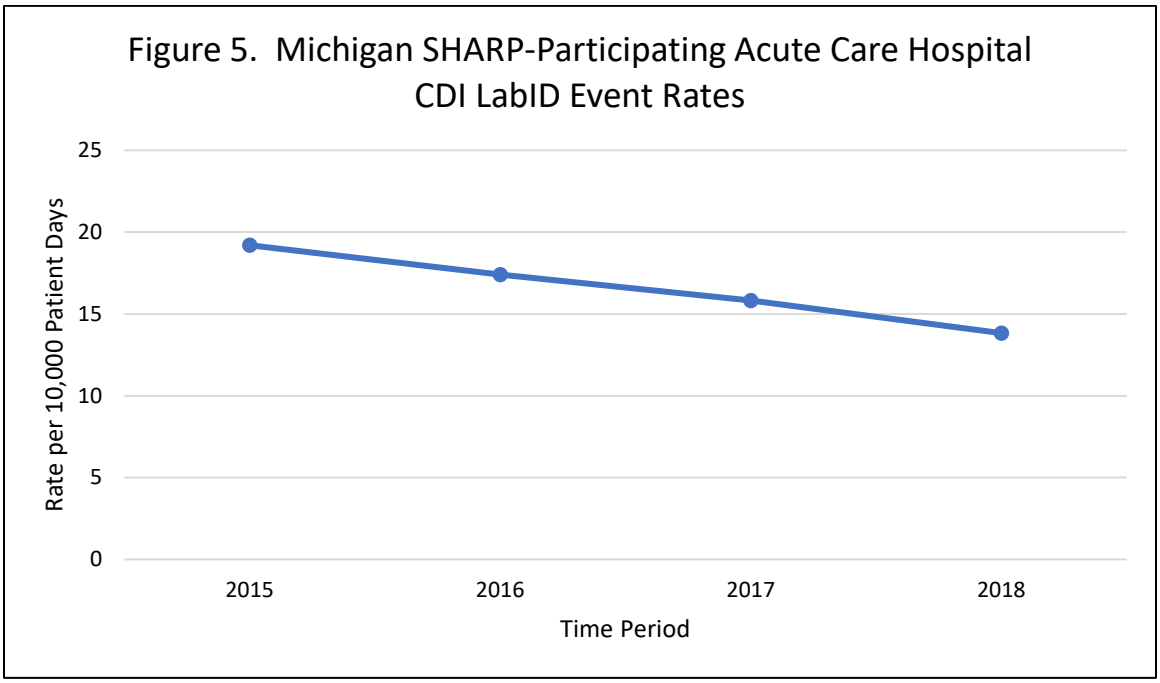


Table 9 provides inpatient CDI LabID rates stratified by onset of HO, CO-HCFA, and CO.

Table 9. *Michigan CDI LabID[1] Rate by Onset*

Number of Reporting Facilities	Onset	Number of Inpatient CDI LabID[1] Events	Number of Patient Days	Number of Patient Admits	HO Incidence Rate	CO/CO-HCFA Prevalence Rate	Percentage of Total
113	HO	2,591 LabID	4,870,254	-----	5.320 ↓	-----	39
113	CO-HCFA	1,022 Lab ID	-----	1,161,433	-----	0.088	15
113	CO	3,055 Lab ID	-----	1,161,433	-----	0.263 ↓	46

↓ or ↑ Indicates statistically significantly less than or greater than previous year (respectively)

Like 2016 and 2017, the number of CO event onsets is greatest, followed by HO events and lastly CO-HCFA. The CDI HO incidence rate was 5.320 per 10,000 patient days, which was a significant decrease (p=0.0001) from 5.925 in 2017. The CDI CO prevalence rate decreased significantly from 0.092 to 0.088 per 100 admissions (p<0.001).

MRSA/CDI LabID Standardized Infection Ratios (SIRs)

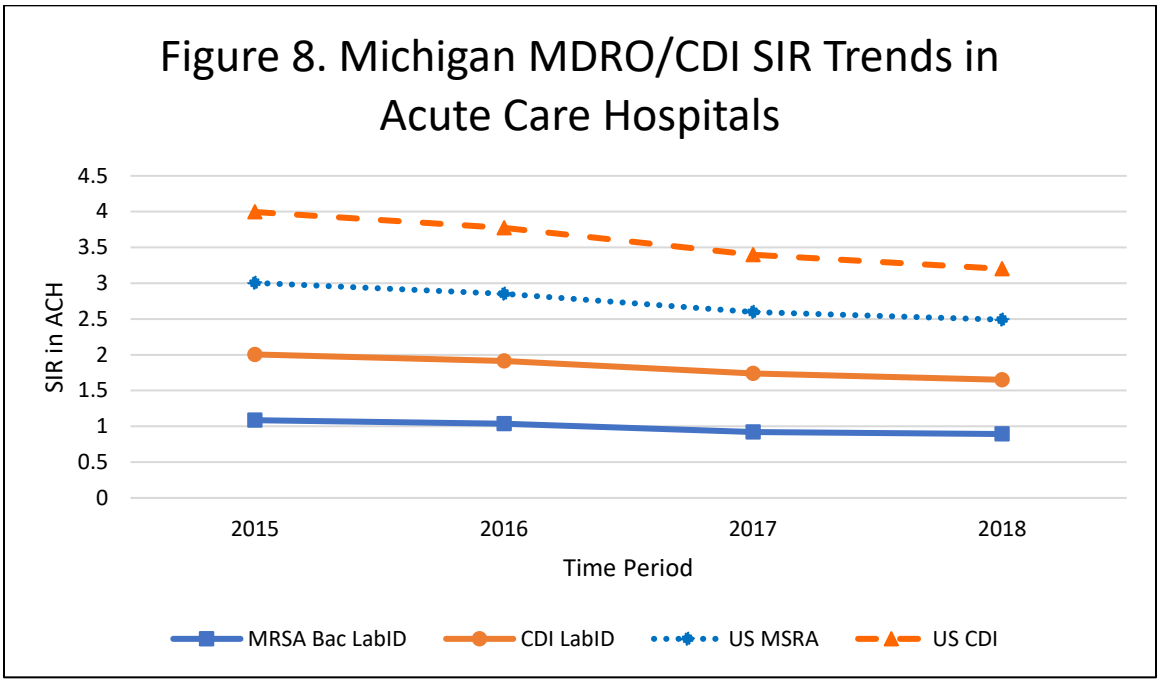
Table 10 shows the 2018 annual standardized infection ratios (SIRs) for facilities sharing data with the SHARP Unit. The table displays the number of observed and predicted infections for both MRSA bacteremia LabID and CDI LabID. SIRs have been calculated utilizing the 2015 baseline. **Note: these SIRs included all data viewable by MDHHS and are not limited to the facilities included in CMS reporting.**

Table 10. *MDRO/CDI Standardized Infection Ratios (SIR)*

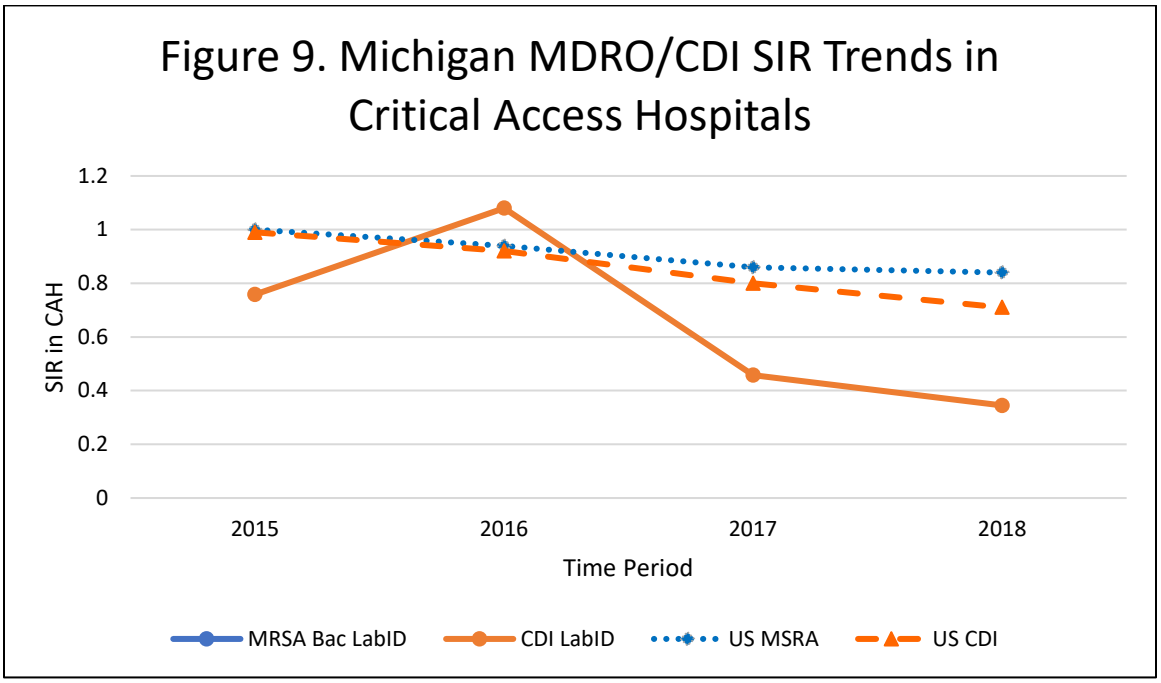
Type of Infection	Facilities	Patient Days	Observed	Predicted	SIR[1]	p-value	95 percent CI	CAD[2]
MRSA Bac LabID ACH	92	5,128,431	300	335.87	0.893	0.0504	0.796, 0.999	48.096
MRSA Bac LabID CAH	18	45,228	0	0.94	.	.	.	-0.705
***C.diff* LabID ACH**	92	4,796,711	2,571	3390.54	**0.758 ↓**	<0.001	0.729, 0.788	197.622
***C.diff* LabID CAH**	18	43,713	5	14.50	**0.345**	0.005	0.126, 0.764	-5.15

Green Text or **Red Text** indicates significantly fewer or greater infections than expected (respectively).
↓ or ↑ Indicates statistically significantly less than or greater than previous year (respectively).
[1]The SIR is only calculated if the number of Predicted events is ≥1.
[2]Cumulative Attributable Difference. HHS 2020 Target Reduction goals are 25 percent for MRSA and 30 percent for CDI.

The annual MRSA bacteremia LabID SIR for acute care hospitals was 0.893, which means that there were 10.7 percent fewer blood specimen MRSA LabID events than expected, based on the national 2015 baseline; this was not statistically significant. The CDI LabID SIR for acute care hospitals was 0.758, which indicates that there were 24.2 percent fewer CDI LabID events than expected; this was statistically significant less infections that expected ($p<0.001$), and significantly fewer infections than 2017. There were also significantly less CDI LabID events in critical access hospitals than expected, with an SIR of 0.345. Infections need to be prevented for both MRSA and CDI in Acute Care Facilities in order to meet the HHS reduction goals. Shown below in Figure 8 is the trend figure for MDRO/CDI SIR in acute care hospitals, and in Figure 9, the trends for MDRO/CDI SIR in critical access hospitals. No data was available for MRSA in critical access hospitals.



National (US) data acquired from the Center for Disease Control and Prevention (CDC) 2018 National and State Healthcare – Associated Infections (HAI) Progress Report.



National (US) data acquired from the Center for Disease Control and Prevention (CDC) 2018 National and State Healthcare – Associated Infections (HAI) Progress Report.

Stratified Cumulative Rates and SIRs

MRSA bacteremia and CDI LabID rates and SIRs were calculated on an aggregate level for acute care hospitals and critical access hospitals, separately, by hospital type (teaching or non-teaching), region group (based on Michigan emergency preparedness regions), and by bed size (less than or equal to 200 beds or greater than 200 beds). Rates and SIRs were provided when five or more hospitals shared data for the MDRO/CDI module. Significance testing was performed comparing previous annual rates and SIRs to present rates and SIRs. Trend graphs are made available for SIRs.

Table 11. *MDRO Rate[1] and SIR by Facility Type*

Facility Type	MDRO Infection Type	Facilities	Rate[1]	SIR	SIR p-value	SIR 95% Confidence Interval
Teaching	MRSA LabID ACH	73	0.060	**0.891**	0.047	0.793, 0.997
	MRSA LabID CAH	5	0.000	----	----	----
	CDI LabID ACH	73	5.411 ↓	**0.759↓**	0.000	0.729, 0.789
	CDI LabID CAH	5	0.000	**0.000**	0.015	0,0.714
Non-Teaching	MRSA LabID ACH	19	0.032	1.034	0.884	0.419, 2.150
	MRSA LabID CAH	13	0.000	----	----	----
	CDI LabID ACH	19	4.024	**0.746**	0.010	0.587, 0.936
	CDI LabID CAH	13	1.635	**0.485**	0.080	0.178, 1.075

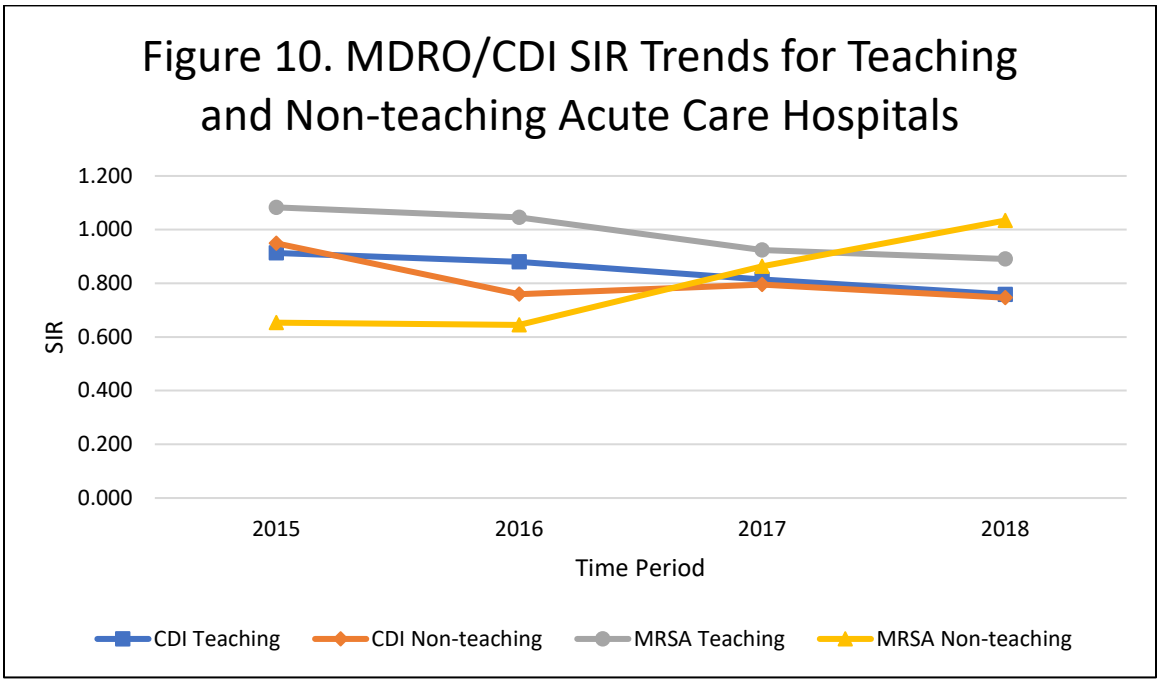
Green Text or **Red Text** indicates significantly fewer or greater infections than expected (respectively).

↓ or ↑ Indicates statistically significantly less than or greater than previous year (respectively)

[1]Rate was calculated using the number of infections/events per 1,000 (or per 10,000 for CDI) patient days among hospitals that reported medical school affiliation status on their 2018 Hospital survey.

As illustrated in Table 11, teaching hospitals had significantly fewer CDI LabID events than expected for both acute care (SIR = 0.759) and critical access (SIR = 0.000). Furthermore, CDI LabID was significantly less than 2017 (p = 0.0106). Additionally, there significantly fewer MRSA LabID events in acute care hospitals (SIR = 0.891). The rate for CDI in acute care teaching hospitals decreased significantly from 2017. The MRSA rates for both teaching and non-teaching acute care hospitals was very low, with rates of 0.060 (teaching) and 0.032 (non-teaching) for 2018.

Figure 10, below, demonstrates MDRO/CDI SIR trends for teaching and non-teaching acute care hospitals, while Figure 11 shows MDRO/CDI SIR trends for teaching and non-teaching critical access hospitals. There were no MRSA infections reported for critical access hospitals and the number of predicted infections was less than 1, resulting in no SIR for teaching and non-teaching critical access hospitals.



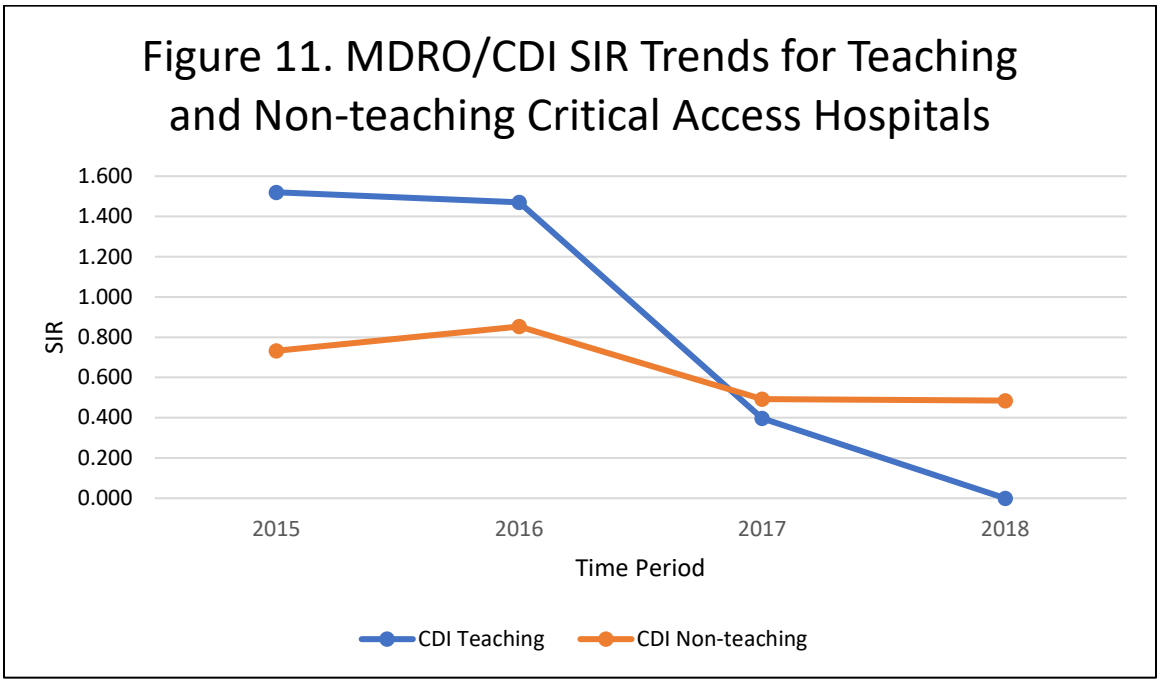


Table 12 below describes rates and SIRs for CDI and MRSA LabID events by Michigan Emergency Preparedness Regions. Due to the limited number of acute care facilities in Regions 7 and 8, the number of facilities in these two regions have been combined for this report. Additionally, all critical access hospitals have been aggregated and represent Region CAH in the table on the next page.

Table 12. *MDRO Rate[1] and SIR by Michigan Region*

Michigan Region	MDRO Infection Type	Rate[1]	SIR	SIR p-value	SIR 95% Confidence Interval
Region 1	MRSA LabID[5]	0.053	0.810	0.367	0.502, 1.242
	CDI LabID[6]	4.000↓	**0.697**	0.000	0.587, 0.822
Region 2N	MRSA LabID[5]	0.059	0.897	0.359	0.707, 1.123
	CDI LabID[6]	5.440↓	**0.752↓**	0.000	0.695, 0.812
Region 2S	MRSA LabID[5]	0.051↓	**0.707↓**	0.001	0.563, 0.878
	CDI LabID[6]	5.877↓	**0.795↓**	0.000	0.742, 0.850
Region 3	MRSA LabID[5]	0.059	0.846	0.303	0.607, 1.150
	CDI LabID[6]	5.861	**0.775**	0.000	0.697, 0.858
Region 5	MRSA LabID[5]	0.047	0.906	0.740	0.515, 1.483
	CDI LabID[6]	6.548	**0.804**	0.003	0.692, 0.929
Region 6	MRSA LabID[5]	0.048	0.896	0.487	0.607, 1.278
	CDI LabID[6]	4.566↓	**0.764↓**	0.000	0.667 ,0.872
Region 7&8	MRSA LabID[5]	0.024	0.500	0.067	0.203, 1.041
	CDI LabID[6]	3.279	**0.536**	0.000	0.425, 0.667
Region CAH[2]	MRSA LabID[5]	0.000	----	----	----
	CDI LabID[6]	0.803	**0.325**	0.004	0.066, 0.703

Green Text or **Red Text** indicates significantly fewer or greater infections than expected (respectively).

↓ or ↑ Indicates statistically significantly less than or greater than previous year (respectively)

[1]Rate was calculated using the number of infections/events per 1,000 (or per 10,000 for CDI) patient days among hospitals that shared data with MDHHS SHARP through NHSN.

[2]All Critical Access Hospitals data are aggregated into one region, due to too few hospitals sharing NHSN data in each region.

CDI LabID rates were significantly lower than 2017 in Regions 1, 2N, 2S and 6. Additionally, Region 2S has a significantly lower rate than the previous year for MRSA LabID events. SIRs for CDI LabID show that the number of infections were significantly less than expected in all regions and for MRSA LabID in Region 2S.

Table 13. *MDRO Rate[1] and SIR by Number of Beds*

Number of Beds	MDRO Infection Type	Facilities	Rate[1]	SIR	SIR p-value	SIR 95% Confidence Interval
≤200 Beds	MRSA LabID ACH	50	0.044	0.948	0.761	0.681, 1.288
	MRSA LabID CAH	18	0.000	----	----	----
	CDI LabID ACH	50	4.709	**0.781**	0.000	0.706, 0.861
	CDI LabID CAH	18	1.144	**0.345**	0.005	0.126, 0.764
>200 Beds	MRSA LabID ACH	42	0.062	**0.886**	0.049	0.783, 0.998
	MRSA LabID CAH	0	----	----	----	----
	CDI LabID ACH	42	5.497↓	**0.754** ↓	0.000	0.723, 0.787
	CDI LabID CAH	0	----	----	----	----

Green Text or **Red Text** indicates significantly fewer or greater infections than expected (respectively).

↓ or ↑ Indicates statistically significantly less than or greater than previous year (respectively)

[1]Rate was calculated using the number of infections/events per 1,000 (or per 10,000 for CDI) patient days among hospitals that reported bed size on their 2018 Hospital Survey.

Table 13 shows that in 2018 there were significantly fewer CDI infections than expected in acute care and critical access hospitals with less than 200 beds. Facilities with greater than 200 beds had less MRSA and CDI infections than expected in acute care hospitals. Furthermore, the 2018 rate and SIR for CDI in acute care hospitals was significantly lower than the 2017 rate and SIR ($p<0.001$ and $p = 0.0186$, respectively).

Figure 12, below, shows SIR trends for MDRO/CDI events for acute care hospitals by bed size. There is no figure for critical access hospitals due to limited SIR data, as shown in the table above.

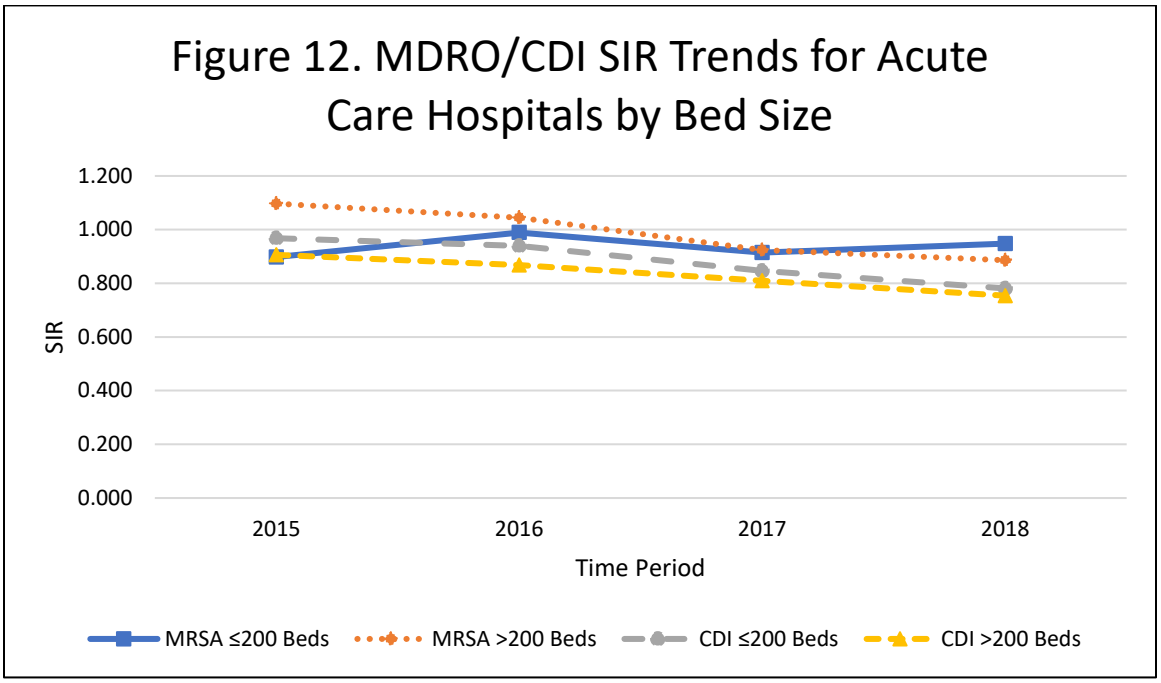


Figure 12. MDRO/CDI SIR Trends for Acute Care Hospitals by Bed Size
1.200
1.000
0.800
0.600
0.400
0.200
0.000
SIR
2015
2016
2017
2018
Time Period
MRSA ≤200 Beds
MRSA >200 Beds
CDI ≤200 Beds
CDI >200 Beds

Device-Associated Module

NHSN's Device-Associated Module offers surveillance of infectious complications associated with the use of medical devices such as urinary catheters, central lines and ventilators. More specifically, infections monitored in this module include central-line associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI) and ventilator-associated events (VAE). Further information and definitions related to the above mentioned HAIs in the device-associated module can be found in the 2019 Patient Safety Component Manual, Chapters 4,7 and 10.

Device-Associated Annual Reports

Table 14 describes the demographics of risk factor variables for device-associated infections. The average number of days between date of admission and date of event was 19.3 days for CAUTI, 21.1 days for CLABSI and 23.2 days for VAE.

Table 14. *Device-Associated Risk Factors*

Risk Factor	CAUTI	CLABSI	VAE
Gender (Percent)			
percentFemale	58	46	42
percentMale	42	54	58
Age			
Median Age at Event	64.9	54.8	59.3
Number of Days from Admission to Date of Event			
Average	19.3	21.1	23.2
Minimum	3	3	3
Maximum	3037	442	3660
Includes out of plan data			

The table below shows device-associated events categorized by specific event type. As shown, majority of CAUTIs were symptomatic urinary tract infections (SUTIs). All CLABSI infections were laboratory confirmed bloodstream infections. Most VAEs were classified as ventilator-associated conditions followed by possible ventilator-associated pneumonia (PVAP).

Table 15. *Specific Event Types*		
CAUTI	**Number**	**Percent**
SUTI	696	98
ABUTI	12	2
CLABSI		
LCBI	614	100
VAE		
VAC	1054	63
PVAP	201	12
IVAC	405	24
Includes out of plan data		

In Table 16, the top three pathogens identified in each device associated infection are displayed by percentage of the total number of events. Only events that identified a pathogen were included in the total count. E. coli was the most common pathogen identified in CAUTIs. S. aureus was the most common identified pathogen for both CLABSIs and VAEs.

Table 16. *Top 3 Identified Pathogens by Infection*	
CAUTI	**Percent (n = 708)**
Escherichia coli	35
Pseudomonas aeruginosa	15
Klebsiella pnuemoniae	9
CLABSI	**Percent (n = 614)**
Staphylococcus aureus	14
Escherichia coli	10
Staphylococcus epidermidis	8
VAE	**Percent (n = 201)**
Staphylococcus aureus	31
Pseudomonas aeruginosa	15
Serratia marcescens	6
Includes out of plan data n = number of infections/events with identified pathogen	

Table 17, below, describes aggregated device use data for all facility types. Rates of infections per 1,000 device days were not significantly different for CAUTI, CLABSI or IVAC events. However, the rate for VAE was significantly greater in 2018 than in 2017 (p=0.006). Conversely, the device utilization ratios have all decreased significantly since 2017.

Table 17. *Michigan Device-Associated Rates*						
Type of Infection	**Number of Facilities**	**Number of Infections**	**Number of Patient Days**	**Number of Device Days**	**Rate[1]**	**DU[2]**
CAUTI	110	624	4,394,664	664,903	0.938	0.151 ↓
CLABSI	110	431	4,297,828	648,005	0.665	0.151 ↓
IVAC	89	591	1,293,874	180,077	3.282	0.139 ↓
Total VAE	103	1,626	1,293,874	180,164	9.025 ↑	0.139 ↓

↓ or ↑ Indicates statistically significantly less than or greater than previous year (respectively)

[1]Rate: The number of device-associated infections per 1,000 device days among participating hospitals.

[2]DU: Device Utilization. The proportion of days on a device divided by the total number of patient days reported for the unit. The device could be a catheter, central line, or ventilator. The MI DU is the proportion of Michigan patient days that are spent using a device.

Device-Associated Standardized Infection Ratios (SIRs)

Table 18 shows the SIRs for CAUTI, CLABSI, Total VAE and IVAC in acute care and critical access hospitals.

Table 18. *Device Standardized Infection Ratios (SIR)*

Type of Infection	Number of Facilities	Device Days	Observed	Predicted	SIR[1]	SIR p-value	95 percent CI	CAD[2]
CAUTI ACH	89	639,127	583	807.930	**0.722**	<0.001	0.665, 0.782	-22.948
CAUTI CAH	18	4,776	0	4.422	**0**	0.012	0, 0.677	-3.317
CLABSI ACH	89	623,467	414	648.048	**0.639**	<0.001	0.579, 0.703	89.976
CLABSI CAH	18	1,976	1	0.539	.	.	.	0.731
Total VAE[3] ACH	87	175,806	1,622	1,372.7	**1.182** ↑	0.000	1.125, 1.240	N/A
Total VAE[3] CAH	14	87	0	0.124	.	.	.	N/A
IVAC[3] ACH	87	175,806	591	495.70	**1.192**↑	0.000	1.099, 1.291	N/A

Green Text or **Red Text** indicates significantly fewer or greater infections than expected (respectively).
↓ or ↑ Indicates statistically significantly less than or greater than previous year (respectively)
[1]The SIR is only calculated if the number of Predicted events is ≥ 1.
[2]Cumulative Attributable Difference. HHS 2020 Target Reduction goals are 25 percent for CAUTI and 50 percent for CLABSI. There are currently no reduction goals for VAE.
[3] Total VAE and IVAC may include out-of-plan data.

As shown in the table above, there were significantly less (27.8 percent) CAUTI events in acute care and critical access hospitals than expected in 2018. Additionally, there were significantly fewer (36.1 percent) CLABSI events than expected in acute care hospitals. The HHS reduction goal was exceeded for CAUTI as shown by negative CAD values, however increased CLABSI prevention is needed to meet the HHS reduction goals.

Conversely, there more significantly more VAEs and IVACs observed than expected in acute care hospitals and the SIRs significantly increased from 1.081 to 1.182 for VAE and from 1.054 to 1.192 for IVAC.

Figures 15-17 illustrate SIR trends from 2015-2018 for the device-associated infections discussed above and in Table 18. Michigan CAUTI and CLABSI SIR trends appear to be declining from 2015 to 2018, matching the national SIR trends. Michigan VAE SIRs have slightly increased while the national trend remains consistent.

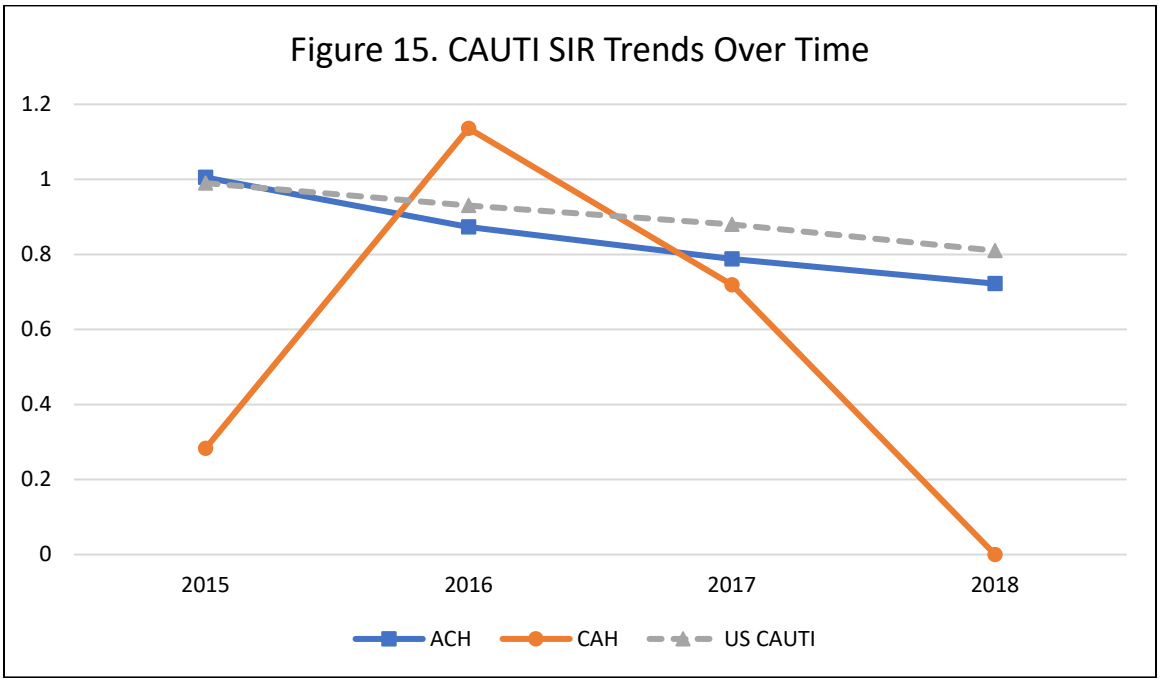


Figure 15. CAUTI SIR Trends Over Time
1.2
1
0.8
0.6
0.4
0.2
0
2015
2016
2017
2018
ACH
CAH
US CAUTI

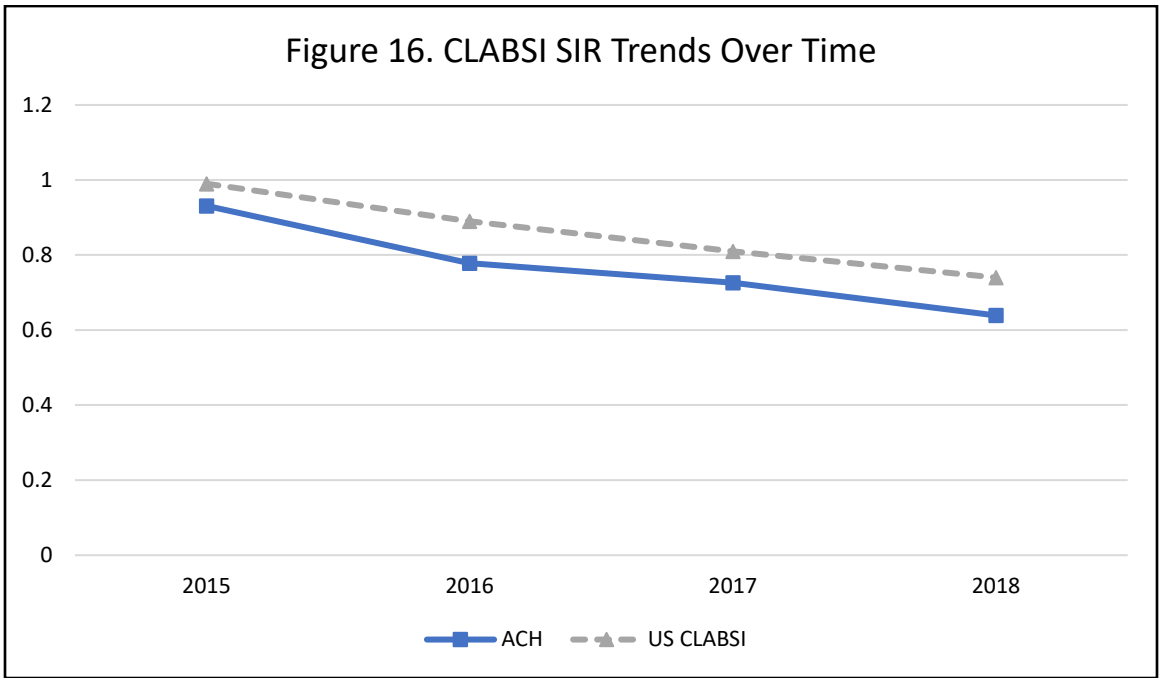
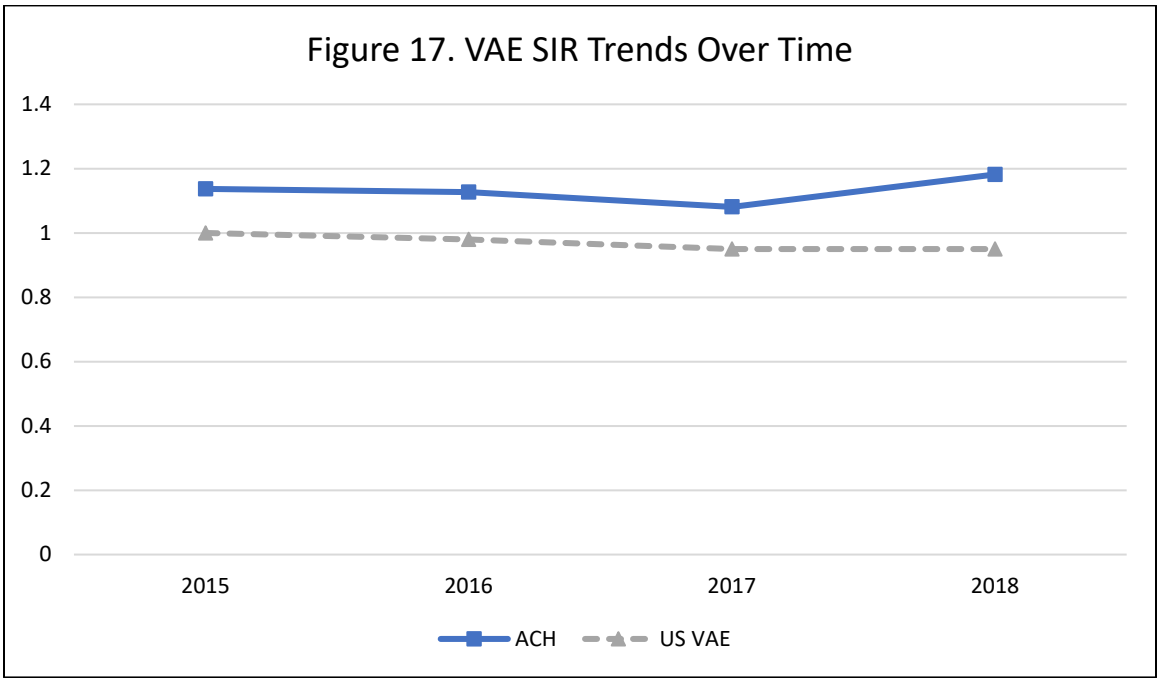


Figure 16. CLABSI SIR Trends Over Time
1.2
1
0.8
0.6
0.4
0.2
0
2015
2016
2017
2018
ACH
US CLABSI



National (US) data acquired from the Center for Disease Control and Prevention (CDC) 2018 National and State Healthcare – Associated Infections (HAI) Progress Report.

Stratified Cumulative Rates and SIRs

Table 19 provides NICU-specific CLABSI and VAP rates by birth weight. Up to 18 hospitals share and have CLABSI NICU data, and up to 12 hospitals share and have VAP NICU data (depending on birthweight code). If device days were recorded as '0', those data were excluded. There was a significant decrease in NICU CLABSIs in all birthweight classes, except B (751-1000g). However, there was a significant increase in NICU VAPs in all birthweight classes from 2017 to 2018.

Table 19. *Michigan NICU Device-Associated Rates by Birth Weight*

Type of Infection	Birth weight Code	Number of Facilities	Number of Infections	Number of Patient Days	Number of Device Days	Rate[1]	DU[2]
CLABSI	**Overall**	**18**	**22**	**168,340**	**27,796**	**0.791**	**0.165** ↓
	A[4]	18	6	20,708	5,549	1.081	0.268 ↓
	B[5]	18	4	19,648	5,019	0.797	0.255
	C[6]	18	7	36,260	6,251	1.12	0.172 ↓
	D[7]	18	2	53,730	5,209	0.384	0.097 ↓
	E[8]	18	3	37,994	5,768	0.52	0.152 ↓
VAP	**Overall**	**12**	**3**	**59,314**	**5,511**	**0.544**	**0.093** ↑
	A	12	2	6,105	1,804	1.109	0.295 ↑
	B	10	1	8,069	1,093	0.915	0.135 ↑
	C	11	0	12,510	743	0	0.059 ↑
	D	8	0	19,774	714	0	0.036 ↑
	E	8	0	12,856	1,157	0	0.09 ↑

↓ or ↑ Indicates statistically significantly less than or greater than previous year (respectively)

[1]Rate: The number of device-associated infections per 1,000 device days among participating Michigan hospitals.

[2]DU: Device Utilization. The proportion of days on a device over the total number of patient days reported for the unit. The device could be a catheter, central line, or ventilator. The MI DU is the proportion of Michigan patient days that are spent using a device.

[4]A: Birthweight ≤750g

[5]B: Birthweight 751–1000g

[6]C: Birthweight 1001–1500g

[7]D: Birthweight 1501–2500g

[8]E: Birthweight >2500g

Table 20 illustrates infection rates and SIRs by Michigan Emergency Preparedness Regions. There was a significant decrease in CAUTI rates and SIRs in Region 2S (p-values <0.001, 0.01) and Region 5 (p-values 0.023, 0.019) from 2017 to 2018. There were significantly less CAUTIs than expected in Regions 1, 2S, 2N, 3 and for Region CAH. There were also significantly less CLABSIs than expected in Region 1 and 2S. However, there was significant increase in Total VAE SIRs for Region 2S and Region 6 from the previous year. There were also significantly more infections than expected for Total VAE in Regions 2S, 6 and 7&8 in 2018. Similarly, the number of infections was significantly greater than expected for IVAC in Regions 2S and 6.

Table 20. *Device-Associated HAI Rate[1] and SIR by Michigan Region*

Michigan Region	Infection Type	Rate	SIR	SIR p-value	SIR 95% Confidence Interval
Region 1	CAUTI	0.527	**0.426**	0.000	0.282, 0.620
	CLABSI	0.466	**0.472**	<0.001	0.300, 0.709
	Total VAE	8.661	1.085	0.446	0.873, 1.333
	IVAC	3.223	1.075	0.665	0.748, 1.500
Region 2N	CAUTI	0.888	**0.690**	0.000	0.577, 0.818
	CLABSI	0.848	0.824	0.075	0.658, 1.019
	Total VAE	7.219	0.929	0.206	0.829, 1.038
	IVAC	2.194	**0.767**	0.008	0.623, 0.935
Region 2S	CAUTI	0.977↓	**0.713↓**	0.000	0.615, 0.822
	CLABSI	0.764	**0.686**	0.000	0.591, 0.792
	Total VAE	9.249	**1.127↑**	0.004	1.041, 1.217
	IVAC	3.791	**1.295**	<0.001	1.144, 1.461
Region 3	CAUTI	0.933	**0.699**	<0.001	0.566, 0.854
	CLABSI	0.343	0.344	0.000	0.241, 0.477
	Total VAE	6.147	0.834	0.059	0.688, 1.002
	IVAC	1.466	0.440	0.000	0.285, 0.649
Region 5	CAUTI	0.909↓	0.810↓	0.176	0.587, 1.092
	CLABSI	0.442	0.483	<0.001	0.299, 0.740
	Total VAE	9.842	1.511	<0.001	1.249, 1.812
	IVAC	2.571	1.072	0.691	0.731, 1.519
Region 6	CAUTI	1.156	1.003	0.963	0.801, 1.242
	CLABSI	0.809	0.805	0.199	0.566, 1.112
	Total VAE	15.665	**1.970↑**	0.000	1.753, 2.208
	IVAC	6.667	**2.364**	0.000	1.973, 2.811
Region 7&8	CAUTI	0.809	0.830	0.277	0.581, 1.147
	CLABSI	0.630	0.730	0.161	0.453, 1.119
	Total VAE	12.385	**1.739**	0.000	1.390, 2.151
	IVAC	3.823	1.478	0.063	0.977, 2.149
Region CAH	CAUTI	0.000	**0.000**	0.003	---- ,0.523
	CLABSI	0.538	----	----	----
	Total VAE	0.000	----	----	----

Green Text or **Red Text** indicates significantly fewer or greater infections than expected (respectively).

↓ or ↑ Indicates statistically significantly less than or greater than previous year (respectively)

[1]Rate was calculated using the number of infections/events per 1,000 device days among hospitals that shared data with MDHHS SHARP through NHSN.

[2]All Critical Access Hospitals data are aggregated into one region, due to too few hospitals sharing NHSN data in each region.

Procedure-Associated Module

The Procedure-Associated Module of NHSN provides surveillance for surgical site infections, or SSIs, as they relate to an operative procedure. The module covers a variety of surgical procedures. Beginning January 1, 2012, hospitals were required by CMS to report all colon surgery (COLO) and abdominal hysterectomy (HYST) procedures through NHSN. No such mandates are required for any other SSI type as of 2018. In this section of the annual report, the term "All SSIs" refers to all SSI types reported into NHSN. Further stratification by SSI type is limited to COLO, HYST, HPRO (hip arthroplasty) and KPRO (knee arthroplasty) because these are the most commonly surveyed infections in the Michigan NHSN group. Additional information regarding Surgical Site Infection Events and the Procedure-Associated Infection Module can be found in the 2019 NHSN Patient Safety Manual, Chapter 9.

Procedure-Associated Annual Reports

Table 21 illustrates average values of SSI risk factors, including body mass index (BMI), age, length of procedure, percentage of patients with diabetes, specific wound class at time of procedure and the American Society of Anesthesiologists physical status classification, or ASA score.

Table 21. SSI Risk Factors

Risk Factor	All SSIs	COLO	HYST	HPRO	KPRO
Median BMI	32.27	29.73	34.85	33.31	35.2
Median Age	57.9	59.9	47.7	67.0	65.2
Median Procedure Length (Hours)	2.59	3.04	2.72	1.76	1.79
Diabetes (percentYES)	76.61	79.24	80.00	73.96	73.47
Wound Class (percent)					
Clean	34.33	0.00	6.49	92.19	93.88
Clean-Contaminated	41.39	51.29	88.65	2.08	1.53
Contaminated	9.21	19.00	2.70	1.04	0.00
Dirty	15.07	29.72	2.16	4.69	4.59
ASA Score (percent)					
1	0.84	0.68	2.16	0.52	0.51
2	28.41	21.03	49.19	17.71	27.04
3	56.16	56.99	45.95	75.52	68.37
4	14.17	20.49	2.16	6.25	4.08
5	0.42	0.81	0.54	0.00	0.00

Procedure-Associated Standardized Infection Ratios (SIRs)

Table 22 shows the 2018 annual SSI infections rates and SIRs by procedure type. Only procedure types for which ten or more hospitals provided data were included in this report. The All SSI SIR was 1.031 (95 percent CI: 0.951, 1.116), which demonstrated greater infections than expected.

Table 22. 2018 Annual SSI Rates and SIR by Procedure Type

Procedure Type	Number of Facilities	Number of Procedures	Number of Observed SSIs	Number of Predicted SSIs	SSI Rate	SSI SIR	SIR p-value	SIR 95% Confidence Interval	CAD[5]
All SSIs	96	70,593	599	580.99	8.49	1.031	0.4656	0.951, 1.116	192.3042
COLO[1]	94	10,294	270	265.353	26.23	1.018	0.7917	0.901, 1.144	84.2529
HYST[2]	85	8,958	67	63.611	7.48	1.053	0.6592	0.823, 1.329	22.4723
HPRO[3]	73	14,021	90	89.176	6.42	1.009	0.9167	0.816, 1.235	27.5768
KPRO[4]	73	19,247	76	66.509	3.95	1.143	0.2478	0.907, 1.422	29.4437

Green Text or **Red Text** indicates significantly fewer or greater infections than expected (respectively).

↓ or ↑ Indicates statistically significantly less than or greater than previous year (respectively)

SSI Rate: The number of SSIs per 1,000 procedures among participating hospitals

[1]COLO: Colon surgery

[2]HYST: Abdominal hysterectomy

[3]HPRO: Hip prosthesis

[4]KPRO: Knee prosthesis

[5]Cumulative Attributable Difference. HHS 2020 Target Reduction goals are 30 percent for SSIs

No procedure types had statistically more infections than expected or than 2017, however the top four reported procedures (COLO, HYST, HPRO, and KPRO) and overall SSI SIR are all above 1.0. Additionally, SSI prevention is needed in all SSIs overall and individually to meet the HHS target reduction goal of 30 percent. The figures below illustrate the trend in SIR values from 2015-2018 for COLO, HYST, HPRO and KPRO procedures. National SIR trends are also included in the figures.

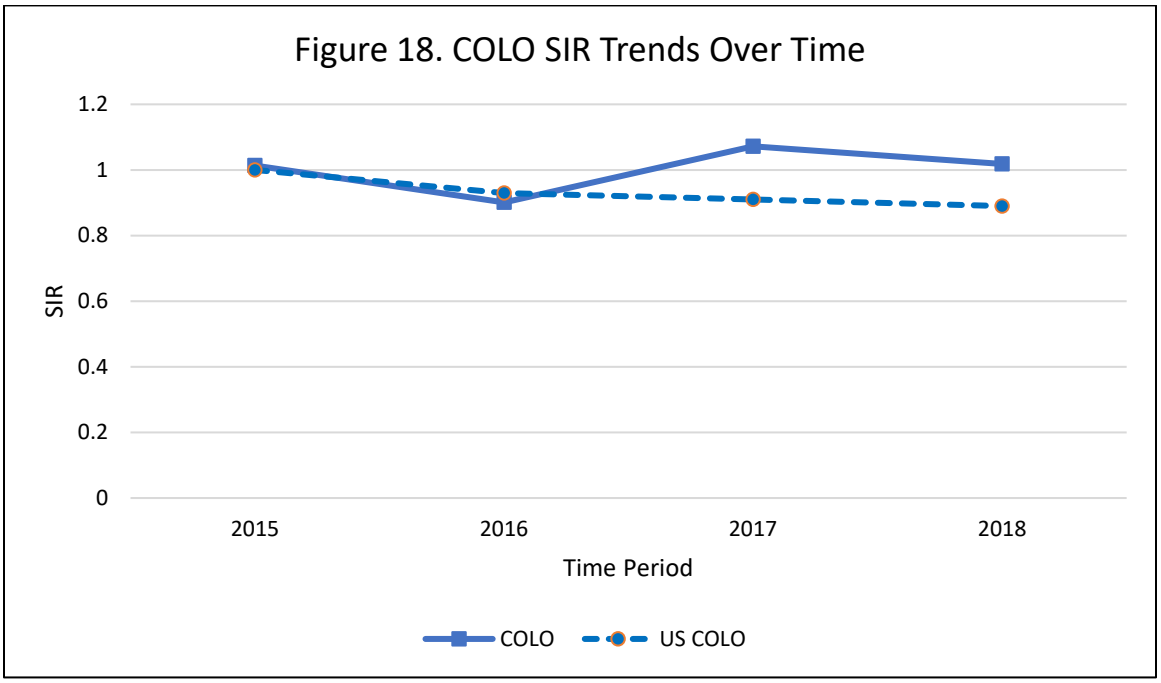


Figure 18. COLO SIR Trends Over Time
1.2
1
0.8
0.6
0.4
0.2
0
SIR
2015
2016
2017
2018
Time Period
COLO
US COLO

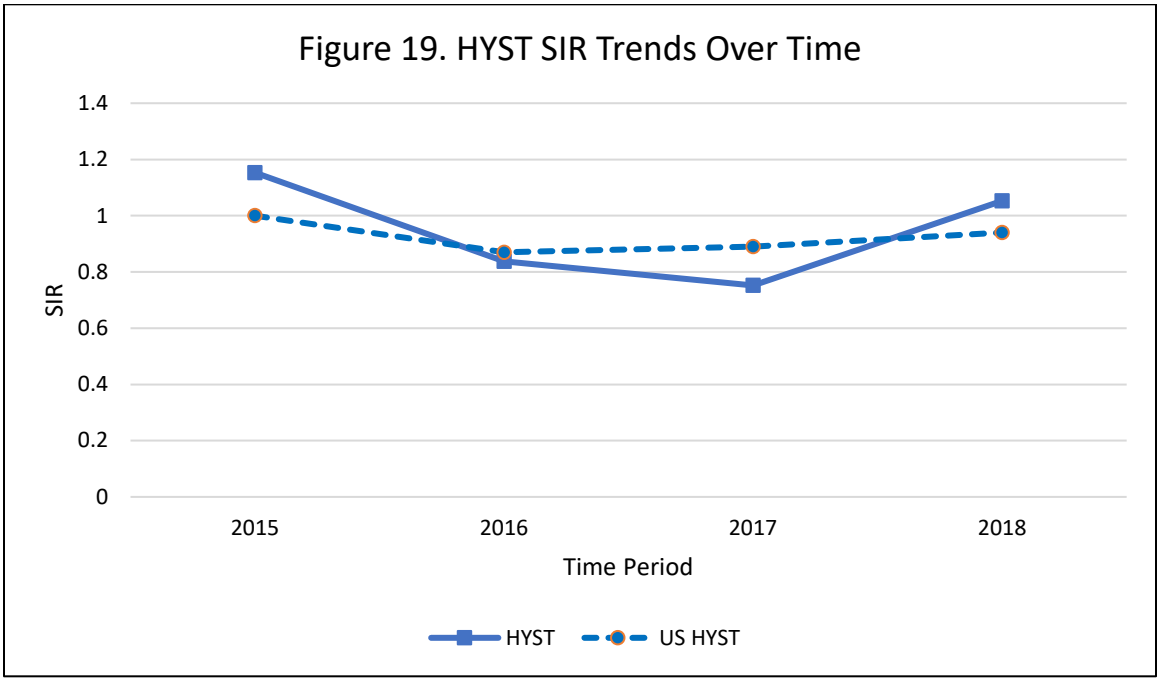
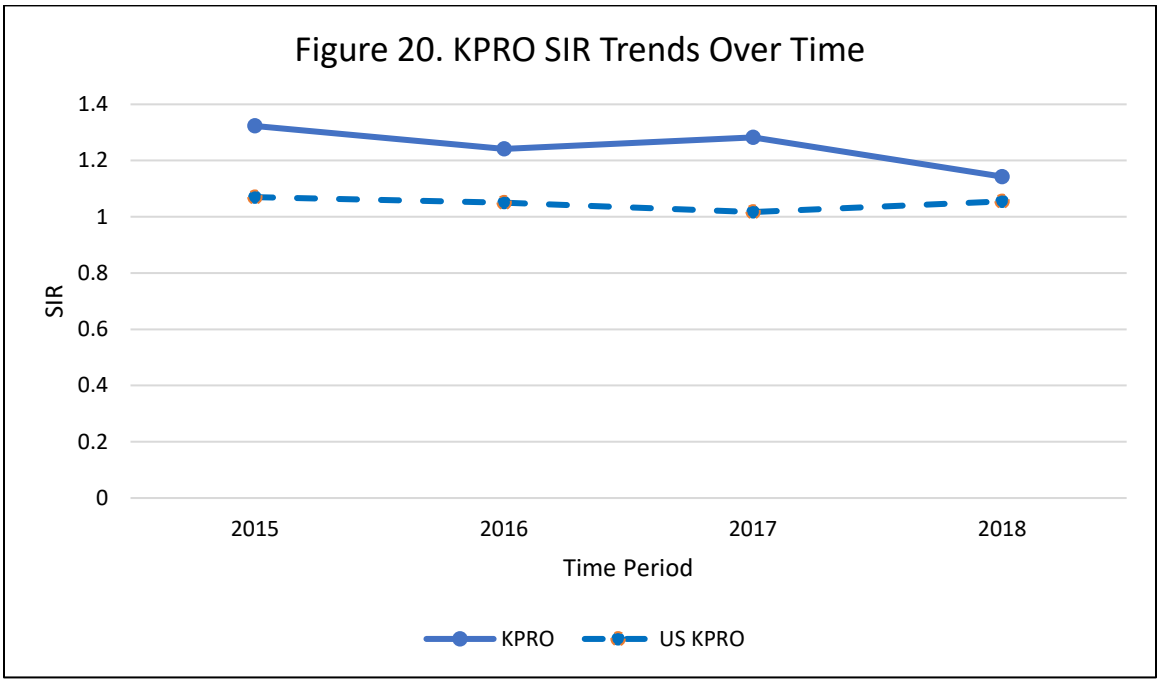
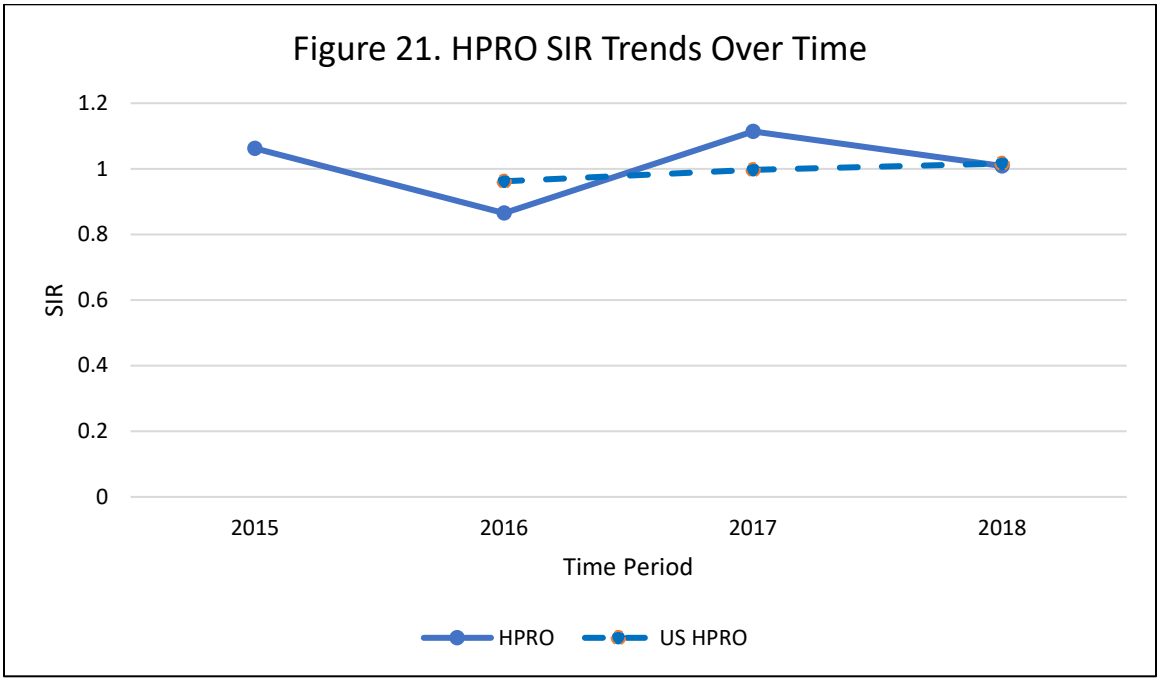


Figure 19. HYST SIR Trends Over Time
1.4
1.2
1
0.8
0.6
0.4
0.2
0
SIR
2015
2016
2017
2018
Time Period
HYST
US HYST





National (US) data acquired from the Center for Disease Control and Prevention (CDC) 2018 National and State Healthcare – Associated Infections (HAI) Progress Report. Predicted values for US HPRO infections in 2015 were < 1. No SIR value was calculated.

Table 23 describes rates and SIRs for SSI events by Michigan Emergency Preparedness Regions. Due to the limited number of acute care facilities in Regions 7 and 8, the number of facilities in these two regions have been combined for this report. Additionally, all critical access hospitals have been aggregated and represent Region CAH in the table below.

Table 23. *SSI Rate and SIR by Michigan Region*

Michigan Region	SSI	Rate	SIR	SIR p-value	SIR 95% Confidence Interval
Region 1	All SSIs	7.382	0.984	0.937	0.715, 1.322
	COLO[1]	21.300	0.944	0.830	0.585, 1.447
	HYST[2]	6.242	0.984	1.000	0.360, 2.180
	HPRO[3]	4.053	0.687	0.478	0.218, 1.658
	KPRO[4]	5.810	2.031	0.067	0.943, 3.856
Region 2N	All SSIs	9.424	0.92	0.427	0.755, 1.111
	COLO	24.308	0.899	0.423	0.689, 1.154
	HYST	6.050	0.873	0.635	0.497, 1.430
	HPRO	8.629	1.319↑	0.247	0.806, 2.044
	KRPO	2.503	0.66	0.202	0.322, 1.211
Region 2S	All SSIs	9.793	1.06	0.434	0.919, 1.217
	COLO	34.648	1.157	0.162	0.940, 1.410
	HYST	9.279↑	1.1↑	0.636	0.707, 1.638
	HPRO	5.861↓	0.87	0.574	0.532, 1.349
	KRPO	4.066	1.139	0.604	0.648, 1.866
Region 3	All SSIs	9.065	1.01	0.923	0.779, 1.288
	COLO	21.094	0.877	0.507	0.590, 1.258
	HYST	3.994	0.643	0.325	0.235, 1.425
	HPRO	8.895	1.128	0.649	0.611, 1.918
	KRPO	6.938	**1.823**	0.038	1.038, 2.986
Region 5	All SSIs	6.912	1.125	0.457	0.811, 1.522
	COLO	20.930	1.059	0.780	0.647, 1.641
	HYST	8.316	1.197	0.674	0.380, 2.887
	HPRO	3.876	0.696	0.434	0.255, 1.542
	KRPO	5.495	1.703	0.132	0.831, 3.126
Region 6	All SSIs	7.371	1.1	0.355	0.903, 1.327
	COLO	25.954	0.973	0.896	0.685, 1.344
	HYST	10.256	1.326	0.370	0.674, 2.364
	HPRO	7.521	1.214	0.341	0.796, 1.779
	KRPO	2.613↓	0.777↓	0.390	0.421, 1.321

Region 7&8	**All SSIs**	7.346	1.006	0.950	0.750, 1.322
	COLO	21.136	1.082	0.725	0.641, 1.720
	HYST	10.160	2.041	0.084	0.893, 4.038
	HPRO	4.279	0.755	0.476	0.330, 1.493
	KRPO	4.040	1.19	0.595	0.553, 2.260
Region CAH[5]	**All SSIs**	8.065	1.588	0.237	0.694, 3.141
	COLO	40.541	1.939	0.275	0.493, 5.276
	HYST	0.000	----	----	----
	HPRO	7.194	1.384	0.601	0.232, 4.573
	KRPO	4.367	1.782	0.413	0.299, 5.887

Green Text or **Red Text** indicates significantly fewer or greater infections than expected (respectively).

↓ or Indicates statistically significantly less than or greater than previous year (respectively)

SSI Rate: The number of SSIs per 1,000 procedures among participating hospitals

[1]COLO: Colon surgery

[2]HYST: Abdominal hysterectomy

[3]HPRO: Hip prosthesis

[4]KPRO: Knee prosthesis

[5]All Critical Access Hospitals data are aggregated into one region, due to too few hospitals sharing NHSN data in each region.

As illustrated in the table above, there were many regions in which SSIs were greater than expected. However, only HPRO infections in region 2N and HYST infections in region 2S were statistically significantly greater than the 2017 SIR; p-values 0.015 and 0.018, respectively. Additionally, KRPO infections in region 3 were significantly greater than expected. Conversely, KRPO SIR in region 6 was significantly less than the previous year. Rates for HRPO infections in region 2S and KPRO infections in region 6 are significantly less than rates in 2017. Also, the rate for HYST infection in region 2S is significantly greater than the previous year.

Antibiotic Use (AU) Module

Core Elements of Antibiotic Stewardship and Hospital Characteristics

The Core Elements of Hospital Antibiotic Stewardship Programs, also known as the Core Elements, were constructed by the CDC to help hospitals achieve the goal of implementing an antibiotic stewardship program in their facility. The Core Elements are as follows:

Hospital Leadership Commitment (Leadership): Dedicate necessary human, financial and information technology resources to improve antibiotic use.

Accountability: Appoint a leader or co-leaders, such as a physician and pharmacy co-leadership, responsible for program outcomes.

Pharmacy Expertise: Appointing a single pharmacist leader responsible for working to improve antibiotic use.

Tracking: Monitor antibiotic prescribing, impact of interventions, and other important outcomes like *C. difficile* infection and resistance patterns.

Action: Implement interventions, such as prospective audit and feedback or preauthorization, to improve antibiotic use.

Reporting: Regularly report information on antibiotic use and resistance to prescribers, pharmacists, nurses and hospital leadership.

Education: Educate prescribers, pharmacists, and nurses about adverse reactions from antibiotics, antibiotic resistance and optimal prescribing.

As described in Table 24, implementation of each individual element is over 90 percent, with the most implemented element being Leadership (99 percent). Furthermore, eighty-nine percent of Michigan hospitals have met all 7 Core Elements, compared to 85 percent nationally.

Table 24. *Antibiotic Stewardship Core Elements Met, 2018 MI NHSN Group*

Core Element	Number	Percent (n= 110)
Leadership	109	99
Accountability	105	95
Pharmacy Expertise	105	95
Action	107	97
Tracking	107	97
Reporting	102	93
Education	106	96
Facilities Meeting all 7 Core Elements	**MI percent**	**US percent**
	89	85

The MDHHS SHARP Unit began collecting Antibiotic Use (AU) data from the AU/AR Module of NHSN in 2016. As of the data access date, the MI NHSN Group has 29 facilities, representing 8 health systems, sharing in the AU portion of the module. For the purposes of this report, data in this section will only include 2018. Future reports will include trending data as it is available. More information and definitions used in this section can be found in the Antibiotic Use and Resistance (AUR) protocol. The table below illustrates the facility characteristics of the hospitals sharing NHSN AU data.

Table 25. *Characteristics of Facilities Sharing Antibiotic Use Data*

Facility Type[1]	**Number**	**Percent (n= 29)**
Acute Care	23	79
Critical Access	6	21
Medical School Affiliation[2]	**Number**	**Percent (n= 29)**
Teaching	19	65
Non-teaching	10	35
Bed size[3]	**Number**	**Percent (n= 29)**
≤100	12	41
101–200	5	17
201–500	8	28
≥501	4	14

[1]Hospitals who have had reporting plan in place for at least one month in 2018

[2]Teaching includes major, graduate, and limited affiliation with medical schools as indicated on their facility survey

[3]Hospitals who have filled out a 2018 facility survey and indicated bed size

Antimicrobial Days

An antimicrobial day is defined by any amount of a specific antimicrobial agent delivered in a calendar day. In Figure 22 below, as expected, there were more antibacterial days (961,226) reported than antifungal days (59,992) and anti-influenza days (20,175) in inpatient locations in 2018.

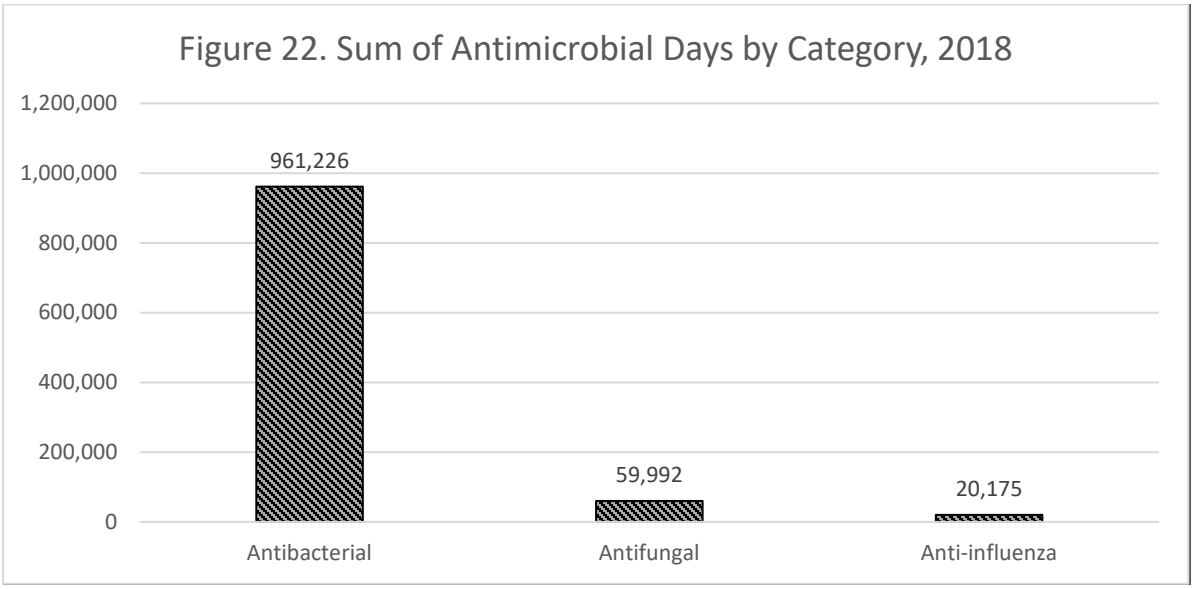
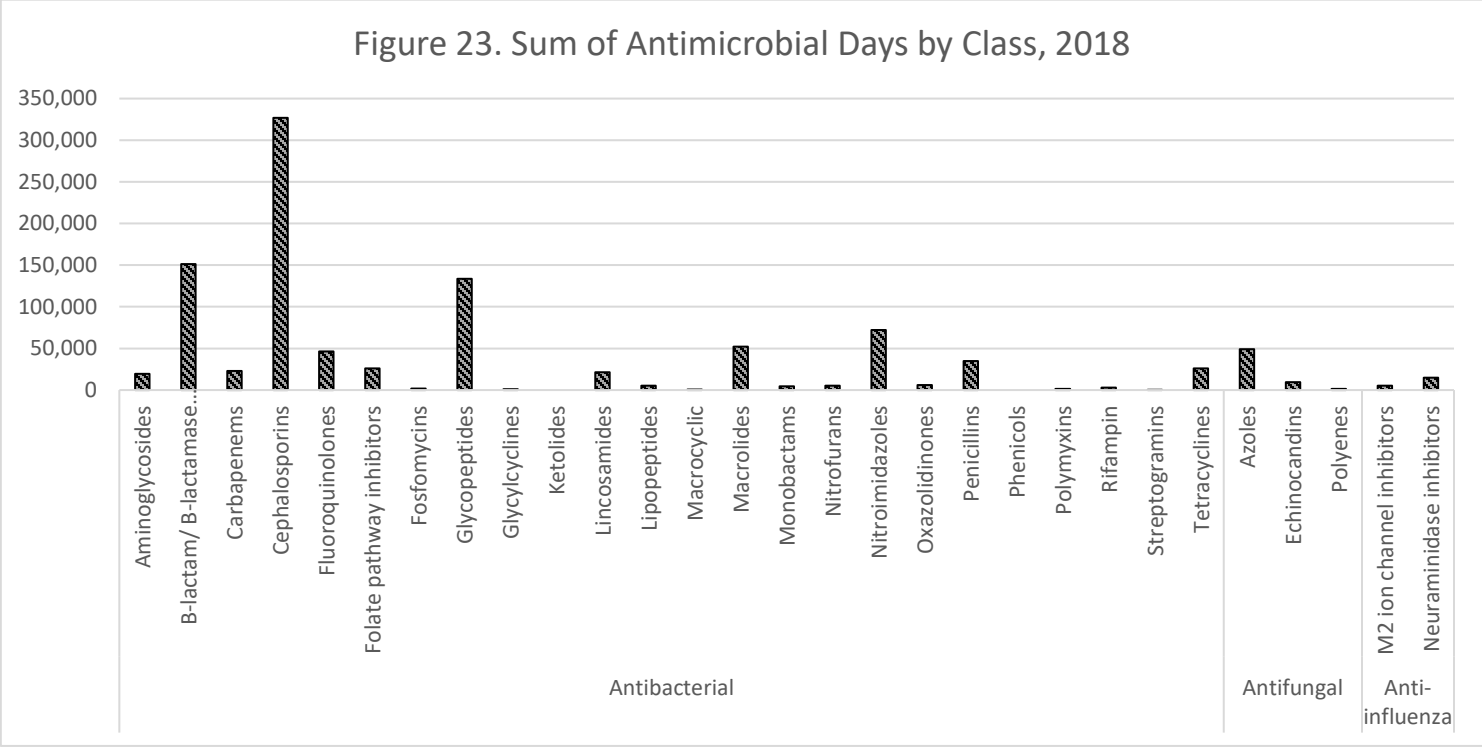


Figure 23 further stratified the data shown above by class. In the antibacterial category, cephalosporins had the greatest number of antimicrobial days with 326,804 days. Additionally, the azole and neuraminidase inhibitor classes had the highest antimicrobial days for the antifungals and anti-influenza categories with 49,199 and 14,872 days, respectively.



The primary metric used in the NHSN AU module is antimicrobial days per 1,000 days present. Days present is defined as the aggregate number of patients housed in a specific patient care location or facility any time throughout a day during a calendar month. Therefore, it is like that the number of days present will be greater than the number of patient days in each facility. In this report, the antimicrobial days and days present were aggregated to the group-level, and outpatient locations were excluded. Table 26 illustrates the rate of antimicrobial days per 1,000 days present for all agents and specific groups of agents followed by the top 3 agents in each group. Information describing each group and the agents included in them can be found in the Antimicrobial Use and Resistance (AUR) Module protocol - Appendix E.

Table 26. Rate of Antimicrobial Days per 1,000 Days Present	
All Agents	
All	409.96
Ceftriaxone	51.30
Vancomycin	50.21
Cefazolin	38.62
Agents with Highest Risk of C. *difficile* Infection	
All	106.393
Ceftriaxone	51.30
Cefepime	24.51
Clindamycin	9.35
Agents Predominately Used for Extensively Antibiotic Resistant Bacteria	
All	1.16
Colistimethate	0.53
Tigecycline	0.30
Ceftazidime/Avibactam	0.17
Agents Predominately Used for Hospital Onset Infections	
All	76.79
Piperacillin with Tazobactam	35.75
Cefepime	24.51
Meropenem	6.21
Agents Predominately Used for Community Onset Infections	
All	75.08
Ceftriaxone	51.30
Ciprofloxacin	9.15
Levofloxacin	8.88

In 2018, the rate for all antimicrobial agents was 409.96 antimicrobial days per 1,000 days present. The top 3 agents in this category were ceftriaxone, vancomycin and cefazolin. Agents with the highest risk of CDI had a rate of 106.93 antimicrobial days per 1,000 days present. Additionally, rates for agents used in hospital-onset infections and community-onset infections were 767.92 and 75.08 antimicrobial days per 1,000 days present, respectively. Lastly, the rate of antimicrobial days for agents used for extensively antibiotic resistant bacteria was 1.16 per 1,000 days present.

Standardized Antimicrobial Administration Ratio (SAAR)

The Standardized Antimicrobial Administration Ratio, or SAAR, is the standardized metric utilized in the Antibiotic Use Module of NHSN. This metric is like the SIR, as observed antimicrobial days to predicted antimicrobial days ratio. The observed antimicrobial days is the reported number of antimicrobial days by a facility in a specific location or agent category. The predicted antimicrobial days is predicted for a hospital based on a negative binomial model, which is applied to nationally aggregated antibiotic use data. The SAAR was developed to allow facilities to make comparisons for antibiotic use data over time and across groups.

Table 27. Standardized Antimicrobial Administration Ratio (SAAR) by Category of Agents

Agent Category	Number of Antimicrobial Days	Number Predicted Antimicrobial Days	SAAR	p-value	95% Confidence Interval
All Antimicrobial Agents	602,277	620,937.07	0.970	0.000	0.967,0.972
Agents Predominately Used for Hospital Onset Infections	138,161	154,897.25	0.892	0.000	0.887, 0.897
Agents Predominately Used for Community Onset Infections	108,358	138,624.41	0.782	0.000	0.777, 0.786
Broad spectrum antibacterial agents predominately used for gram-positive infections	86,661	95,103.04	0.911	0.000	0.905, 0.917
Agents with Highest Risk of C. *difficile* Infection	159,459	172,960.43	0.922	0.000	0.917, 0.926

The following table illustrate the SAAR for five antimicrobial groups, including all antibacterial agents, broad spectrum antibacterial agents predominately used for hospital-onset infections, broad spectrum antibacterial agents predominately used for community-onset infections, broad spectrum antibacterial agents predominately used for gram-positive infections and antibacterial agents posing the highest risk for CDI. All the above categories are limited to adult populations.

A SAAR of greater than 1 is interpreted as more antimicrobials being used than expected in the specific group. As shown in Table 27, no SAARs are greater than 1, and all are significantly less than 1 (p-value >0.05).

CP-CRE MDSS Data

As of January 1, 2018, carbapenemase-producing, carbapenem-resistant Enterobacteriaceae (CP-CRE) became a reportable communicable disease condition in the state of Michigan. Physicians, laboratories, and other authorized healthcare professionals must report CP-CRE cases to the Michigan Disease Surveillance System (MDSS) or the local health department. CP-CRE cases should be reported according to the following surveillance criteria:

- Healthcare record contains a diagnosis of CP-CRE, or any of the following carbapenemase genes in *Klebsiella* spp., *Escherichia coli*, or *Enterobacter* spp.:
    - Klebsiella pneumoniae carbapenemase (KPC)
    - New Delhi metallo-β-lactamase (NDM)
    - Verona integron encoded metallo-β-lactamase (VIM)
    - Imipenemase metallo-β-lactamase (IMP)
    - Oxacillinase-48 type carbapenemase (OXA-48)
    - Other novel carbapenemase gene
- Any isolate of *Klebsiella* spp., *E. coli*, or *Enterobacter* spp. demonstrating carbapenemase production by a phenotypic method (e.g., Carba-NP, modified carbapenemase inactivation method (mCIM))
- Any isolate of *Klebsiella* spp., *E. coli*, or *Enterobacter* spp. with a known carbapenem resistance gene by a recognized test (e.g., PCR, Carba-R)
- If laboratories are unable to detect CP-CRE (i.e., cannot test for carbapenemase production or carbapenem resistance genes), report:
    - Any isolate of *Klebsiella* spp., *E. coli*, or *Enterobacter* spp. with a minimum inhibitory concentration (MIC) of ≥4 µg/mL for doripenem, imipenem, or meropenem, or ≥2 µg/mL for ertapenem

CP-CRE cases are then classified as confirmed or suspect cases according to the following criteria:

- Confirmed: *Klebsiella* spp., *E. coli*, or *Enterobacter* spp. demonstrating carbapenemase production or a carbapenemase resistance gene
- Suspect: *Klebsiella* spp., *E. coli*, or *Enterobacter* spp. demonstrating resistance to 1 or more carbapenem antibiotics when no phenotypic or genetic testing for carbapenemases was performed

This report summarizes the CP-CRE cases reported to MDSS with specimen collection or onset dates between January 1st and December 31st, 2018. Case data was extracted from MDSS on March 6, 2019.

In 2018, a total of 376 cases of CP-CRE were reported into MDSS. Table 28 shows clinical characteristics of CP-CRE cases reported in 2018, where data was available. The mean age of all CP-CRE cases was 65 years, half were female, and 36 percent were Caucasian. Comorbid conditions were common, with 58 percent of cases having a history of cardiovascular disease, 24 percent with diabetes mellitus, and 17 percent with renal failure. Indwelling device use was also common, with 46 percent of CP-CRE cases having a urinary catheter within 2 days of specimen collection, 34 percent with a central venous catheter, and 21 percent requiring mechanical ventilation. Prior healthcare exposure was common, with 74 percent of CP-CRE cases having a recent acute care hospitalization, 48 percent having a recent stay in a long-term care facility, and 52 percent having a recent surgical procedure. Urine was the most common specimen source, with 62 percent of CP-CRE cases identified from urine culture.

Table 28. *Characteristics of CP-CRE Cases*

Characteristic	**N**	**mean**
Age, years	373	65.1
		n (percent)
Female	376	188 (50)
Race	376	
Caucasian		136 (36)
Black or African American		86 (23)
Asian		6 (2)
American Indian or Alaska Native		2 (1)
Other		4 (1)
Unknown		142 (38)
Comorbidities	225	
Cardiovascular disease		130 (58)
Chronic lung disease		58 (15)
Diabetes mellitus		89 (24)
Malignancy		37 (10)
Para- /Hemi- /Quadri- plegia		31 (8)
Renal failure		63 (17)
Device use		
Central venous catheter	194	66 (34)
Urinary catheter	197	90 (46)
Mechanical ventilation	202	42 (21)
Wound VAC	170	15 (9)
Acute care hospitalization in last 90 days	172	128 (74)
Long-term acute care hospitalization in last 90 days	124	27 (22)
Long-term care facility stays in last 90 days	145	70 (48)
Hemodialysis in last 90 days	177	34 (19)
Surgery in last 90 days	181	94 (52)
Organ transplant, ever	165	9 (5)

International travel in last 6 months	134	9 (7)
Specimen Source	376	
Urine		232 (62)
Wound, skin or soft tissue		45 (12)
Respiratory/sputum		38 (10)
Blood		30 (8)
Rectal/perianal		3 (1)
Other		28 (7)

Figure 24 shows the number of CP-CRE cases reported per month. Monthly CP-CRE case reports ranged from 19 to 51 cases per month.

Figure 24. *CP-CRE Cases Reported into MDSS by Month*

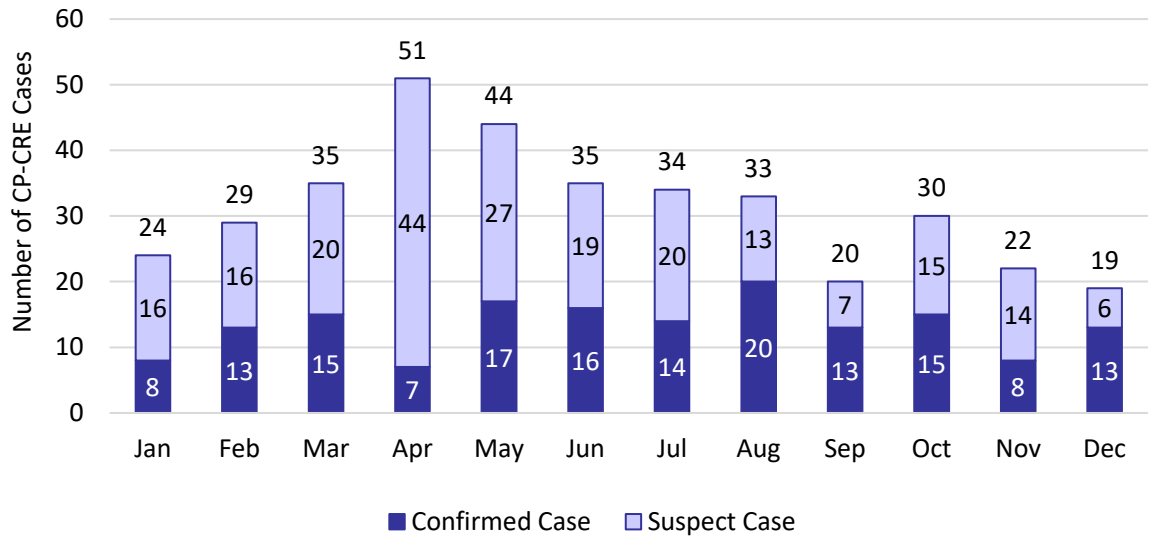


Figure 25 shows the number of CP-CRE cases classified by case status. In 2018, 42 percent of CP-CRE cases were confirmed cases, while 58 percent were suspect cases.

***Figure 25**. CP-CRE Cases by Case Status*

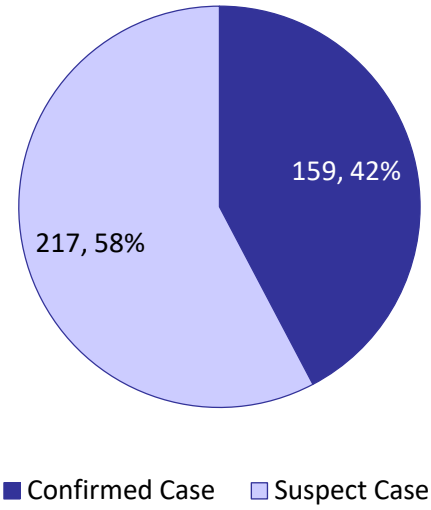


Table 29 shows the number of confirmed and suspect CP-CRE cases by organism. In 2018, *Klebsiella* spp. comprised 53 percent of all CP-CRE cases reported, and 69 percent of all confirmed CP-CRE cases.

***Table 29.** CP-CRE Cases by Case Classification and Organism*

Organism	CP-CRE Cases		
	Confirmed n=159	Suspect n=217	Total n=376
***Klebsiella* spp.**	110 (69)	89 (41)	199 (53)
Klebsiella pneumoniae	102 (64)	68 (31)	170 (45)
Klebsiella aerogenes	4 (3)	14 (6)	18 (5)
Klebsiella oxytoca	3 (2)	7 (3)	10 (3)
Klebsiella variicola	1 (1)	0 (0)	1 (0)
Escherichia coli	23 (14)	69 (32)	92 (42)
***Enterobacter* spp.**	26 (16)	59 (27)	85 (23)
Enterobacter cloacae	26 (16)	57 (26)	83 (22)
Enterobacter asburiae	0 (0)	1 (0)	1 (0)
Enterobacter hormaechei	0 (0)	1 (0)	1 (0)

Figure 26 shows the percentage of confirmed CP-CRE cases by resistance mechanism. In 2018, most confirmed CP-CRE cases harbored a KPC gene (132, 83 percent). However, 14 cases harbored a novel resistance gene (9 percent) such as NDM, OXA-48, or VIM.

Figure 26. *Confirmed CP-CRE Cases by Resistance Mechanism*

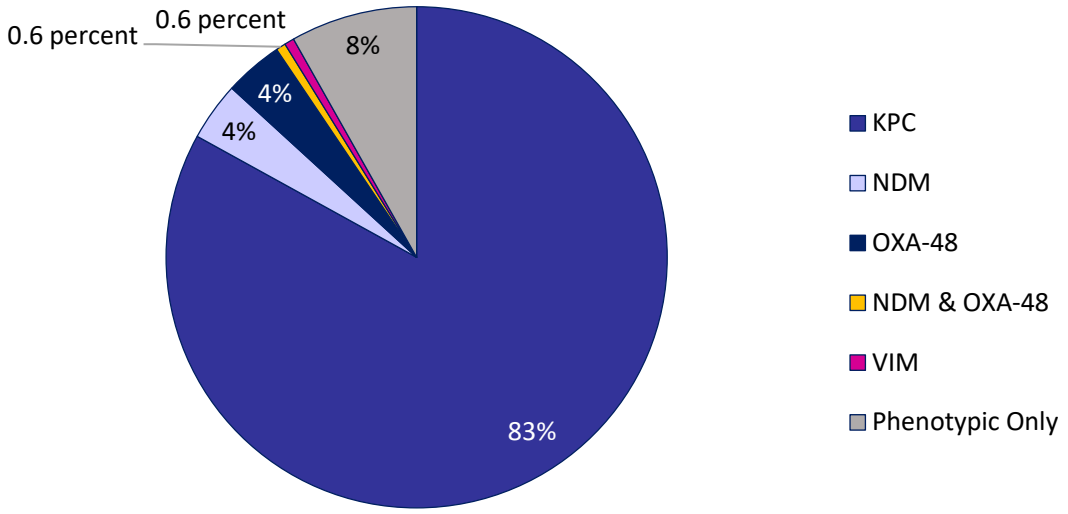


Table 30 shows the number of confirmed CP-CRE cases resistance mechanism and organism. In 2018, *Klebsiella pneumoniae* comprised 65 percent of all KPC cases, and *K. pneumoniae* KPC comprised 54 percent of all confirmed CP-CRE cases. Overall, 17 percent of *Escherichia coli* and 9 percent of *Klebsiella pneumoniae* confirmed CP-CRE cases harbored a novel resistance gene (NDM or OXA-48).

Table 30. *Confirmed CP-CRE Cases by Resistance Mechanism and Organism*

Organism	Resistance mechanism						
	KPC (n=132)	NDM (n=6)	OXA-48 (n=6)	NDM & OXA-48 (n=1)	VIM (n=1)	Phenotypic Only (n=13)	Total (n=159)
***Klebsiella* spp.**	92	3	5	1	1	8	110
Klebsiella pneumoniae	86	3	5	1	0	7	102
Klebsiella aerogenes	2	0	0	0	1	1	4
Klebsiella oxytoca	3	0	0	0	0	0	3
Klebsiella variicola	1	0	0	0	0	0	1
Escherichia coli	18	3	1	0	0	1	23
***Enterobacter* spp.**	22	0	0	0	0	4	26
Enterobacter cloacae	22	0	0	0	0	4	26
Enterobacter asburiae	0	0	0	0	0	0	0
Enterobacter hormaechei	0	0	0	0	0	0	0

Figure 27 shows the geographic distribution of CP-CRE cases by county of residence. In 2018, a total of 73 percent (276/376) of all CP-CRE cases resided in Southeast Michigan (i.e., Macomb, Oakland, Wayne, and City of Detroit).

***Figure 27**. CP-CRE Cases by County of Residence*

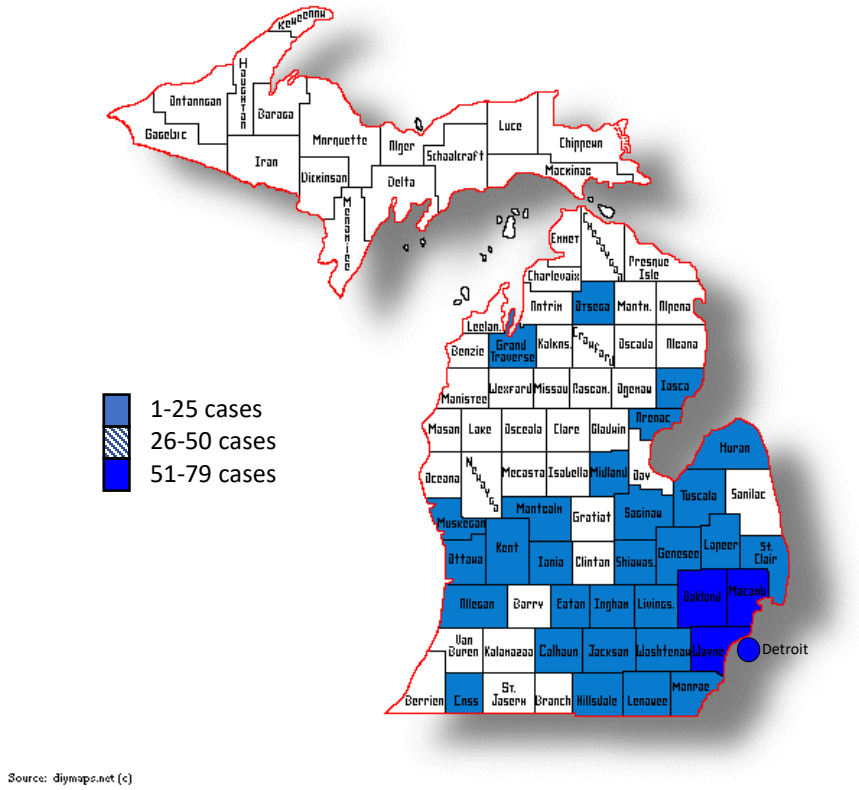
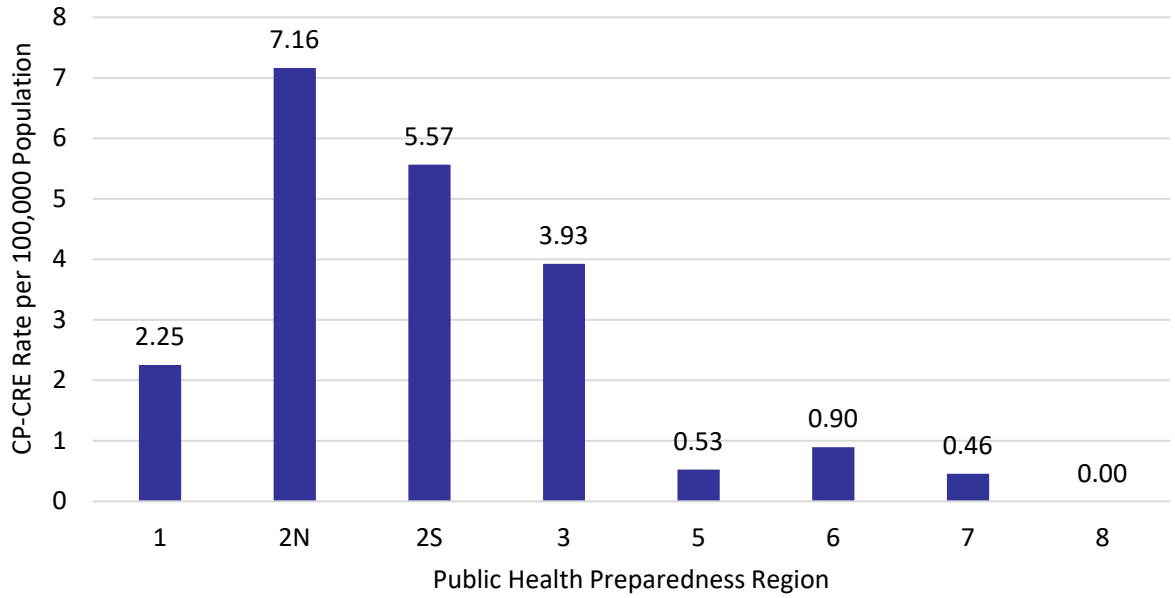


Figure 28 shows the CP-CRE Rate for each public health preparedness region in Michigan. In 2018, Region 2N had the highest reported CP-CRE rate across all regions of the state, at 7.16 per 100,000 population, followed by Region 2S and Region 3 at 5.57 and 3.93, respectively.

Figure 28. *CP-CRE Rate by Public Health Preparedness Region*



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