





Original Article

Healthcare-associated infections in Veterans Affairs acute-care and long-term healthcare facilities during the coronavirus disease 2019 (COVID-19) pandemic

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Abstract

Objective: To assess the impact of the coronavirus disease 2019 (COVID-19) pandemic on healthcare-associated infections (HAIs) reported from 128 acute-care and 132 long-term care Veterans Affairs (VA) facilities.

Methods: We compared central-line-associated bloodstream infections (CLABSIs), ventilator-associated events (VAEs), catheter-associated urinary tract infections (CAUTIs), methicillin-resistant *Staphylococcus aureus* (MRSA), and *Clostridioides difficile* infections and rates reported from each facility monthly to a centralized database before the pandemic (February 2019 through January 2020) and during the pandemic (July 2020 through June 2021).

Results: Nationwide VA COVID-19 admissions peaked in January 2021. Significant increases in the rates of CLABSIs, VAEs, and MRSA all-site HAIs (but not MRSA CLABSIs) were observed during the pandemic in acute-care facilities. There was no significant change in CAUTI rates, and *C. difficile* rates significantly decreased. There were no significant increases in HAIs in long-term care facilities.

Conclusions: The COVID-19 pandemic had a differential impact on HAIs of various types in VA acute care, with many rates increasing. The decrease in CDI HAIs may be due, in part, to evolving diagnostic testing. The minimal impact of COVID-19 in VA long-term facilities may reflect differences in patient numbers and acuity and early recognition of the impact of the pandemic on nursing home residents leading to increased vigilance and optimization of infection prevention and control practices in that setting. These data support the need for building and sustaining conventional infection prevention and control strategies before and during a pandemic.

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Recently, the US Centers for Disease Control and Prevention reported data collected by the National Healthcare Safety Network (NHSN) on the impact of the coronavirus disease 2019 (COVID-19) pandemic on healthcare-associated infections (HAIs) in acute-care hospitals in the United States.¹ They noted an increase in the standardized infection ratios (SIRs) for central-line bloodstream infections (CLABSIs), ventilator-associated events (VAEs), catheter-associated urinary tract infections (CAUTIs), and methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia, but no change in the *Clostridioides difficile* infection (CDI) SIR. Few data from the US Department of Veterans Affairs Health

Administration (VA) were included in that report since <20% of VA facilities voluntarily report to the NHSN and no data from long-term care facilities were included. We are unaware of any report to date analyzing the impact of the pandemic on HAIs in long-term care facilities. Here, we have compared CLABSI, VAE, CAUTI, and MRSA and *C. difficile* rates before the pandemic to those during the COVID-19 pandemic in the VA's 128 acute-care and 132 long-term care facilities, which are part of the largest integrated healthcare system in the nation.

Methods

Monthly HAI data entered by infection prevention and control professionals and dedicated multidrug resistant organism (MDRO) prevention coordinators (MPCs) at each acute-care and long-term care facility (the latter are called “community living centers” or CLCs in the VA) into the centralized VA Inpatient Evaluation Center

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(IPEC) database were analyzed.² Data from February 2019 through January 2020 served as the pre-COVID-19 pandemic 12-month baseline. The requirement for entering HAI data into IPEC was suspended for 5 months from February 2020 through June 2020 because of the COVID-19 pandemic but was reinstated in July 2020, like the suspension of Centers for Medicare and Medicaid Services reporting requirements for HAIs.¹ Data from July 2020 through June 2021 (designated herein as the “pandemic period”) were compared to the prepandemic baseline. Facility data for CLABSIs, VAEs, and CAUTIs were normalized per 1,000 device days, MRSA HAIs were normalized per 1,000 patient or resident days, CDI HAIs were normalized per 10,000 patient or resident days, and device utilization (DU) ratios were calculated as the number of device days divided by the number of patient or resident days. Mean HAI rates and DU ratios per month were compared using the Student *t* test. VAEs were subcategorized as ventilator-associated conditions (VACs), infection-related ventilator-associated complications (IVACs), and possible ventilator-associated pneumonia (PVAP).³ Rates of each subcategory were compared for the prepandemic and pandemic periods using the Student *t* test, and the overall distribution of events in each subcategory between analysis periods was compared using the χ^2 test. Because CDI reporting may be influenced by the testing algorithm [eg, toxin immunoassays (toxin EIA) typically have lower sensitivity than nucleic amplification tests (NAAT) and potentially result in lower rates], the type of CDI diagnostic test was included in the analyses and results were compared using the χ^2 test.⁴ Numbers of CDI complications (colectomies, intensive care unit admissions, and deaths) before and during the pandemic were compared using the Fisher exact test. Definitions for HAIs were those described previously.^{2,5–8}

COVID-19 data were extracted from the VA COVID-19 National Surveillance Tool, which draws and processes data from the VA Corporate Data Warehouse.⁹ The monthly COVID-19 admission prevalence per acute-care facility per month was calculated and compared to the monthly facility HAI incidence using linear regression.

This work was conducted under the University of Cincinnati Institutional Review Board (submission no. 2016-9502), which determined that the analysis of deidentified national VA operational data was a quality improvement/quality assurance activity and did not meet regulatory criteria for research involving human subjects.

Results

All VA acute-care facilities and CLCs nationwide reported data into the IPEC database each month for all HAIs for both 12-month reporting periods.

Acute-care facilities

In the 128 VA acute-care facilities, there was an aggregate of 987,720 admissions during the 2 periods (530,231 before the pandemic and 457,489 during the pandemic) comprising 5,246,582 patient days (2,693,347 before the pandemic and 2,553,235 during the pandemic). The mean number of facility admissions per month decreased 14% from 44,186 ($\pm 1,819$) before the pandemic to 38,124 ($\pm 2,586$) during the pandemic ($P < .0001$). The average length of stay increased 10% from 5.08 days (± 0.13) before the pandemic to 5.60 days (± 0.35) during the pandemic ($P = .0002$). The mean number of monthly COVID-19 admissions to VA acute-care facilities nationwide from July 2020 through June 2021 was 3,417

admissions per month nationwide (range, 790–6,999). The prevalence of monthly facility admissions that were infected with SARS-CoV-2 ranged from 0.35% to 96.72% (59 of 61 admissions in one facility in January). However, there was no correlation between the facility monthly COVID-19 admission prevalence and the monthly facility HAI incidence ($r = 0.08$). There were no significant trends in HAI rates during the 12-month prepandemic period (CLABSIs, $P = .31$; CAUTIs, $P = .99$; VAEs, $P = .17$; MRSA HAIs, $P = 0.86$; linear regression), nor in the 2-year period from February 2018 through January 2020, except for decreasing trends in CDI rates during the prepandemic period ($P = .05$) and the 2-year period ($P < .0001$).

In total, 660,416 central-line days and 678 CLABSIs (including MRSA CLABSIs) occurred during the 2 analysis periods. During the pandemic, the average monthly CLABSI rates increased significantly by 31% and the central-line catheter utilization ratios increased significantly by 3% (Table 1 and Fig. 1).

There were 137,412 ventilator days and 903 VAEs during the 2 analysis periods. Monthly mean VAE rates increased significantly as did ventilator utilization ratios during the pandemic (Table 1 and Fig. 2). Notably, 73% of the 282 prepandemic VAEs were VACs, 23% were IVACs, and 4% were PVAPs, whereas 69% of the 621 pandemic VAEs were VACs, 23% were IVACs, and 8% were PVAPs. The rate of each increased significantly during the pandemic period (VACs, $P = .001$; IVACs, $P = .001$; PVAPs, $P = .004$). However, the distribution of events in these VAE subcategories did not differ statistically ($P > .05$) between analysis periods.

There were 951,135 urinary catheter days and 926 CAUTIs during the 2 analysis periods. The mean monthly rate did not increase significantly during the pandemic although the urinary catheter utilization ratios increased significantly (Table 1).

In total, 518 MRSA HAIs of all body sites were reported during the 2 analysis periods. The mean rates of these HAIs increased significantly by 51% during the pandemic (Table 1 and Fig. 3). The most common MRSA HAIs were bloodstream infections (BSIs) which accounted for ~30% of all MRSA HAIs during both analysis periods; ~65% of BSIs were not device associated. Notably, the average monthly rate of MRSA CLABSIs did not increase significantly during the pandemic (Table 1). Before the pandemic, BSIs were followed in incidence by skin and soft-tissue MRSA infections and non-device-associated pneumonia cases. During the pandemic, non-device-associated pneumonia was the most common MRSA HAI after BSI.

Approximately 1,500 tests for the diagnosis of CDI were performed in the prepandemic period, with a similar number during the pandemic (Table 2). There was a significant shift ($P < .0001$) from using NAAT alone for the diagnosis of CDI to using 2-step testing (NAAT followed by toxin EIA with results of the last test reported in the patient record) during the pandemic. In this context, the mean monthly CDI rates decreased significantly during the pandemic (Table 1). There were 4 colectomies, 14 intensive care unit admissions, and 2 deaths attributable to CDI in the prepandemic period, and 5 colectomies, 12 intensive care unit admissions, and 8 deaths attributable to CDI in the pandemic period, but none of these patients had a COVID-19 diagnosis. The distribution of complications between the 2 analysis periods was not statistically significantly different for colectomies or intensive care unit admissions but was significant for deaths.

Community living centers

In the 132 VA long-term care facilities, there were 76,331 admissions in the 2 12-month periods (49,459 before the pandemic and

Table 1. Monthly Healthcare-Associated Infection Rates in VA Acute-Care Facilities Before and During the COVID-19 Pandemic

Healthcare-Associated Infection	Mean Rate ^a Before the Pandemic	Mean Rate ^a During the Pandemic	P Value	% Change	Mean DU Ratio Before the Pandemic	Mean DU Ratio During the Pandemic	P Value	% Change
CLABSI	0.887 (±0.157)	1.163 (±0.321)	.0165	↑31	0.124 (±0.003)	0.128 (±0.006)	.0284	↑3
VAE	4.501 (±1.114)	7.808 (±2.538)	.0009	↑73	0.023 (±0.001)	0.029 (±0.006)	.0044	↑26
CAUTI	0.932 (±0.151)	1.018 (±0.182)	.2213	↑9	0.176 (±0.005)	0.187 (±0.006)	<.0001	↑6
All MRSA infections	0.079 (±0.026)	0.120 (±0.037)	.0058	↑51				
MRSA BSI	0.024 (±0.009)	0.037 (±0.014)	.0156	↑56				
MRSA CLABSI	0.072 (±0.043)	0.098 (±0.053)	.2019	↑36				
CDI	4.325 (±0.637)	3.606 (±0.397)	.0038	↓17				

Note. MRSA, methicillin-resistant *Staphylococcus aureus*; BSI, bloodstream infection; CLABSI, central-line-associated bloodstream infection; VAE, ventilator-associated event; CAUTI, catheter-associated urinary tract infection; CDI, *Clostridioides difficile* infection; DU, device utilization. Bold indicates statistical significance.
^aPer 1,000 patient days or device days except CDI, which was per 10,000 patient days.

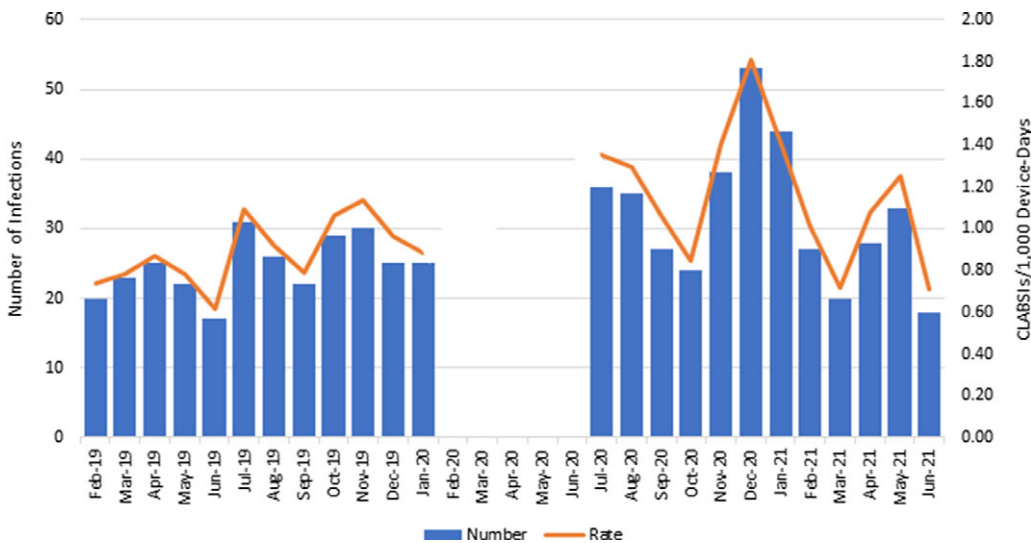


Fig. 1. Nationwide central-line-associated bloodstream infections (CLABSIs) and rates in acute-care facilities 1 year before (baseline) and 1 year during the COVID-19 pandemic. (Data were not required to be reported from February through June 2020.)

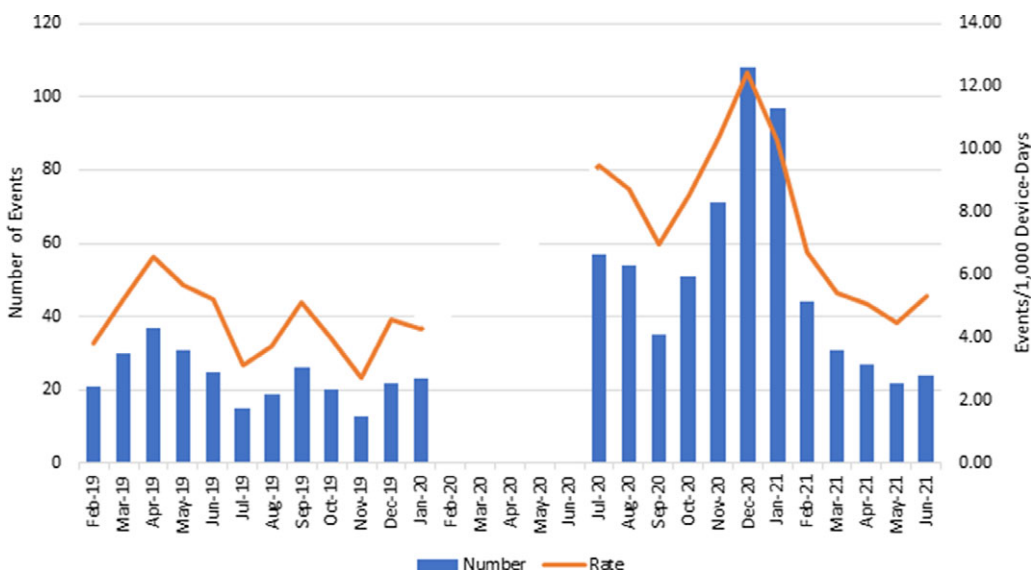


Fig. 2. Nationwide ventilator-associated events (VAEs) and rates in acute-care facilities 1 year before (baseline) and 1 year during the COVID-19 pandemic. (Data were not required to be reported from February through June 2020.)

Table 2. Tests for *Clostridioides difficile* Infection in VA Acute Care (AC) and Long-Term (LT) Care Facilities Before and During the COVID-19 Pandemic

Period	NAAT, No. (%)	NAAT + Toxin EIA, No. (%)	GDH + Toxin EIA Arbitrated by NAAT, No. (%)	Others, No. (%) ^a	Total, No. (%)
Prepandemic AC	930 (60.2)	313 (20.3)	133 (8.6)	168 (10.9)	1,544 (100)
During pandemic AC	728 (47.7)	504 (33.0)	144 (9.5)	150 (9.8)	1,526 (100)
Prepandemic LT	966 (60.4)	263 (16.4)	111 (6.9)	259 (16.2)	1,599 (100)
During pandemic LT	800 (50.6)	425 (26.9)	116 (7.3)	240 (15.2)	1,581 (100)

Note. NAAT, nucleic acid amplification test; toxin EIA, *C. difficile* toxin immunoassay; GDH, glutamate dehydrogenase
^aGDH + NAAT, GDH + toxin EIA, or toxin EIA alone, $P < .0001 \chi^2$ before vs during for both acute and long-term care.

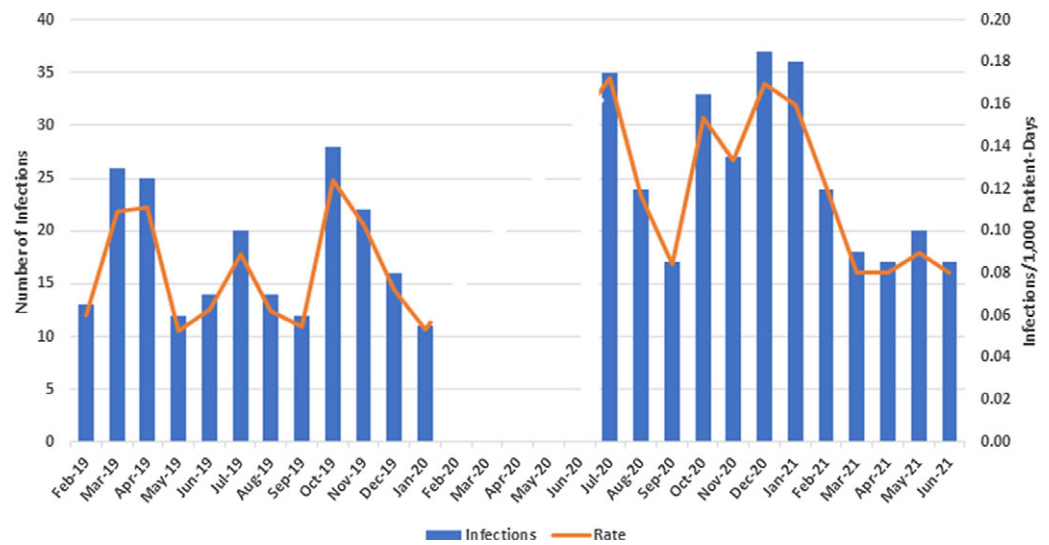


Fig. 3. Nationwide methicillin-resistant *Staphylococcus aureus* (MRSA) health-care-associated infections and rates per 1,000 patient days in acute-care facilities 1 year before (baseline) and 1 year during the COVID-19 pandemic. (Data were not required to be reported from February through June 2020.)

26,872 during the pandemic) comprising 5,717,132 resident days (3,210,571 before the pandemic and 2,506,561 during the pandemic). The mean number of facility admissions per month decreased 46% from 4,122 (± 469) before the pandemic to 2,239 (± 152) during the pandemic ($P < .0001$), and the average length of stay increased 43% from 65.56 days (± 6.32) before the pandemic to 93.57 days (± 5.51) during the pandemic ($P < .0001$). The mean number of monthly COVID-19 admissions to the CLCs nationwide from July 2020 through June 2021 was 2,115 admissions per month (range, 1,863–2,391). We did not detect any significant trends in HAI rates during the 12-month prepandemic period (CLABSIs, $P = .24$; CAUTIs, $P = .53$; MRSA HAIs, $P = .37$; linear regression) nor in the 2-year period from February 2018 through January 2020, except for decreasing trends in CDI rates during the prepandemic period ($P = .0005$) and the 2-year period ($P = .0001$).

In total, 262,736 central-line days and 67 CLABSIs (including MRSA CLABSIs) were reported in the CLCs nationwide during the 2 analysis periods. The average monthly CLABSI rates decreased nonsignificantly by 21% during the pandemic (Table 3). The central-line catheter utilization ratio decreased significantly by 17% during the pandemic.

There were 582,442 urinary catheter days and 831 CAUTIs during the 2 analysis periods. Like acute-care facilities, monthly CAUTI rates in the CLCs did not change significantly during the pandemic, although urinary catheter utilization ratios increased significantly during the pandemic (Table 3).

In total, 496 MRSA HAIs of all body sites were reported during the 2 analysis periods. The monthly mean MRSA HAI rate did not change significantly during these periods (Table 3). The mean monthly rate of MRSA BSIs (device and non-device associated) increased 17%, but this was not statistically significant (Table 3). The monthly mean rates of MRSA CLABSIs increased 120%, but this difference also was not statistically significant.

Almost 1,600 tests were performed for CDI in both the prepandemic and pandemic periods (Table 2), and the shift in diagnostic testing from NAAT alone to 2-step testing during the 2 analysis periods was similar to that in acute care (Table 2). The average monthly CDI rates during the pandemic decreased significantly by 26% from that of the prepandemic period.

Discussion

These findings for HAI rates in the national VA healthcare system during the pandemic compared to the immediate prepandemic period add to observations regarding the impact the pandemic has had on patient safety and healthcare operations. Early reports suggested that from 3% to 50% of patients with COVID-19 died of a secondary infection,^{10–13} but many of these studies were not from the United States and did not adequately describe the timing of the infections, making it difficult to distinguish community infections from health-care-associated infections. In a large study from the United Kingdom, clinically significant respiratory or bloodstream culture results were obtained from only 1,107 (2.3%) of 48,902

Table 3. Monthly Healthcare-Associated Infection Rates in VA Long-Term Care Facilities Before and During the COVID-19 Pandemic

Healthcare-Associated Infection	Mean Rate ^a Before the Pandemic	Mean Rate ^a During the Pandemic	P Value	% Change	Mean DU ratio Before the Pandemic	Mean DU Ratio During the Pandemic	P Value	% Change
CLABSI	0.281 (±0.148)	0.219 (±0.182)	.3664	↓21	0.060 (±0.003)	0.050 (±0.006)	.0001	↓17
CAUTI	1.386 (±0.221)	1.473 (±0.355)	.4758	↑6	0.120 (±0.005)	0.128 (±0.005)	.0012	↑6
All MRSA infections	0.087 (±0.023)	0.086 (±0.029)	.9555	↓1				
MRSA BSI	0.012 (±0.006)	0.014 (±0.012)	.5921	↑17				
MRSA CLABSI	0.030 (±0.038)	0.066 (±0.093)	.2383	↑120				
CDI	0.943 (±0.314)	0.694 (±0.187)	.0299	↓26				

Note. MRSA, methicillin-resistant *Staphylococcus aureus*; BSI, bloodstream infection; CLABSI, central-line-associated bloodstream infection; CAUTI, catheter-associated urinary tract infection; CDI, *Clostridioideis difficile* infection; DU, device utilization. Bold indicates statistical significance.

^aPer 1,000 resident days or device days except CDI which was per 10,000 resident days.

patients hospitalized with COVID-19, but 71% of these cases were defined as healthcare associated.¹⁴ In one US hospital, microbiologically confirmed HAIs occurred in 12% of 3,028 COVID-19 patients.¹⁵

The most relevant report to our study is the data recently reported from the NHSN.¹ Like VA data, these are nationwide data rather than single-center reports and are not likely to be influenced by local or regional trends. Recently, the NHSN reported increases in CLABSI SIRs of 47%, VAEs of 44.8%, CAUTIs of 18.8% and MRSA BSIs of 33.8% when comparing fourth-quarter data for 2019 and 2020.¹ CDI SIRs decreased by 5.5%. Many of these changes mirror those seen in VA acute-care hospitals. Although we evaluated HAI rates rather than SIRs, we found increases in CLABSI rates of 31%, VAEs of 73%, and MRSA BSIs of 56% when comparing the prepandemic and pandemic periods. The lack of a significant difference in MRSA CLABSIs in the 2 analysis periods in the face of a significant difference in total MRSA BSI rates may have been due the relatively small number of MRSA CLABSIs reported (2.00 ± 1.21 per month before vs 2.67 ± 1.44 during the pandemic). In contrast to NHSN, there were no significant changes in CAUTI rates in the VA, and like NHSN, CDI rates decreased. The lack of an impact of the COVID-19 pandemic on CDI HAIs has been reported by others and has been postulated to be due to less antibiotic use or the ordering of fewer tests.^{1,16,17} In VA, antibiotic utilization during the pandemic period did decrease to levels below those of the prepandemic period, but there was little difference in the number of CDI diagnostic tests performed (Table 2).¹⁸ Before the pandemic, there was a significant decreasing trend in CDI rates nationwide in both acute care and long-term care. This trend may have been the result of improved infection control. However, when the 2 periods are compared, our data show a significant shift from using NAAT alone to NAAT followed by toxin EIA with the results of the last test being used for surveillance reporting. This shift may have had an effect of masking any CDI HAI increases; we have previously shown that adoption of 2-step testing in VA decreased the laboratory-reported incidence of CDI by >60%.⁴

The VA has had formal nationwide MDRO prevention programs in place in all patient and resident care venues for MRSA beginning in 2007 and CDI since 2012. These programs are managed by dedicated personnel at each facility and have been continuously monitored by the VA National Infectious Diseases Service, with infection control guidelines updated periodically. The programs have been associated with significant decreases in MDRO

HAIs in acute care, spinal cord injury units, and the CLCs^{7,8,19,20} and have been associated with decreases in gram-negative bacteremias.²¹ In addition, VA has had comprehensive bundle-based prevention initiatives for device-associated HAIs starting with CLABSIs in 2005 and expanding to CAUTIs and VAP/VAEs in all patient and resident care venues by 2010.^{6,22} This effort has been coordinated nationally through IPEC supplying support for infection prevention and control personnel working to implement the prevention bundles. In this context, VA Central Office promulgated a comprehensive pandemic response and operations plan to protect veterans, their families, and the workforce in March 2020. This plan proactively addressed screening and management of patients, infection control, laboratory resources, logistics, communications, pharmacy, and other key activities within outpatient venues and acute-care and long-term care inpatient facilities.²³ However, the COVID-19 pandemic has stressed healthcare systems in the United States extensively, which may have resulted in marginalized or altered routine infection prevention and control practices at some acute care VA facilities to focus on more emergent problems. These changes in practice may have resulted in the atypical use of PPE (eg, extended wear and reuse), foregoing hand hygiene at indicated times and alterations to recommended cleaning and disinfection needed to prevent transmission of other pathogens as has been described in other, non-VA, settings during the pandemic²⁴ and may account for the increased CLABSIs, VAEs, and MRSA HAIs observed in some VA acute-care facilities.

Changes in healthcare utilization in VA facilities might have led to an inpatient population that was systematically at higher risk of an HAI due to underlying severity of illness. The increases in some HAIs may not have been due to lapses in infection control. Elective admissions were often postponed, as shown by a 19% decrease in completed surgeries. The increased LOS and device utilization rate during the pandemic are consistent with patients being more acutely ill. Although healthcare personnel numbers (medical doctor, registered nurse, pharmacist, medical support assistant) increased 3%–8% during the pandemic and healthcare worker absenteeism peaked at only slightly more than 1.6% in December 2020,²⁵ data on healthcare worker to patient/resident ratios are not available, nor are data on case mix indices or other factors that might help explain the increases in HAIs.

The limited effect of the COVID-19 pandemic on HAIs in VA long-term care facilities may be the result of several interventions. Rigorous protocols were implemented for symptom monitoring, diagnostic testing and screening, resident and staff isolation, and

quarantine. CLC staff were restricted to working only in a CLC (often specific units), and nonessential staff were restricted from access, thereby limiting the potential for introduction of the virus by staff who had worked in other environments. Some facilities restricted new admissions or required new admissions to quarantine prior to being admitted to the main facility. Restrictions were placed on visitors; visits by residents outside the CLCs were postponed; and respite care was paused. These policies and an emphasis on the threat of COVID-19 to nursing home residents may have made staff more acutely aware of healthcare-associated infections in general and reinforced the need to practice good infection control.^{26,27}

This study had several strengths. We included a large number of facilities from across the United States, included long-term care data, reported MRSA HAIs in addition to BSIs, broke down VAEs by subcategory, reported CDI complications, and offered potential reasons for CDI HAIs decreasing during the pandemic. Evaluation of a vulnerable population of predominantly elderly patients/residents with respiratory, cardiovascular, and endocrinologic comorbidities predisposing them to adverse outcomes of SARS-CoV-2 infection may also be a strength.⁹

This study also had several limitations. We were unable to determine the relative risk of bacterial or fungal HAIs in SARS-CoV-2-infected patients because our data were collected in aggregate and not on a patient-level basis. Notably, this determination was not reported in the review of NHSN data, even though patient-level data were collected.¹ As with NHSN, VA HAI data were manually entered into a national database by personnel at each facility, potentially allowing errors in reporting. We are unaware of any current, large, national databases for HAIs that operate solely using in silico data extraction. Finally, the apparent success of limiting HAIs in VA long-term care facilities may not be generalizable to non-VA nursing homes that may have fewer resources and are less able to implement the stringent admission and isolation protocols used in the VA.

We observed increases in some HAIs in acute care but not in long-term care facilities during the pandemic. Additional study to determine the reasons behind this, and continued surveillance for HAIs in both settings, are needed during crises such as the COVID-19 pandemic to clarify what can be improved for building and sustaining infection control programs to withstand future pandemics.

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