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Concise Communication

Methicillin-resistant *Staphylococcus aureus* bacteremia during the coronavirus disease 2019 (COVID-19) pandemic: Trends and distinguishing characteristics among patients in a healthcare system in New York City

Saif Aslam MD[1], Habtamu Asrat MD[1], Rina Liang MD[2], Wenqi Qiu MPH[3], Subin Sunny PharmD[4], Anna Maro MD[1], Marie Abdallah MD[1], Mary Fornek RN[5], Briana Episcopia RN[6] and John Quale MD[1]

[1]Division of Infectious Diseases, NYC Health+Hospitals/Kings County, Brooklyn, New York, [2]Department of Medicine, SUNY-Downstate Medical Center, Brooklyn, New York, [3]School of Public Health, SUNY Downstate Medical Center, Brooklyn, New York, [4]Department of Pharmacy Services, NYC Health+Hospitals/Kings County, Brooklyn, New York, [5]Department of Infection Control and Prevention, NYC Health+Hospitals/Central Office, New York, New York and [6]Department of Infection Control and Prevention, NYC Health+Hospitals/Kings County, Brooklyn, New York

Abstract

During the pandemic, the rate of healthcare facility–onset methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia was 5 times greater in patients admitted with coronavirus disease 2019 (COVID-19). The presence of central lines and mechanical ventilation likely contribute to this increased rate. The number of central-line–associated bacteremia cases may be underestimated in patients with COVID-19.

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Reports early in the coronavirus disease 2019 (COVID-19) pandemic documented marked reductions in healthcare-acquired infections, including those due to methicillin-resistant *Staphylococcus aureus* (MRSA). This reduction has been attributed to compliance to personal protective equipment.[1,2] However, subsequent studies have not been as promising.[3–7] National Healthcare Safety Network (NSHN) data gathered during 2020 showed a significant increase in MRSA bacteremia across US hospitals compared to 2019.[3] Moreover, increasing evidence shows that coinfection with COVID-19 and MRSA bacteremia is associated with poor clinical outcomes.[7–9] In this report, we document trends of healthcare facility-onset (HCFO) MRSA bacteremia infections across a public health hospital system in New York City during the COVID-19 pandemic. Also, the clinical features and the potential impact on NHSN reporting of healthcare facility–onset (HCFO) MRSA infections in patients with and without COVID-19 are examined.

Methods

The New York City Health and Hospitals Enterprise consists of 11 public, acute-care, medical centers. All are tertiary-care academic hospitals serving patients primarily of low socioeconomic status in the boroughs of Bronx, Brooklyn, Manhattan, and Queens.

Data for patients with laboratory-identified MRSA bacteremia were obtained from the NHSN database. HCFO cases were retrospectively reviewed. We excluded cases with a positive culture during the first 3 days of admission and cultures that fell within the 14-day repeat-infection time frame. In addition to basic demographic information, cases were reviewed to determine whether they met the criteria for secondary bacteremia. Specifically, related criteria during the infection window period were sought for the following NHSN-defined infections (https://www.cdc.gov/nhsn/pdfs/pscmanual/17pscnosinfdef_current.pdf): pneumonia (PNU2), endocarditis (ENDO), septic arthritis (JNT), osteomyelitis (BONE), and discitis (DISC). Antimicrobial use data (days of therapy per 1,000 patient days) for each hospital were obtained from the NHSN. For patients with COVID-19, the use of mechanical ventilation (within 3 days of bacteremia) and corticosteroids (within 7 days) were also documented. For each calendar quarter, the number of inpatients per day with an admission diagnosis of COVID-19 was determined. Using that data, the numbers of patient days per quarter of patients with and without a COVID-19 diagnosis were calculated.

The Student *t* test, χ^2 analysis, and the Fisher exact test were used to compare continuous and categorical values. Univariate and multiple regression analyses were used to correlate system census and consumption of specific antibiotics with rates of MRSA bacteremia. This study was approved by the SUNY Downstate Medical Center Institutional Review Board and the Health and Hospitals System to Track and Approve Research program.

Results

Trends in HCFO MRSA bacteremia

From January 1, 2019, through March 31, 2022, there were 216 cases of HCFO MRSA bacteremia across the 11 hospitals

Author for correspondence: Marie Abdallah, E-mail: marie.abdallah@nychhc.org
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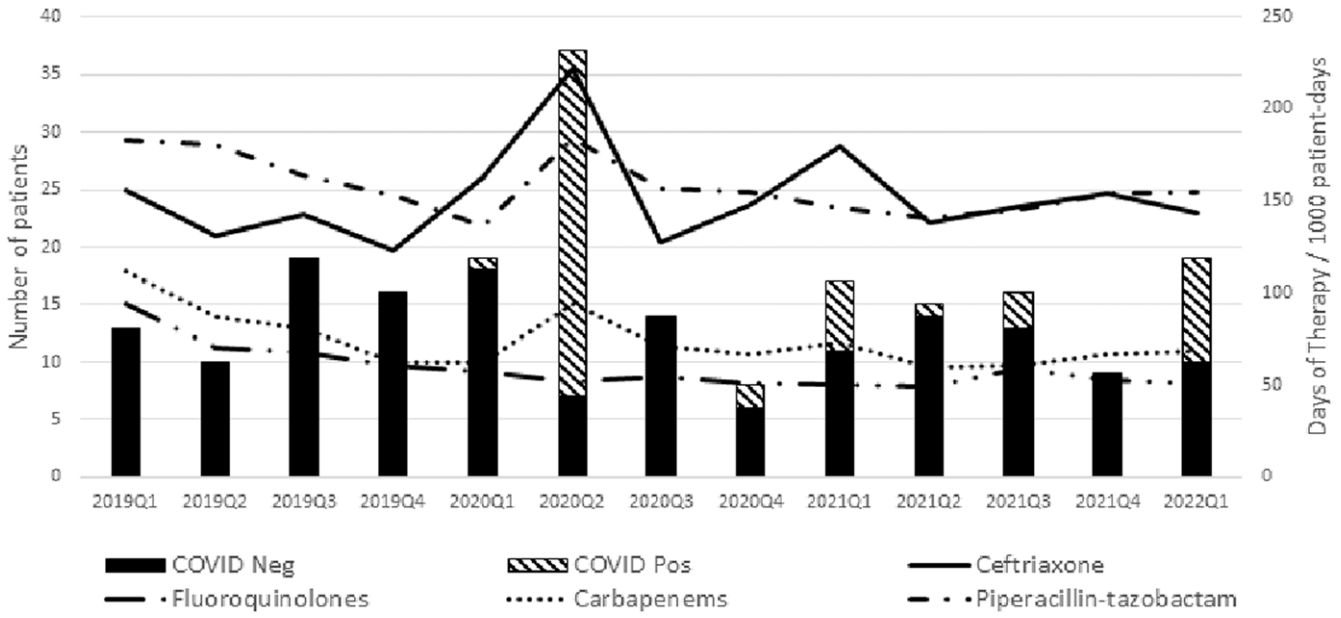

Fig. 1. Trends of patients with healthcare facility-onset MRSA bacteremia and antibiotic consumption January 2019–March 2022.

Table 1. Distinguishing Characteristics of Patients With and Without COVID-19 and HCFO MRSA Bacteremia

Variable	SARS-CoV-2 Negative Patients (n = 164), No.	SARS-CoV-2 Positive Patients (n = 52), No.	*P* Value
NHSN defined infection			
PNU2	64	41	<.0001
ENDO	12	0	.07
JNT	2	0	NS
BONE/DISC	8	1	NS
CLABSI	20	4	NS
Central-line data			
Total central catheters	38	20	.05
Short-term central catheters	22	14	.03
Time from insertion to bacteremia, d	13.0±13.1	7.1±3.5	.04

Note. NS, not significant; HCFO, healthcare facility onset; MRSA, methicillin-resistant *Staphylococcus aureus*; PNU2, pneumonia; ENDO, endocarditis; JNT, joint infection; BONE/DISC, osteomyelitis/discitis; CLABSI, central-line–associated bloodstream infection.

(Fig. 1). The baseline rate of MRSA bacteremia in 2019 was 0.073 per 1,000 patient days. During surges of COVID-19, markedly increased rates of MRSA bacteremia were observed in patients with COVID-19. The rates of MRSA bacteremia for patients with COVID-19 during the initial surge (2020-Q2), the SARS-COV-2 α (alpha) wave (2021-Q1), the SARS-COV-2 δ (delta) wave (2021-Q3), and the SARS-COV-2 o (omicron) wave (2022-Q1) were 0.53, 0.20, 0.51, 0.43 infections per 1,000 patient days, respectively. During the pandemic period (2020-Q1 through 2022-Q1), the overall rate of MRSA bacteremia in patients without COVID-19 was 0.065 per 1,000 patient days. During the same period, the rate of MRSA bacteremia was 0.34 per 1,000 patient days in patients with COVID-19 ($P < .0001$). During 2020-Q2, there was a marked increase in ceftriaxone use (Fig. 1). Univariate linear regression analysis correlating the system inpatient census, ceftriaxone, fluoroquinolone, carbapenem, or piperacillin-tazobactam usage with quarterly MRSA bacteremia rates revealed a significant correlation only with ceftriaxone usage ($P = .005$). However, with multiple regression analysis, this association was no longer statistically significant ($P = .11$).

Comparison of HCFO MRSA bacteremia in patients with and without COVID-19

Of the 216 cases of HCFO MRSA bacteremia from January 1, 2010, to March 31, 2022, 52 cases (24%) occurred in patients with an admitting diagnosis of COVID-19. Patients with COVID-19 were older (67.2±11.1 vs 55.6±20.8 years; $P < .0001$), more likely to be Asian (31% vs 4%; $P < .0001$), and less likely to be Black (13% vs 36%; $P = .002$). The time from admission to bacteremia was similar in patients with and without COVID-19 (20.7±24.6 vs 27.8±57.0 days; $P = .20$). Compared to those without COVID-19, more patients with COVID-19 were receiving care in an intensive care area at the time of MRSA bacteremia (58% vs 34%; $P < .0001$). Of the patients with COVID-19, 77% were on mechanical ventilation and 63% were receiving corticosteroids. Mortality rates were higher in the patients coinfected with COVID-19 (81% vs 34%; $P < .0001$). Only 4% of patients with HCFO MRSA and COVID-19 were discharged home, compared to 23% of patients without COVID-19 ($P = .002$).

Criteria for PNU2 was fulfilled in 79% of patients with COVID-19 (Table 1), compared to 39% of patients without COVID-19 ($P < .001$). Only 2 patients with COVID-19 had a clinically suspected skin or soft-tissue source of the bacteremia, compared to 13 patients without COVID-19 (*P* value not significant).

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In addition, 20 central catheters (in 18 patients) were in place at the time of bacteremia in patients with COVID-19, compared to 38 catheters (in 37 patients) at the time of bacteremia in patients without COVID-19 ($P = .05$). The time from catheter insertion to infection was shorter in patients with COVID-19 (8.4±6.1 vs 16.9±24.7 days; $P = .05$). Of the 18 patients with COVID-19 and central-venous catheters, only 4 had CLABSIs. In contrast, 20 of the 37 patients without COVID-19 had a CLABSI ($P = .04$).

Discussion

The association of *S. aureus* infections in patients with COVID-19 has generated comparisons with the linkage of *S. aureus* with influenza. During influenza pandemics, increased cases of community-onset coinfection of *S. aureus* have been well documented.[8,9] In contrast, bacterial infections are relatively uncommon upon admission for patients with COVID-19.[5,7] Rather, coinfection in patients with COVID-19 with multidrug-resistant bacteria, including MRSA, is common after prolonged hospitalization.[5–8] In this study, the rate of HCFO MRSA bacteremia was ~5 times higher than that in patients without COVID-19 during the pandemic. Similar increased rates have been noted elsewhere and were associated with COVID-19 surges.[4,6] The reasons for increases in healthcare-associated infections during the pandemic, including MRSA bacteremia, are likely multifactorial. As seen with *Clostridioides difficile*, increased antimicrobial pressure early in the pandemic, especially with ceftriaxone, was likely an important contributing factor.[10] The high rates of corticosteroid use and mechanical ventilation in patients with COVID-19 also likely contributed to superimposed MRSA infection. For this 11-hospital enterprise, the case-mix index rose during the pandemic, and staffing shortages were documented (www.osc.state.ny.us/files/reports/osdc/pdf/report-9-2022.pdf).

Compared to patients without COVID-19, distinguishing features were noted in patients with COVID-19 and MRSA bacteremia. Patients with COVID-19 were older and had a significantly higher mortality rate than those without COVID-19. As might be expected, most patients with COVID-19 met the NHSN surveillance definition for pneumonia. However, compared to patients with MRSA bacteremia without COVID-19, significantly more patients with COVID-19 had central lines that were eligible for catheter-related bacteremia. The presence of COVID-19 likely masked the true number of reportable catheter-related bloodstream infections. Because such masking can also occur with gram-negative pathogens, the true number of central-line–catheter infections during the pandemic may be underreported.

This study had several limitations. This study was retrospective in design, which limits the applicability of these findings to patient populations outside NYC. Also, practices between hospitals within the system varied.

The elevated rates of HCFO MRSA bacteremia during the pandemic emphasizes the important role of antibiotic stewardship and infection control efforts, especially during surges of patients with COVID-19.

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