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Original Article

Comparative antimicrobial use in coronavirus disease 2019 (COVID-19) and non–COVID-19 inpatients from 2019 to 2020: A multicenter ecological study

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Abstract

Objective: We sought to determine whether increased antimicrobial use (AU) at the onset of the coronavirus disease 2019 (COVID-19) pandemic was driven by greater AU in COVID-19 patients only, or whether AU also increased in non–COVID-19 patients.

Design: In this retrospective observational ecological study from 2019 to 2020, we stratified inpatients by COVID-19 status and determined relative percentage differences in median monthly AU in COVID-19 patients versus non–COVID-19 patients during the COVID-19 period (March–December 2020) and the pre–COVID-19 period (March–December 2019). We also determined relative percentage differences in median monthly AU in non–COVID-19 patients during the COVID-19 period versus the pre–COVID-19 period. Statistical significance was assessed using Wilcoxon signed-rank tests.

Setting: The study was conducted in 3 acute-care hospitals in Chicago, Illinois.

Patients: Hospitalized patients.

Results: Facility-wide AU for broad-spectrum antibacterial agents predominantly used for hospital-onset infections was significantly greater in COVID-19 patients versus non–COVID-19 patients during the COVID-19 period (with relative increases of 73%, 66%, and 91% for hospitals A, B, and C, respectively), and during the pre–COVID-19 period (with relative increases of 52%, 64%, and 66% for hospitals A, B, and C, respectively). In contrast, facility-wide AU for all antibacterial agents was significantly lower in non–COVID-19 patients during the COVID-19 period versus the pre–COVID-19 period (with relative decreases of 8%, 7%, and 8% in hospitals A, B, and C, respectively).

Conclusions: AU for broad-spectrum antimicrobials was greater in COVID-19 patients compared to non–COVID-19 patients at the onset of the pandemic. AU for all antibacterial agents in non–COVID-19 patients decreased in the COVID-19 period compared to the pre–COVID-19 period.

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The arrival of coronavirus disease 2019 (COVID-19) in March 2020 in the United States was marked by a lack of medical knowledge regarding the illness that led to improvisational patient management.[1,2] Examples of ultimately disproved management strategies include the use of azithromycin, hydroxychloroquine, and ivermectin for their purported antiviral or anti-inflammatory effects,[3–5] and the administration of remdesivir in advanced stages of COVID-19.[6] Antimicrobial use (AU) was similarly extemporary given the need by medical providers to rely on empiricism due to lack of information on bacterial superinfections in COVID-19 and the reallocation of antimicrobial stewardship resources to more pressing healthcare system needs such as the creation and implementation of COVID-19–specific treatment guidance.[7,8]

A retrospective cohort study in 17 hospitals in South Carolina comparing AU from March–June 2020 to the same period in 2019

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found a 7% increase in overall AU in 7 hospitals that admitted patients with COVID-19 and no significant change in 10 hospitals that did not admit patients with COVID-19.[9] Hospitals that admitted patients with COVID-19 had a 16% increase in the use of agents that predominantly target hospital-onset infections and a 10% increase in the use of anti–methicillin-resistant *Staphylococcus aureus* (MRSA) agents compared to the previous year. On a national scale, a report from the Centers for Disease Control and Prevention (CDC) stated that almost 80% of patients hospitalized with COVID-19 from March to October 2020 received an antibiotic.[10] In contrast, current research shows that bacterial coinfections occur in only 4%–8% of hospitalized COVID-19 patients,[11–14] suggesting overuse of antimicrobials in this patient population. Although antimicrobials are lifesaving when used appropriately, any use exposes patients to risks that include allergic reactions, medication toxicity, and *Clostridioides difficile* infection.[15] Therefore, it is important that antimicrobials are used only when needed.

To determine differences in antimicrobial utilization between COVID-19 and non–COVID-19 patients, we conducted a retrospective observational ecological study to compare AU in COVID-19 patients versus non–COVID-19 patients in March–December 2020 (COVID-19 period) and non–COVID-19 patients in March–December 2019 (pre–COVID-19 period). In addition, to examine shifts in antimicrobial utilization in non–COVID-19 patients with the onset of the COVID-19 pandemic, we compared AU in non–COVID-19 patients in the COVID-19 and pre–COVID-19 periods. We stratified inpatients by COVID-19 status, applied AU metrics developed by the National Healthcare Safety Network (NHSN),[16] and measured AU facility-wide and in major intensive care units (ICUs). Our hypotheses were (1) that there was greater use of broad-spectrum antibacterial agents predominantly used for hospital-onset infections as classified by NHSN in COVID-19 patients compared to non–COVID-19 patients and (2) that antimicrobial utilization in non–COVID-19 patients did not increase with the onset of the COVID-19 pandemic.

Methods

Data sources

We leveraged existing informatics infrastructure developed for Chicago-Area Patient Centered Outcomes Research Network (CAPriCORN) at 3 tertiary acute-care hospitals in Chicago, Illinois, that transformed electronic health record data into normalized databases with standardized clinical vocabularies using Patient-Centered Outcomes Research Network (PCORnet) common data model specifications.[17] For this project, we augmented the PCORnet common data model with bed location information to capture patient movement within hospital stays.[18] We verified mappings of laboratory SARS-CoV-2 tests to LOINC codes, antimicrobial agents to RxNORM codes, routes of antimicrobial administration to PCORnet value sets,[19] and facility unit locations to CDC location code sets for inpatient location.[20] Data from the 3 hospitals were sent to Medical Research Analytics and Informatics Alliance (MRAIA) for data aggregation and analysis. The study protocol was approved by the Chicago-Area Institutional Review Board.

Query development

A central SQL query was developed and distributed to each hospital to run against normalized databases to extract the monthly number of antimicrobial days for 91 specific antimicrobial agents and the monthly number of patient days present stratified by COVID-19 status, both facility-wide and in major ICUs. We included ICU types that were shared across the 3 hospitals, classified as medical critical care, surgical critical care, medical cardiac critical care, and medical-surgical critical care. Antimicrobial days and patient days present conformed to NHSN rules for counting and aggregation,[16] and SARS-CoV-2 tests included nucleic acid amplification, rapid antigen immunoassay, whole-genome nucleotide sequencing, and virus culture. The CDC location codes, LOINC codes, and RxNORM codes used in this study are listed in Supplementary Table 1 (online).

AU assessment in COVID-19 versus non–COVID-19 patients

If a patient had a specimen collected and a positive result for SARS-CoV-2 within the first 7 days of hospital admission, they were classified as a COVID-19 patient and COVID-19 patient days present were counted from the patient's hospital admission date to discharge date. If a patient had a specimen collected and a positive SARS-CoV-2 result after >7 days following their hospital admission, then they were still classified as a COVID-19 patient, but COVID-19 patient days present were counted from 7 days prior to the patient's earliest specimen collection date to discharge date. Patient days present were defined as non–COVID-19 patient days if the COVID-19 patient days definition was not met. AU in COVID-19 patients was only assessed for days that qualified as COVID-19 patient days present according to the definitions above and was calculated as antimicrobial therapy days per 1,000 COVID-19 patient days present. AU in non–COVID-19 patients was calculated as antimicrobial therapy days per 1,000 non–COVID-19 patient days present.

Antimicrobial categories

We assessed AU for select antimicrobial categories specified by the NHSN, and specific antimicrobials and classes frequently used in clinical settings. The following antimicrobial categories specified by the NHSN were evaluated: adult all antibacterial agents, broad-spectrum antibacterial agents predominantly used for hospital-onset infections, broad-spectrum antibacterial agents predominantly used for community-acquired infections, narrow-spectrum β-lactam agents, and antifungal agents predominantly used for invasive candidiasis.[16] Specific antimicrobials and classes identified by physician experts as frequently used in clinical settings were aminoglycosides (amikacin, gentamicin, and tobramycin), azithromycin, carbapenems (imipenem-cilastatin, meropenem, and ertapenem), ceftriaxone, piperacillin-tazobactam, quinolones (ciprofloxacin, moxifloxacin, and levofloxacin), and vancomycin.

Statistical analyses

AU in COVID-19 patients in March–December 2020 versus non–COVID-19 patients in March–December 2020 (COVID-19 period), AU in COVID-19 patients versus non–COVID-19 patients in March–December 2019 (pre–COVID-19 period), and AU in non–COVID-19 patients in the COVID-19 period versus the pre–COVID-19 period were compared using relative percentage difference in median monthly AU and Wilcoxon signed-rank tests. Tests of homogeneity were conducted using the Levene test among hospitals. A P threshold of .05 was considered statistically significant. Analyses were performed using SAS version 9.3 software (SAS Institute, Cary, NC).

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	COVID 2020 vs Non-COVID 2020, Percent Difference			COVID 2020 vs Non-COVID 2019, Percent Difference			Non-COVID 2020 vs Non-COVID 2019 Percent Difference		
	A	B	C	A	B	C	A	B	C
Facility-Wide									
All antibacterial agents	NS	+19 **	+42 **	NS	+11 **	+30 **	-8 **	-7 **	-8 **
Broad-spectrum antibacterial agents hospital-onset infections	+73 **	+66 **	+91 **	+52 **	+64 **	+66 **	-12 **	NS	-13 **
Broad-spectrum antibacterial agents community-acquired infections	NS	NS	+31 **	NS	NS	+26 **	-11 **	-6 **	NS
Narrow-spectrum beta-lactam agents	-50 **	NS	-32 **	-41 **	NS	-32 **	+15 **	-13 **	NS
Antifungal agents used for invasive candidiasis	NS	NS	NS	NS	NS	NS	NS	NS	-16 **
Major Intensive Care Units									
All antibacterial agents	NS	+18 **	-14 **	NS	+21 **	-22 **	NS	NS	-9 **
Broad-spectrum antibacterial agents hospital-onset infections	+29 **	+27 **	NS	+52 **	+48 **	NS	NS	+17 **	NS
Broad-spectrum antibacterial agents community-acquired infections	NS	NS	NS	NS	NS	NS	NS	NS	NS
Narrow-spectrum beta-lactam agents	-65 **	NS	-39 **	-53 **	NS	-40 **	NS	-20 **	NS
Antifungal agents used for invasive candidiasis	NS	NS	NS	NS	NS	NS	NS	NS	NS

Figure 1. Heat maps of relative percentage differences in median monthly antibiotic use (AU) at 3 hospitals (A, B, and C) for antimicrobial categories specified by the NHSN for (1) COVID-19 patients from March–December 2020 versus non–COVID-19 patients from March to December 2020, (2) COVID-19 patients from March–December 2020 versus non–COVID-19 patients from March–December 2019, and (3) non–COVID-19 patients from March–December 2020 versus non–COVID-19 patients from March–December 2019. Note. $^{**}P \leq .05$. NS, not significant.

Results

Comparative AU shown as heatmaps of relative percentage differences in median monthly AU and corresponding levels of statistical significance for antimicrobial categories specified by NHSN and specific antimicrobials and classes frequently used in clinical settings are shown in Figures 1 and 2. The median monthly AU for COVID-19 patients versus non–COVID-19 patients in the COVID-19 and pre–COVID-19 periods and the median monthly AU for non–COVID-19 patients from COVID-19 versus pre–COVID-19 periods are shown in Supplementary Tables 2 and 3 (online). Given statistically significant variances in certain AU data (eg, in the case of azithromycin in major ICUs between hospital A and B; $P = .019$), information for each hospital is reported separately. Trends for AU for all antibacterial agents, broad-spectrum antibacterial agents predominantly used for hospital-onset infections, azithromycin, and ceftriaxone are shown in Figures 3–5. Congruent and statistically significant differences in AU in at least 2 of 3 hospitals are highlighted in the text below.

Comparative AU for COVID-19 patients versus non–COVID-19 patients from the COVID-19 period

AU for all antibacterial agents facility-wide was significantly greater in COVID-19 patients compared to non–COVID-19 patients from the COVID-19 period in 2 of 3 hospitals (Fig. 1). AU for broad-spectrum antibacterial agents predominantly used for hospital-onset infections was significantly greater in COVID-19 patients compared to non–COVID-19 patients facility-wide in all 3 hospitals and in major ICUs in 2 of 3 hospitals (Fig. 1). AU rates for azithromycin (Fig. 3), carbapenems, ceftriaxone (Fig. 4), piperacillin-tazobactam, and vancomycin facility-wide were significantly greater in COVID-19 patients compared to non–COVID-19 patients from the COVID-19 period in at least 2 of 3 hospitals

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	COVID 2020 vs Non-COVID 2020, Percent Difference			COVID 2020 vs Non-COVID 2019, Percent Difference			Non-COVID 2020 vs Non-COVID 2019 Percent Difference		
	A	B	C	A	B	C	A	B	C
Facility-Wide									
Aminoglycosides (amikacin, gentamicin, tobramycin)	NS	-66 **	+200 **	-70 **	-68 **	+129 **	-66 **	NS	-24 **
Azithromycin	+99 **	NS	+216 **	+59 **	NS	+129 **	NS	NS	-28 **
Carbapenems (imipenem/cilastatin, meropenem, ertapenem)	+84 **	NS	+182 **	NS	NS	+150 **	-25 **	-16 **	NS
Ceftriaxone	+24 **	+39 **	+102 **	+33 **	NS	+98 **	NS	NS	NS
Piperacillin/tazobactam	NS	+52 **	+38 **	NS	+67 **	+16 **	NS	NS	-15 **
Quinolones (ciprofloxacin, moxifloxacin, levofloxacin)	NS	NS	-56 **	-55 **	NS	-62 **	-17 **	-28 **	-15 **
Vancomycin	+48 **	+54 **	NS	+32 **	+42 **	NS	NS	-8 **	-10 **
Major Intensive Care Units									
Aminoglycosides (amikacin, gentamicin, tobramycin)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Azithromycin	NS	NS	NS	NS	NS	NS	NS	-52 **	-30 **
Carbapenems (imipenem/cilastatin, meropenem, ertapenem)	NS	NS	NS	NS	NS	NS	-18 **	NS	NS
Ceftriaxone	NS	NS	NS	NS	NS	NS	NS	NS	NS
Piperacillin/tazobactam	NS	NS	NS	NS	+51 **	NS	NS	NS	NS
Quinolones (ciprofloxacin, moxifloxacin, levofloxacin)	NS	NS	-52 **	NS	NS	-75 **	-56 **	-37 **	-48 **
Vancomycin	NS	NS	-36 **	NS	33 **	-45 **	NS	NS	-14 **

Figure 2. Heat maps of relative percentage differences in median monthly antibiotic use (AU) at 3 hospitals (A, B, and C) for (1) specific antimicrobials and classes frequently used in clinical settings from March–December 2020 versus non–COVID-19 patients from March–December 2020, (2) COVID-19 patients from March–December 2020 versus non–COVID-19 patients from March–December 2019, and (3) non–COVID-19 patients from March–December 2020 versus non–COVID-19 patients from March–December 2019. Note. $^{**}P \leq .05$. NS, not significant.

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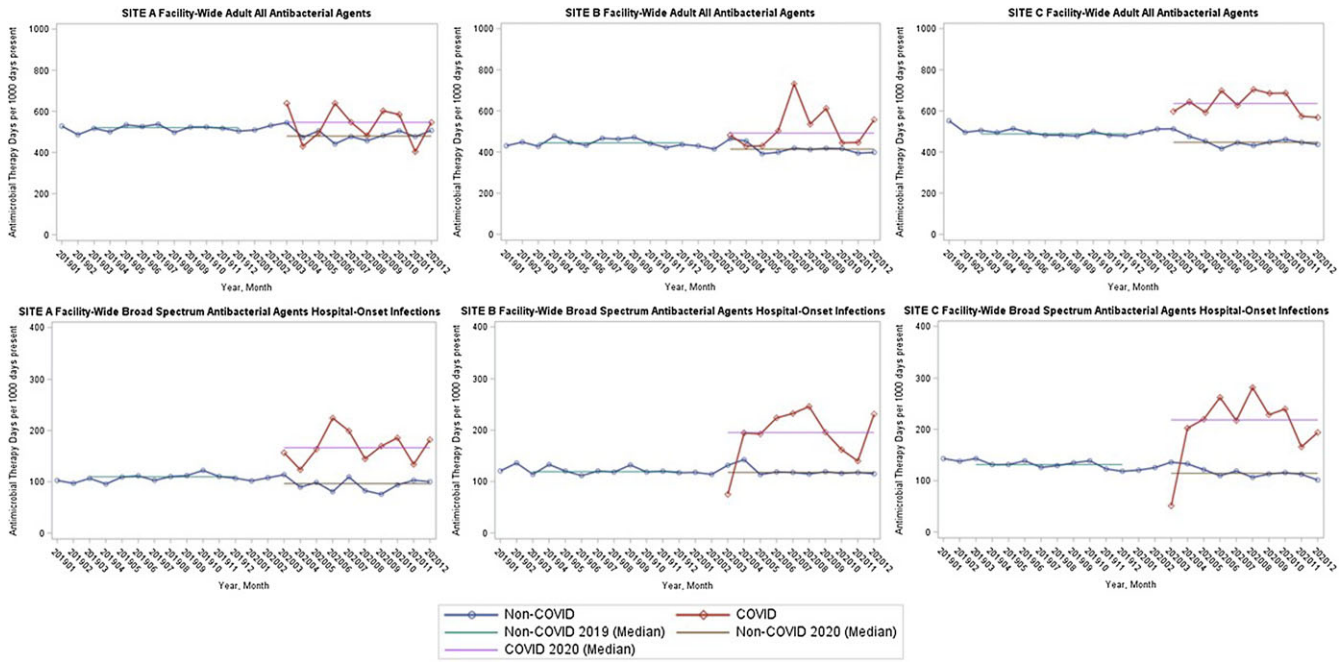

Figure 3. Trends for median monthly antibiotic use (AU) for all antibacterial agents at 3 hospitals (A, B, and C) facility-wide, and trends for median monthly AU for broad-spectrum antibacterial agents predominantly used for hospital-onset infections at 3 hospitals (A, B, and C) facility-wide from January 2019 to December 2020 stratified by COVID-19 status.

(Fig. 2). AU for narrow-spectrum β-lactam agents were significantly lower in COVID-19 patients compared to non–COVID-19 patients facility-wide and in major ICUs in 2 of 3 hospitals (Fig. 1).

Comparative AU for COVID-19 patients versus non–COVID-19 patients from the pre–COVID-19 period

The AU rate for all antibacterial agents facility-wide was significantly greater in COVID-19 patients compared to non–COVID-19 patients from the pre–COVID-19 period in 2 of 3 hospitals (Fig. 1). The AU rate for broad-spectrum antibacterial agents predominantly used for hospital-onset infections was significantly greater in COVID-19 patients compared to non–COVID-19 patients facility-wide in all 3 hospitals and in major ICUs in 2 of 3 hospitals (Fig. 1). The AU rate for azithromycin (Fig. 3), ceftriaxone (Fig. 4), piperacillin-tazobactam, and vancomycin facility-wide were significantly greater in COVID-19 patients compared to non–COVID-19 patients from the pre–COVID-19 period in 2 of 3 hospitals (Fig. 2). The AU rate for narrow-spectrum β-lactam agents and quinolones were significantly lower in COVID-19 patients compared to non–COVID-19 patients facility-wide in 2 of 3 hospitals, and the AU rate was significantly lower for narrow-spectrum β-lactam agents in COVID-19 patients compared to non–COVID-19 patients in major ICUs in 2 of 3 hospitals (Figs. 1 and 2).

Comparative AU for non–COVID-19 patients from the COVID-19 period versus non–COVID-19 patients from the pre–COVID-19 period

The AU rate for all antibacterial agents facility-wide was significantly lower in non–COVID-19 patients from the COVID-19 period compared to non–COVID-19 patients from the pre–COVID-19 period in all 3 hospitals (Fig. 1). AU for broad-spectrum antibacterial agents predominantly used for hospital-onset infections, broad-spectrum antibacterial agents predominantly used for community-acquired infections, aminoglycosides, carbapenems, quinolones, and vancomycin were significantly lower in non–COVID-19 patients from the COVID-19 period compared to non–COVID-19 patients from the pre–COVID-19 period facility-wide in at least 2 of 3 hospitals (Figs. 1 and 2). The AU rates for azithromycin (Fig. 3) and quinolones were significantly lower in non–COVID-19 patients from the COVID-19 period compared to non–COVID-19 patients from the pre–COVID-19 period in major ICUs in at least 2 of 3 hospitals (Fig. 2).

Discussion

In this retrospective multicenter ecological study, the AU rate for broad-spectrum antibacterial agents predominantly used for hospital-onset infections was greater in COVID-19 patients compared to non–COVID-19 patients in COVID-19 and pre–COVID-19 periods in all 3 hospitals facility-wide, and in major ICUs of 2 of 3 hospitals. In contrast, AU rates were lower for all antibacterial agents in non–COVID-19 patients during the COVID-19 period compared to the pre–COVID-19 period. Increased AU rates for broad-spectrum antimicrobials in COVID-19 patients likely resulted from diagnostic and therapeutic uncertainty in the context of high mortality rates in the beginning of the pandemic,[1,2] whereas reduced AU rates for all antibacterial agents in non–COVID-19 patients during the pandemic may have reflected changes in inpatient populations.

Rates of facility-wide use of broad-spectrum antibacterial agents predominantly used for hospital-onset infections (eg, cefepime, meropenem, piperacillin-tazobactam), azithromycin, ceftriaxone, and vancomycin were significantly greater in COVID-19 patients compared to non–COVID-19 patients in at least 2 of 3 hospitals. Empiric administration of broad-spectrum antimicrobials by healthcare providers likely resulted from difficulties in differentiating between bacterial and nonbacterial

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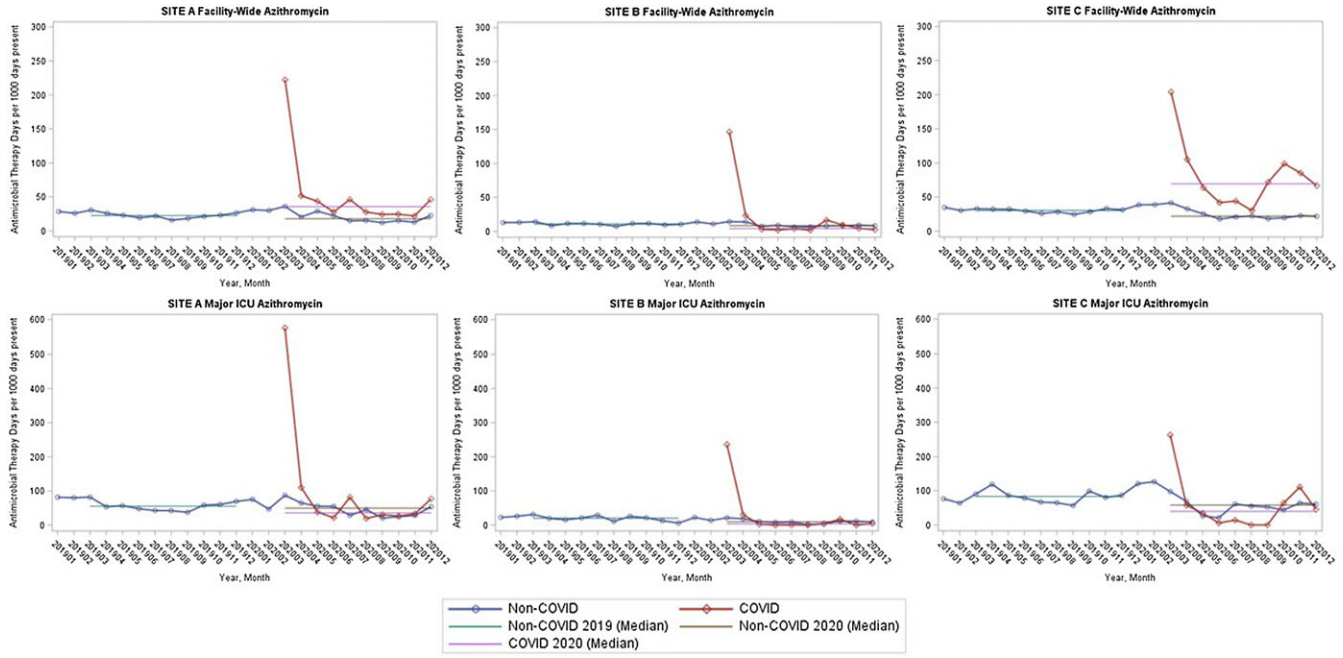

Figure 4. Trends for median monthly antibiotic use (AU) for azithromycin at 3 hospitals (A, B, and C) facility-wide and in major intensive care units from January 2019 to December 2020 stratified by COVID-19 status.

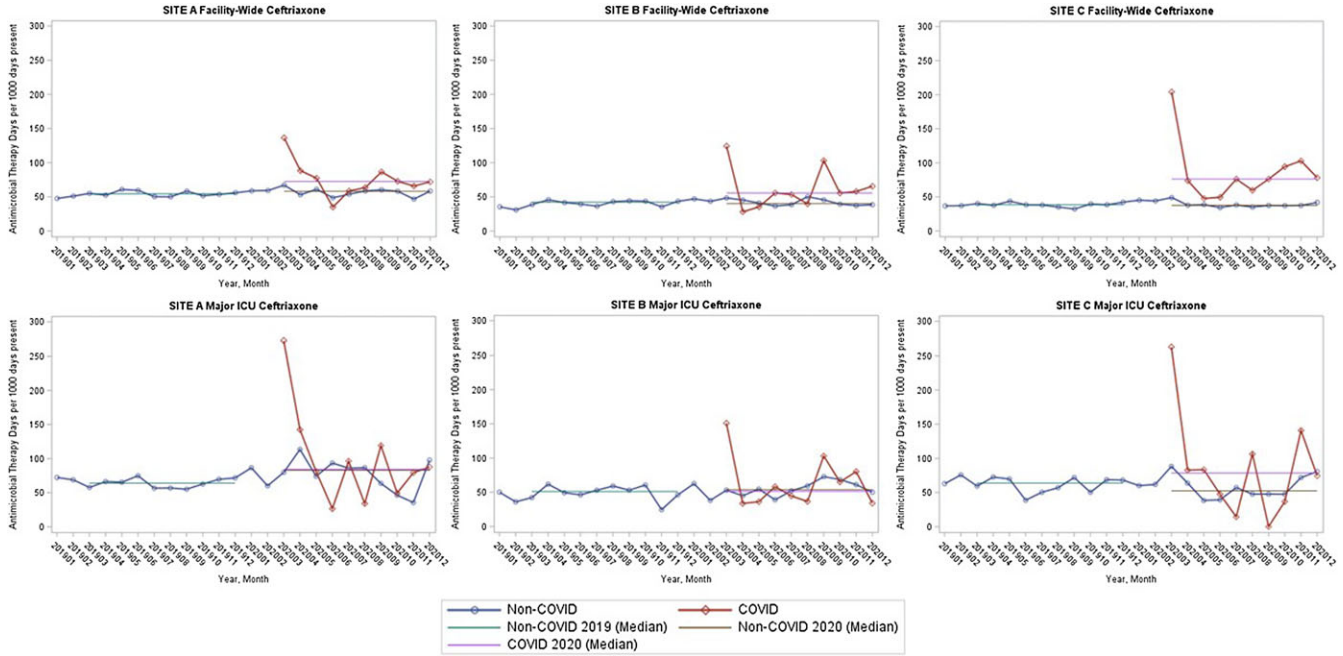

Figure 5. Trends for median monthly antibiotic use (AU) for ceftriaxone at 3 hospitals (A, B, and C) facility-wide and in major intensive care units from January 2019 to December 2020 stratified by COVID-19 status.

causes of systemic inflammatory response syndrome such as virus-induced inflammation and cytokine storm.[11–14] Moreover, exacerbations in underlying comorbidities triggered by COVID-19 (eg, congestive heart failure)[21] and complications of COVID-19 (eg, thrombosis and pulmonary embolism)[22,23] can result in critical illness and can trigger the administration of broad-spectrum antimicrobials. Empiric administration of vancomycin was likely driven by the same factors because prescribers often overestimate the occurrence of methicillin-resistant *Staphylococcus aureus* as a causative agent for infection in inpatient settings.[24]

The administration of ceftriaxone and azithromycin to COVID-19 patients was likely driven by empiric coverage for community-acquired pneumonia.[11] Ceftriaxone and azithromycin administration was especially high in March 2020 in the setting of constrained testing capacity for SARS-CoV-2 at the onset of the pandemic,[25] likely leading healthcare providers to cover for

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bacterial infection given diagnostic uncertainty. In addition, the very high use of azithromycin for COVID-19 patients in March 2020 was likely due to its promotion as a repurposed drug for COVID-19 in response to its purported anti-inflammatory and antiviral properties that were later disproven in randomized controlled trials.[4,5] The marked decrease in azithromycin use starting in April 2020 was likely due to its QTc-prolonging effects, especially when coadministered with hydroxychloroquine, another medication alleged to have antiviral properties against COVID-19 on the basis of in vitro information that was also disproven in randomized controlled trials.[26–28]

The increased use of broad-spectrum antimicrobials at the start of the pandemic led antimicrobial stewardship teams in our hospitals to create COVID-19 antibiotic guidance that recommended use of empiric antibiotics only for patients with critical illness and a high suspicion of bacterial superinfection, use of short-course antibiotic duration of 5 days for patients with suspected bacterial pneumonia, and antibiotic de-escalation based on microbiological culture results.[29] Although this guidance likely reduced ceftriaxone and azithromycin use after March 2020, increased use of broad-spectrum antibacterial agents in COVID-19 patients persisted. This was likely driven by the poor outcomes of COVID-19 patients before the delivery of vaccines and effective therapeutics.[11–14]

Not all antimicrobials were more frequently used in COVID-19 patients. Facility-wide AU rates for narrow-spectrum β-lactam agents and quinolones were significantly lower in COVID-19 patients compared to non–COVID-19 patients in 2 of 3 hospitals. Narrow-spectrum β-lactam agents such as ampicillin, cefazolin, oxacillin, and penicillin G tend to be used more for culture-directed therapy.[30–32] Their less frequent use in COVID-19 patients might reflect fewer culture-proven infections with bacteria (eg, enterococci, staphylococci, and streptococci) for which these agents are commonly used. Quinolones are subject to prospective audit and feedback in our hospitals, and they are often used for culture-directed urinary tract infection treatment, as well as prophylactic antimicrobial therapy in the setting of neutropenia.[33] Their less frequent use in COVID-19 patients might indicate a lower proportion of these indications in COVID-19 patients compared to non–COVID-19 patients, coupled with the audit and feedback that comes with their prescription that might prevent their administration for empiric purposes.

Hospital A was different from hospitals B and C in that it did not have greater AU for all antibacterial agents in COVID-19 patients compared to non–COVID-19 patients from both 2019 and 2020. Hospital A had markedly lower AU of narrow-spectrum β-lactam agents, which offset the increase in AU for broad-spectrum antibacterial agents used for hospital-onset infections. In contrast, hospital B had greater AU for broad-spectrum antibacterial agents used for hospital-onset infections without lower AU for other antibacterial classes, and hospital C had greater AU for broad-spectrum antibacterial agents used for hospital-onset infections and community-acquired infections that was not entirely offset by lower AU for narrow-spectrum β-lactam agents. Reasons for this heterogeneity could not be inferred from the data available in this study, but this trend may relate to differences in hospital operations, characteristics, and patient populations.

Facility-wide AU rates for all antibacterial agents, broad-spectrum antibacterial agents predominantly used for hospital-onset infections as specified by NHSN, broad-spectrum antibacterial agents predominantly used for community-acquired infections as specified by NHSN, aminoglycosides, carbapenems, quinolones, and vancomycin were significantly lower in non–COVID-19 patients from March to December 2020 compared to non–COVID-19 patients from March to December 2019 in at least 2 of 3 hospitals. This trend likely reflected changes in the inpatient population. Elective procedures were deferred, admissions for less critical illnesses were reduced, and the most chronically ill patients who ordinarily would have been admitted for non–COVID-19 indications may instead have been admitted with COVID-19.[34] Moreover, lockdowns led to a decrease in influenza which may have led to less bacterial superinfection requiring hospital admission.[35]

The strengths of our study include the development of queries to output AU in COVID-19 and non–COVID-19 inpatients using only electronic data, and its application across 3 hospitals sharing a common data model that resulted in knowledge regarding AU in COVID-19 and non–COVID-19 patients. However, this study had several limitations. First, we did not capture clinical scenarios associated with antimicrobial administration nor did we examine admission or discharge diagnoses for patients. Therefore, we were unable to analyze patient-level factors associated with antimicrobial administration or examine changes in patient types at the onset of the pandemic. However, to our knowledge, this is the first study to examine population-level AU based on NHSN metrics in inpatients stratified by COVID-19 status. Second, we did not correct *P* values for multiple comparisons because we did not want to increase the chance of making type 2 errors when attempting to minimize type 1 errors.[36] However, we were hypothesis-driven and the most germane AU comparisons numbered only 9 across 3 hospitals. Moreover, the difference in AU rates for broad-spectrum antibacterial agents used for hospital-onset infections between COVID-19 and non–COVID-19 patients was large, reducing the likelihood of a type 1 error. Third, we refresh our CAPriCORN databases only every 6 months, which means that we cannot provide real-time information to stewardship teams, only retrospective information. However, the information yielded by our queries can be reviewed twice a year and is actionable on a programmatic level. Fourth, this was a 3-center study in a single metropolitan area in the United States, and these findings may not be generalizable. However, the queries developed in this study can be run in other medical centers participating in PCORnet provided they also populate ancillary tables on bed information.[18] This research would yield national data on AU in COVID-19 and non–COVID-19 patients and has the potential to be updated on a periodic basis.

In summary, the increased use of broad-spectrum antibacterial agents at the onset of the pandemic was isolated to COVID-19 patients. In contrast, the facility-wide AU rate for all antibacterial agents was lower in non–COVID-19 patients in the COVID-19 period compared to non–COVID-19 patients in the pre–COVID-19 period. These findings suggest that antimicrobial stewardship program effects were durable despite the focus on COVID-19 patients, but prescribers had likely not yet adapted to the complexities of COVID-19 management in the setting of poor outcomes early in the pandemic. Tracking AU in COVID-19 patients may help antimicrobial stewardship programs in providing feedback and education to healthcare providers caring for patients with COVID-19, especially now that it has reached endemic status.[37] Advances in diagnostic testing to identify bacterial superinfection would contribute greatly to optimizing AU.

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Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2023.180

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Conflicts of interest. All authors report no conflicts of interest relevant to this article.

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