

## Concise Communication

# Diagnostic testing and antibiotic utilization among inpatients evaluated for coronavirus disease 2019 (COVID-19) pneumonia

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## Abstract

We evaluated diagnostic test and antibiotic utilization among 252 patients from 11 US hospitals who were evaluated for coronavirus disease 2019 (COVID-19) pneumonia during the severe acute respiratory coronavirus virus 2 (SARS-CoV-2) omicron variant pandemic wave. In our cohort, antibiotic use remained high (62%) among SARS-CoV-2–positive patients and even higher among those who underwent procalcitonin testing (68%).

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Antibiotic use among patients with coronavirus disease 2019 (COVID-19) pneumonia was high throughout the early phases of the pandemic.<sup>1–3</sup> However, the incidence of bacterial coinfection has been consistently low.<sup>1–3</sup> We hypothesized that these reported trends, in conjunction with stewardship efforts, would translate to reduced antibiotic utilization in later waves. Therefore, we report updated information on antibiotic use in hospitalized patients who underwent evaluation for COVID-19 pneumonia during the severe acute respiratory coronavirus virus 2 (SARS-CoV-2) omicron variant wave. We also describe diagnostic testing and its relationship with antibiotic use in this patient population.

## Methods

### Study design and data collection

We conducted a point-prevalence cohort study of hospitalized patients who were evaluated for pneumonia at acute-care hospitals within the Vizient network.<sup>4</sup> We used Vizient e-mail listservs to recruit participating sites. These sites submitted deidentified clinical details obtained through manual chart review into a structured case

report form in REDCap between February 14, 2022, and March 14, 2022. Sites were instructed to select 1 day in the study period and to capture all adult patients that were currently hospitalized for  $\leq 7$  days who presented with symptoms of pneumonia and also underwent SARS-CoV-2 testing. Patients who received a SARS-CoV-2 test for screening purposes only were excluded. Hospital characteristics included geographical location, type, and number of staffed beds. Patient characteristics included age, sex, race, hospital days, and medical comorbidities. The highest and current level of care were also documented at the time of data extraction.

Primary outcomes included diagnostic tests, antibiotic utilization, and antibiotic indication based on provider documentation. Antibiotics given for prophylactic indications were excluded. The secondary outcome evaluated antibiotic utilization in reference to procalcitonin (PCT) ordering because this marker has been proposed as a means to differentiate viral and bacterial pneumonia.<sup>5,6</sup> This study was granted exempt status by the University of Wisconsin Institutional Review Board.

### Statistical analysis

Descriptive statistics were calculated for patient and hospital characteristics, SARS-CoV-2 status, diagnostic testing, and antibiotic initiation, selection, and indication. Between group differences in antibiotic prescribing were assessed using  $\chi^2$  tests

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with significance at  $P < .05$ . All analyses were completed in Stata version 17 software (StataCorp, College Station, TX).

## Results

Data were collected on 260 inpatients across 16 hospitals. In total, 5 sites submitted data on  $\leq 5$  patients which were excluded leaving 252 patients across 11 institutions in the final analysis. The mean age of patients was  $69 \pm 15$  years. Most patients received care at an academic medical center/university hospital (73%). All geographical locations were represented (5 Midwest, 3 Northeast, 2 South, 1 West). Also, 23% of patients required intensive care unit (ICU) level of care during their hospitalization. Almost all patients (99%) had a risk factor associated with poor COVID-19 outcomes, and 54% had  $\geq 3$  risk factors.<sup>7</sup> Patients were hospitalized for an average of  $2.8 \pm 2.0$  days at the time of data collection (Table 1).

Most patients tested negative for SARS-CoV-2 (72%). Diagnostic workup mostly included chest imaging (98%), respiratory viral testing in addition to SARS-CoV-2 (75%), respiratory cultures (23%), and blood cultures (60%). Inflammatory markers were utilized as follows: erythrocyte sedimentation rate (ESR, 11%); C-reactive protein (CRP, 33%); and PCT (46%).

Antibiotics were prescribed to 67% of patients, and the most common indication was pneumonia or unspecified respiratory tract infection (68%). SARS-CoV-2 status did not significantly impact antibiotic prescribing; 62% of patients who tested positive and 69% of patients who tested negative received antibiotics ( $P = .281$ ). In SARS-CoV-2–positive patients, most antibiotics (70%) were prescribed after the SARS-CoV-2 test result.

Antibiotics were more frequently prescribed in patients who were cared for at any time in the ICU compared to the intermediate care unit (IMC) and general care (83% vs 62%;  $P = .004$ ). Procalcitonin was ordered for 66% of SARS-CoV-2–positive patients and 38% of SARS-CoV-2–negative patients ( $P < .001$ ). Procalcitonin use was associated with a significant increase in overall antibiotic use (78% vs 58%;  $P = .001$ ) and a nonsignificant increase among COVID-19 positive patients (68% vs 50%;  $P = .138$ ) (Table 2).

## Discussion

During the SARS-CoV-2 omicron variant pandemic wave (December 2021–February 2022), our point-prevalence study demonstrates that the use of antibiotics in COVID-19 pneumonia remained high. Our numbers are similar to those described in the early pandemic literature.<sup>1–3</sup> This finding is concerning because the rate of bacterial coinfection has been well characterized to be  $< 10\%$ .<sup>1–3</sup> What is even more concerning is that SARS-CoV-2 test results had no impact on antibiotic prescribing. We hypothesized that those with COVID-19 pneumonia would have received fewer antibiotics than those who tested negative; however, that hypothesis was not confirmed in this study. In fact, our data uniquely confirm that most antibiotics were prescribed or continued after the positive SARS-CoV-2 result. Although uncertainty during initial workup may warrant empiric antibiotics, especially in patients being admitted to the ICU, most patients in our cohort were admitted to general care.

Unsurprisingly, most patients did not receive respiratory cultures because national guidelines no longer recommend them because culture results rarely influence antibiotic therapy selection.<sup>5</sup> However, these guidelines were published before the COVID-19 pandemic, and the risk of antibiotic overutilization in the face of diagnostic uncertainty in this population may

**Table 1.** Characteristics of Inpatients Evaluated for COVID-19 Pneumonia (n = 252)

Variable	No. (%)
Sex, female	130 (52)
Hispanic origin	11 (4)
<b>Race</b>	
White	181 (72)
Black or African American	54 (21)
Other	12 (5)
Native Hawaiian or Other Pacific Islander	4 (2)
Asian Indian	1 (0)
<b>Comorbidities</b>	
BMI $\geq 25$	151 (60)
Chronic heart disease	118 (47)
Chronic lung disease	112 (44)
Diabetes mellitus	82 (33)
Immunosuppressive disease or treatment	68 (27)
<b>Highest level of care</b>	
General	155 (62)
Intermediate	39 (15)
Intensive	58 (23)
SARS-CoV-2 positive test	71 (28)
	<b>Mean (SD)</b>
Age, y	68 (15)
Days hospitalized <sup>a</sup>	2.8 (2)

<sup>a</sup>Days hospitalized at time of data collection.

necessitate reconsidering this recommendation. The rates of collection of inflammatory markers in COVID-19 patients, such as PCT, were similar in our cohort to the rates reported in the literature (60%).<sup>8</sup> Procalcitonin ordering was associated with increased antibiotic use. We speculate that this may be due to selective use of PCT in cases of higher clinical suspicion of bacterial coinfection and/or the results of this diagnostic test in COVID-19 patients is being interpreted similarly to prepandemic evidence describing a level  $> 0.25$ – $0.5$  ng/mL as consistent with bacterial pneumonia.<sup>6</sup> The lack of evidence correlating elevated PCT and bacterial coinfection in COVID-19 pneumonia and the literature describing high values due to the inflammatory state from SARS-CoV-2 infection itself should be a focus of diagnostic stewardship moving forward.<sup>8,9</sup>

Our study had several limitations. First, our survey was conducted in a short period, which likely limited participation by Vizient member hospitals. Although our study only included 11 hospitals, our results demonstrate similar practice patterns across geographic region and include statistically significant findings 252 patients. Second, sites that volunteered were primarily academic medical centers and university hospitals. Therefore, our results may not be generalizable to practices in community hospitals. Third, data were extracted at a single time point, so antibiotic duration and final culture results were not captured.

In conclusion, among acutely hospitalized patients evaluated for COVID-19 pneumonia during the SARS-CoV-2 omicron variant wave, antibiotic use in COVID-19 patients remained

**Table 2.** Antibiotic Prescribing for Inpatients Evaluated for COVID-19 Pneumonia by Procalcitonin (PCT) Usage

	Overall, No. (%)			SARS-CoV-2 Negative, No. (%)			SARS-CoV-2 Positive, No. (%)		
	No PCT (n = 136)	PCT (n = 116)	P Value	No PCT (n = 112)	PCT (n = 69)	P Value	No PCT (n = 24)	PCT (n = 47)	P Value
Antibiotics	79 (58)	90 (78)	.001*	67 (60)	58 (84)	.001*	12 (50)	32 (68)	.138

\* $P < .05$ .

high. Noninvasive diagnostic testing with PCT, which has mixed results in the literature for use in guiding antibiotic prescribing in COVID-19 patients, was more common than collection of respiratory cultures and did not reduce antibiotic utilization. Antimicrobial and diagnostic stewardship should remain a top priority for patients admitted with COVID-19 to mitigate unnecessary antibiotic use.

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