Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Bloodstream infections in hospitalized patients before and during the COVID-19 surge in a community hospital in the South Bronx

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Introduction

New York City's (NYC) public health system, which predominantly serves lower-income communities, bore the burden of care and had to ramp up services to respond to the rapidly evolving COVID-19 pandemic. An increase in critical-care beds, staffing, and equipment was integral to the response, especially in our hospital in the South Bronx, where the number of intensive care unit (ICU) beds were augmented from 34 to 195 (Uppal et al., 2020). Hospitalized patients with COVID-19 usually have severe/critical infection with acute respiratory distress syndrome (ARDS), shock, coagulopathies, and multiorgan failure (Zaim et al., 2020). Multiple studies have confirmed that a high frequency of coinfections including bloodstream infections (BSI) have been observed in hospitalized patients with COVID-19 infection, like with other respiratory viruses (Lee et al., 2011; Chertow and Memoli, 2013; Bhatt et al., 2021). Our study aimed to compare the incidence of BSI, clinical and microbial characteristics of infection among patients with BSI before and during the surge of the COVID-19 pandemic.

Methods

This is a single institution, retrospective study of adult hospitalized patients with BSI admitted before (Jan to Feb 2020) and during the COVID-19 surge (March to May 2020). All adult patients hospitalized to Medicine including Medical Intensive Care from January to May 2020 were included in the study if they had a laboratory-confirmed bloodstream infection during their stay. CLABSI (central line-associated bloodstream infection), defined according to the NHSN (National Healthcare Safety Network) 2020 criteria, is a BSI in a patient that had a central line in place for 48 or more hours before the development of the BSI and is not related to an infection at another site. Primary BSI was determined if the patient did not have a clear source of infection whereas secondary BSI was defined by the identification of the same microorganism in blood culture and the suspected source of infection. BSI was classified as community-acquired if occurred within 48 hours of hospital admission and hospital-acquired if occurred after 48 hours of admission. Polymicrobial BSI encompasses the identification of more than one species of microorganisms from a single positive blood culture.

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Table 1
Baseline characteristics, comorbidities, risk factors for BSI & characteristics of BSI during the pre-COVID-19 period (Jan to Feb 2020) & COVID-19 period (March to May 2020). IQR = Interquartile range; COPD = chronic obstructive pulmonary disease; ARDS = acute respiratory distress syndrome; BSI = bloodstream infection; CLABSI = central line associated bloodstream infection; COVID-19 = coronavirus disease 2019.

	Overall n = 148	Pre-COVID-19 Period n = 59	COVID-19 Period n = 89	*P value*
Patient characteristics				
Age, median (IQR)	60.0 (48.3 - 69.0)	60.0 (45.0-69.0)	60.0 (52.0-69.5)	0.158
Females, no (%)	66 (44.6%)	31 (52.5%)	35 (39.3%)	0.113
Race				0.094
Hispanic	85 (57.4%)	30 (50.8%)	55 (61.8%)	
Black	32 (21.6%)	10 (16.9%)	22 (24.7%)	
White	4 (2.7%)	2 (3.4%)	2 (2.2%)	
Asian	3 (2.0%)	2 (3.4%)	1 (1.1%)	
Others	24 (16.2%)	15(25.4%)	9 (10.1%)	
Body mass index				0.158
Underweight	9 (6.1%)	4 (6.8%)	5 (5.6%)	
Normal	55 (37.2%)	28 (47.5%)	27 (30.3%)	
Overweight	34 (23.0%)	12 (20.3%)	22 (24.7%)	
Obese	44 (28.4%)	15 (25.4%)	35 (39.3%)	
Comorbidities				
Charlson comorbidity index	4.0 (2.0-6.0)	3.0 (2.0-6.0)	4.0 (2.0 -6.0)	0.299
Hypertension	88 (59.5%)	29 (49.2%)	59 (66.3%)	0.038
Diabetes mellitus	64 (43.2%)	20 (33.9%)	44 (49.4%)	0.062
Asthma/COPD	29 (19.6%)	13 (22.0%)	16 (18.0%)	0.543
Autoimmune disease	7 (3.9%)	5 (8.5%)	2 (2.2%)	0.090
Chronic kidney disease	21 (14.2%)	6 (10.2%)	15 (16.9%)	0.254
Dementia	7 (4.7%)	1 (1.7%)	6 (6.7%)	0.157
Previous history of cancer	14 (9.5%)	5 (8.5%)	9 (13.0%)	0.739
HIV	19 (12.8%)	10 (16.9%)	9 (10.1%)	0.223
Smoking history	46 (31.1%)	24 (40.7%)	22 (24.7%)	0.040
Risk factors for BSI				
ARDS on admission, n (%)	41 (27.7%)	5 (8.5%)	36 (40.4%)	0.001
Mechanical ventilation, n (%)	67 (45.3%)	16 (27.1%)	51 (57.3%)	0.001
Days of mechanical ventilation, median (IQR)	14.0 (7.0-31.0)	12.0 (1.5-46.2)	16.0 (8.0 -34.0)	0.128
Pressor Use during hospitalization	54 (36.5%)	13 (22.0%)	41 (46.1%)	0.003
Days of pressors, median (IQR)	6.5 (2.8-13.0)	4.0 (1.5-12.5)	7.0 (3.0-13.5)	0.400
Proning, n (%)	21 (14.2%)	1 (1.7%)	20 (22.5%)	0.001
Rectal tube, n (%)	31 (20.9%)	5 (8.5%)	26 (29.2%)	0.002
Anticoagulation use, n (%)	32 (21.6%)	4 (6.8%)	28 (31.5%)	0.001
Steroid use, n (%)	35 (23.6%)	10 (16.9%)	25 (28.1%)	0.118
Length of stay- days, median (IQR)	13.5 (4.3-29.0)	9.0 (4.0 -21.8)	17.5 (9.4-36.2)	0.136
Death, n (%)	45 (30.4%)	9 (15.3%)	36 (40.4%)	0.001
BSI characteristics	Overall n = 164	Pre-COVID-19 Period n = 53	COVID-19 Period n = 111	P value
Primary BSI, n (%)	87 (53.0%)	42 (79.2%)	45 (40.5%)	0.001
Secondary BSI, n(%)	77 (47.0%)	11 (20.8%)	66 (59.5%)	
CLABSI, n (%)	58 (35.4%)	5 (9.4%)	53 (47.7%)	
Number of central venous access per patient, median (IQR)	1.0 (1.0-2.0)	1.0 (1.0-2.0)	1.0 (1.0-2.0)	
Community acquired BSI, n (%)	83 (56.1%)	43 (81.1%)	40 (36.0%)	0.001
Hospital acquired BSI, n (%)	81 (49.4%)	10 (18.9%)	71 (64.0%)	0.001
Time to first positive blood culture from admission – days, median (IQR)	1.8 (1.5-8.8)	1.7 (1.4-2.1)	2.7 (1.5-14.2)	0.003
Days of antibiotic therapy previous to BSI (DOT), median (IQR)	0 (0-15.0)	0 (0-6.0)	3.0 (0-20.5)	0.017
Polymicrobial BSI	15 (9.1%)	7 (13.2%)	8 (7.2%)	0.191

During the pandemic surge, all the blood cultures were collected by accessing the central line. Peripheral blood cultures were not collected. Hence, in the absence of an alternate source of infection, a positive blood culture was considered a CLABSI. Usual skin commensals were excluded from the analysis. Data regarding the incidence of BSI, clinical and microbial characteristics, various therapeutic interventions including central lines, days to positive blood cultures, DOT (days of antibiotic treatment) previous to BSI, length of stay, patient outcomes, etc. were obtained by retrospective chart review. Interventions associated with COVID-19 care including the use of steroids, mechanical ventilation, proning, inotropes, therapeutic anticoagulation were evaluated for correlation with BSI. Descriptive statistics and chi-square tests were used to compare the characteristics of infection. Univariate Cox regression models were used to evaluate the factors independently associated with the development of BSI during the COVID-19 period. Significant variables from this analysis were included in a multivariate model to determine risk associations for the most prevalent BSI.

Results

Of the 148 patients with BSI, 59 were admitted in the pre-COVID-19 period while 89 were admitted during the surge. Baseline characteristics and therapeutic interventions during hospitalization are shown in Table 1. The incidence of BSI was 4.37 per 1000 patient days in the pre-COVID-19 period compared with 8.36 during the surge ($p = 0.004$). A significant majority of patients during the COVID period had ARDS (40.4%), required mechanical ventilation (57.3%), pressors (46.1%), therapeutic anticoagulation (31.5%), proning (22.5%), rectal tube (29.2%), and steroids (28.1%) in comparison to the pre-COVID-19 period. The median DOT previous to BSI during the COVID-19 surge was 3 days (0 to 20.5) whereas it was <1 day (0 to 6) before the COVID-19 period. Mortality was higher among patients with BSI during the surge (40.4% vs 15.3%, $p = 0.001$).

Of the 164 BSI events, 53 were pre-COVID-19 while 111 were during the surge. BSI during the COVID-19 period was predom-

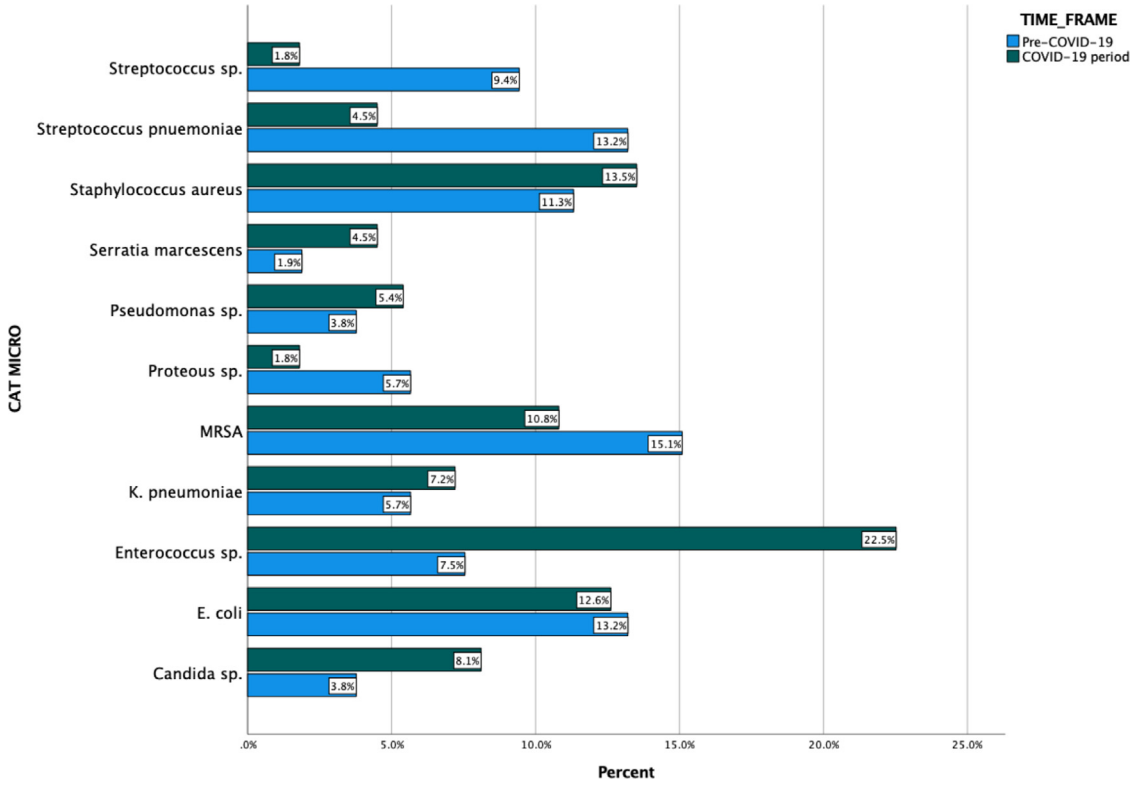

Figure 1. Frequency of microorganisms detected in positive blood cultures in hospitalized patients during the pre-COVID-19 period (Jan to Feb 2020) & COVID-19 period (March to May 2020).

inantly monomicrobial (93%) and nosocomial (64%, p = 0.001). In the Pre-COVID-19 era, primary BSI was predominant compared with central line-associated secondary BSI seen during the COVID-19 surge. Enterococcus (22.5%), *Staphylococcus aureus* (13.5%) and Candida (8.1%) were more common BSI during the COVID-19 surge versus *MRSA* (15.1%), *Escherichia coli* (13.2%), and *Streptococcus pneumoniae* (13.2%) before COVID-19. On multivariate analysis, Enterococcal coinfection was strongly associated with SARS-CoV-2 positivity (odds ratio [OR] 2.685, p = 0.038), mechanical ventilation (OR 8.739, p = 0.002), and chronic obstructive pulmonary disease (COPD)/Asthma (OR 2.823, p = 0.035).

Discussion/Conclusion

Our results highlight the higher incidence of BSI during the COVID-19 surge compared with the pre-COVID-19 period at the NYC public hospital. The increased BSI during the COVID-19 surge in our hospital was higher than the pooled estimated BSI occurrence published in a systematic review (Ippolito et al., 2021), due to our higher burden of critically ill patients requiring mechanical ventilation, pressors, steroids, proning, etc. Empiric antibiotics were used in almost all patients due to a paucity of information about COVID-19 resulting in higher DOT. Data reported by the Centers for Disease Control and Prevention (CDC)/NHSN has confirmed a significant increase in CLABSI throughout the United States in the early months of the pandemic. Due to modification of the infection control practices to accommodate the surge in cases, shortages of personal protective equipment (PPE), staff and supplies occurred. Further adjustments reduced the frequency of contact with patients – decreasing compliance with central line care bundles and disrupting protocols, during proning sessions (Patel et al., 2021; McMullen et al., 2020). The increased mortality observed during the COVID-19 surge has been well described during previous influenza pandemics in patients with secondary BSI (Lee et al., 2011; Chertow and Memoli, 2013).

The predominance of Enterococcus spp. BSI during the peak of the pandemic is consistent with observations from other parts of the world (Ippolito et al., 2021; Bonazzetti et al., 2021; Shukla et al., 2021; Bhatt et al., 2021). Some of the possible reasons for this preponderance could be due to the colonization of respiratory tract by Enterococcus spp. especially among those requiring prolonged intubation, increased risk of cross-transmission between mechanically ventilated patients leading to the BSI (Lund et al., 2002) and gut translocation of the enteric microorganisms facilitated by use of rectal tubes, proning, pressors, etc.

Limitations of our study include retrospective observational design, being single-center, and small sample size, which can all potentially restrict generalizability. We accept that the significant reduction in the frequency of sputum sampling and peripheral blood draws during the COVID-19 surge could have affected the diagnosis of secondary BSI. In addition, the retrospective design of the study prevented detailed genetic analysis of the predominant Enterococcus species to determine the role of patient cross-infection, especially during the surge of the COVID-19 infection.

A better understanding of the BSI trends, causative factors including re-evaluation of existing infection control measures and reinforcement of antimicrobial stewardship principles will be critical to mitigating future outbreaks Fig. 1.

Ethical Approval Statement

The Study Protocol was approved by the Institutional Review Board (IRB). However, ethical approval for this retrospective study was not required.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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