Original Research

Characteristics and Outcomes of 241 Births to Women With Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Infection at Five New York City Medical Centers

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OBJECTIVE: To describe the characteristics and birth outcomes of women with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection as community spread in New York City was detected in March 2020.

METHODS: We performed a prospective cohort study of pregnant women with laboratory-confirmed SARS-CoV-2 infection who gave birth from March 13 to April 12, 2020, identified at five New York City medical centers. Demographic and clinical data from delivery hospitalization records were collected, and follow-up was completed on April 20, 2020.

RESULTS: Among this cohort (241 women), using evolving criteria for testing, 61.4% of women were asymptomatic for coronavirus disease 2019 (COVID-19) at the time of admission. Throughout the delivery hospitalization, 26.5% of women met World Health Organization criteria for mild COVID-19, 26.1% for severe, and 5% for critical. Cesarean birth was the mode of delivery for 52.4% of women with severe and 91.7% with critical COVID-19. The singleton preterm birth rate was 14.6%. Admission to the intensive care unit was reported for 17 women (7.1%), and nine (3.7%) were intubated during their delivery hospitalization. There were no maternal deaths. Body mass index (BMI) 30 or higher was associated with COVID-19 severity (P=.001). Nearly all newborns tested negative for SARS-CoV-2 infection immediately after birth (97.5%).

CONCLUSION: During the first month of the SARS-CoV-2 outbreak in New York City and with evolving testing criteria, most women with laboratory-confirmed infection admitted for delivery did not have symptoms of COVID-19. Almost one third of women who were

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asymptomatic on admission became symptomatic during their delivery hospitalization. Obesity was associated with COVID-19 severity. Disease severity was associated with higher rates of cesarean and preterm birth.
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Coronavirus disease 2019 (COVID-19) is a novel infectious disease first reported in Wuhan, China, on December 31, 2019, as a cluster of cases of pneumonia of unknown etiology.[1] Caused by infection with the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the first distant outbreaks were reported in South Korea, Iran, and Italy before the virus rapidly spread globally. On March 1, 2020, the first case of COVID-19 was confirmed in New York City,[2] and on March 11, a global pandemic was declared by the World Health Organization,[3] with more than 118,000 cases reported in 114 countries. Governor Andrew Cuomo issued the "New York State on PAUSE" Executive Order on March 22, 2020,[4] as community transmission was widely observed and New York City became the epicenter of the pandemic, reporting 10,764 cases.[5] As of this writing on April 26, 2020, in New York State alone there have been 293,991 reported SARS-CoV-2 infections and 22,275 related deaths, with more than half of cases (150,576) and almost half of confirmed deaths (10,961) occurring in New York City.[6,7]

The effect of SARS-CoV-2 infection on pregnant women and pregnancy outcomes is largely unknown, because we are in the early stages of the pandemic. Because coronavirus infections can cause serious pulmonary manifestations, increased morbidity and mortality among pregnant women is biologically plausible owing to the immunologic changes and respiratory adaptations of pregnancy. Previous data evaluating the effect of related coronavirus infections causing severe respiratory illnesses, such as severe acute respiratory syndrome and Middle East respiratory syndrome,[8] showed that pregnant women were more likely to develop sepsis and acute respiratory distress syndrome requiring intensive care. Pneumonia is one of the most prevalent nonobstetric infections that occurs in pregnancy and is among the top three causes of indirect maternal death.[9] In addition, pneumonia from all causes historically has been associated with preterm prelabor rupture of membranes, preterm labor, fetal growth restriction, fetal death, and neonatal death.[10,11]

In a case series of 118 pregnant women with COVID-19 in Wuhan Province, 92% of women had mild disease, 8% had severe disease (defined as hypoxemia), and one woman had critical disease (defined as requiring mechanical ventilation); there were no deaths.[12] This severity of disease breakdown has been similarly reported in New York City.[13] A preceding systematic review and meta-analysis of outcomes of coronavirus infections during pregnancy reported on 19 studies that included 79 women[14] and found higher rates of miscarriage, preterm birth, preeclampsia, cesarean birth, and perinatal death in the setting of COVID-19.

As women with SARS-CoV-2 infection began giving birth on labor and delivery units in New York City in mid-March 2020, we recognized the urgent need for data to guide clinical care. With collaboration from the New York City Maternal Fetal Medicine Research Consortium, we identified and reviewed the medical records of the first 241 births at five New York City medical centers to women with laboratory-confirmed SARS-CoV-2 infection to characterize baseline presentation, disease course and severity, and pregnancy outcomes for women and newborns.

METHODS

This was a prospective cohort study of pregnant women with SARS-CoV-2 infection in the third trimester who were admitted and delivered at five New York City medical centers located in the boroughs of the Bronx, Manhattan, and Queens (Montefiore Medical Center; Mount Sinai Health System, including Mount Sinai Hospital and Mount Sinai West; its affiliate, NYC Health and Hospitals-Elmhurst Hospital; NewYork-Presbyterian Hospital-Columbia University; and New York University Langone Health, including NYU Langone Hospitals, Manhattan campus, and NYU Langone Hospitals-Brooklyn) from March 13, 2020, to April 12, 2020. Only patients with laboratory-confirmed SARS-CoV-2 infection were included, which required documentation of a positive result on a reverse transcriptase-polymerase chain reaction (RT-PCR) assay for SARS-CoV-2. With differential resources and test availability, three of the five medical centers employed universal SARS-CoV-2 testing for all women admitted for delivery during the study period, one employed symptom and epidemiologic risk factor–based testing until April 10, 2020, when it began universal testing, and one continues to employ symptom and epidemiologic risk factor–based testing. Outcome data were collected as of April 20, 2020.

The institutional review board at each medical center approved this study. Data from each medical center's electronic medical record were abstracted using a REDCap (research electronic data capture)

form, and deidentified data were aggregated into one data set hosted at Montefiore Medical Center–Albert Einstein College of Medicine.[15,16]

We obtained data on demographics, presenting signs and symptoms, and medical comorbidities. Delivery data included obstetric outcomes, maternal complications, and immediate neonatal outcomes, as well as laboratory results and radiologic testing performed during the delivery hospitalization. Relevant COVID-19–related clinical information, including disease severity, was collected.

Cases were defined as women with laboratory-confirmed SARS-CoV-2 infection on an RT-PCR assay performed on a nasopharyngeal swab before or during delivery hospitalization. Women defined as being asymptomatic were those who reported being in usual health without signs or symptoms of COVID-19. Mild COVID-19 was defined as symptoms requiring no additional oxygen supplementation beyond standard labor and delivery care. Severe COVID-19 was defined as dyspnea (patient reported), respiratory rate 30 breaths per minute or higher, oxygen saturation 93% or less on room air, or findings consistent with pneumonia on chest X-ray, or a combination of these.[17,18] Critical COVID-19 was defined as any or all of the following: respiratory failure (need for intubation and invasive ventilation), septic shock, and multiple organ dysfunction or failure.[17,18] Medical comorbidities were noted according to the obstetric comorbidity index that has been validated for use on labor and delivery to predict risk of severe maternal morbidity.[19] Severe maternal morbidity was classified according to the guidelines of the American College of Obstetricians and Gynecologists, the Society for Maternal-Fetal Medicine, and the Centers for Disease Control and Prevention (CDC).[20] Preterm birth rate was defined per CDC National Center for Health Statistics as singleton live birth at less than 37 weeks of gestation and early preterm birth as less than 34 weeks.

Statistics such as the median, interquartile range, range, count, and frequency were generated to summarize the data. Associations between categorical variables were assessed using χ^2 tests, and linear trends across ordinal variables with respect to binary outcomes were examined using Cochran-Armitage tests for trend. Presented *P*-values were two-sided, and $P<.05$ considered statistically significant. All analyses were conducted in SAS 9.4. Some information about 84 women in this cohort has been reported previously (Appendix 1, available online at http://links.lww.com/AOG/B962).

RESULTS

Two hundred forty-one women with documented SARS-CoV-2 infection on RT-PCR of nasopharyngeal swabs who gave birth at the study sites were identified. There were 245 live births to 241 women, including six sets of twins, and there were two stillbirths (Table 1). The median age was 32 years (range 18–47), and 25.9% were nulliparous. The majority of women (55.1%) had body mass indexes (BMIs, calculated as weight in kilograms divided by height in meters squared) of 30 or higher; 43.9% identified as Hispanic or Latinx, 30.3% as white, 10.9% as black, and 14.9% as other. Medicaid was the most common insurer (61.2%).

Most (89.2%) women presented to labor and delivery with an obstetric symptom or indication (Appendix 2, available online at http://links.lww.com/AOG/B962); the remainder presented for gastrointestinal or influenza-like symptoms. On admission, 148 women (61.4%) were asymptomatic; 102 (69% of this group) remained asymptomatic throughout their delivery hospitalization, 21 (14.2%) progressed to mild COVID-19, 24 (16.2%) progressed to severe COVID-19, and one (0.7%) progressed to critical COVID-19. Of the 93 (38.6%) symptomatic patients, 54 (58%) reported cough, 46 (49.5%) reported fever, and 19 (20.4%) reported dyspnea (Appendix 3, available online at http://links.lww.com/AOG/B962). Among all 241 women, 64 (26.5%) met criteria for mild COVID-19, 63 (26.1%) met criteria for severe COVID-19, and 12 (5%) met criteria for critical COVID-19 during their delivery hospitalization. In the total cohort, admission to the intensive care unit (ICU) was reported for 17 women (7.1%), and nine women (3.7%) were intubated during their delivery hospitalization. Among the nine women who were intubated, three were extubated within 24 hours (range 4–20 hours), three within 72 hours (range 37–55 hours), and two within 16 days (13 and 16 days); one woman remained intubated (more than 14 days) at the time of this writing.

Imaging studies performed included chest X-ray for 66 women (27.4%) and chest computed tomography for seven (2.9%). Of those, 43 had findings consistent with COVID-19 pneumonia on chest X-ray and seven on chest computed tomography (Appendix 4, available online at http://links.lww.com/AOG/B962). Vital signs and laboratory values for pregnant women showed changes that were consistent with the reported changes in nonpregnant adults with COVID-19, including increased incidence of fever, decreased oxygen saturation, elevated liver

Table 1. Maternal Demographic and Clinical Characteristics of Patients With Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Infection (N=241)

Characteristic	Value
Delivery hospital	
Mount Sinai Health System	81/241 (33.6)
NewYork-Presbyterian Hospital-Columbia University	67/241 (27.8)
Montefiore Medical Center	39/241 (16.2)
NYC Health and Hospitals-Elmhurst Hospital	27/241 (11.2)
New York University Langone Health	27/241 (11.2)
Age (y)	32 (27–36) [18–47]
BMI (kg/m^2)	30.5 (27–34) [21–56]
30–39.9	84/178 (47.2)
40 or higher	14/178 (7.9)
Insurance type	
Medicaid or managed Medicaid	142/232 (61.2)
Medicare	1/232 (0.4)
Private or commercial	89/232 (38.4)
Race–ethnicity	
Black, non-Hispanic	24/221 (10.9)
White, non-Hispanic	67/221 (30.3)
Hispanic (Latinx)	97/221 (43.9)
Other	33/221 (14.9)
Preferred language	
English	160/218 (73.4)
Spanish	55/218 (25.2)
Other	3/218 (2.0)
Current smoker	1/237 (0.4)
Parity	
Nulliparous	52/201 (25.9)
Parous	149/201 (74.1)

BMI, body mass index.
Data are n/N (%) or median (interquartile range) [range].

function tests, elevated C-reactive protein and procalcitonin, and low platelets (Appendix 5, available online at http://links.lww.com/AOG/B962) (Lippi G, Plebani M, Laboratory abnormalities in patients with COVID-2019 infection [letter]. Clin Chem Lab Med 2020 Mar 3 [Epub ahead of print]).

This SARS-CoV-2 cohort had a rate of prelabor rupture of membranes of 17% (41). The rate of cesarean birth was 41.5% (100) overall and 46.2% among nulliparous women (Table 2). Ten (10%) of the cesarean deliveries were performed for worsening maternal respiratory status. Thirty-three (52.4%) women with severe COVID-19 and 11 (91.7%) women with critical COVID-19 delivered by cesarean (Table 3). There is a statistically significant linear trend across COVID-19 severity groups with respect to the risk of cesarean delivery ($P<.001$). This observed trend is largely due to the difference in cesarean birth rates when comparing women with either critical or severe COVID-19 (relative risk of cesarean birth 2.8 [95% CI 2.0–3.8] and 1.6 [95% CI 1.1–2.3], respectively) with those who were asymptomatic (Table 4).

Overall, the singleton preterm birth rate in this cohort was 14.6%. Among the 102 asymptomatic women, 91 (89.2%) delivered at term, 11 (10.8%) delivered preterm at less than 37 weeks of gestation, and three (2.9%) delivered early preterm at less than 34 weeks of gestation. Among the 12 women with critical COVID-19, five (41.7%) delivered at term, seven (58.3%) delivered preterm at less than 37 weeks of gestation, and three (25%) delivered early preterm at less than 34 weeks of gestation (Table 3). There is a statistically significant linear trend across COVID-19 severity groups with respect to the risk of preterm birth ($P<.001$). This observed trend is largely due to the difference in preterm birth rates when comparing women with critical COVID-19 with those who were asymptomatic (relative risk of preterm birth 5.4 (2.6, 11.3) (Table 5).

Of the 245 liveborn neonates, 30% received some form of resuscitation beyond standard measures in the delivery room and 25.7% were admitted to the neonatal intensive care unit (NICU). The majority (62.4%) were hospitalized for less than 2 days. The most common newborn complications were due to

Table 2. Delivery Characteristics of Patients With Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Infection (N=241)

Characteristic	n/N (%)
Pregnancy outcome	
Live birth	245/247 (99.2)
Twins	6/241 (2.5)
Stillbirth	2/247 (0.8)
Singleton preterm birth (less than 37 wk)	34/233 (14.6)
Singleton early preterm birth (less than 34 wk)	10/233 (4.3)
Mode of delivery	
Spontaneous vaginal	136/241 (56.4)
Cesarean	100/241 (41.5)
Operative vaginal	5/241 (2.1)
Indication for cesarean delivery	
Nonreassuring fetal heart rate tracing	23/100 (23)
Failed induction	11/100 (11)
Worsening respiratory distress	10/100 (10)
Active phase arrest	5/100 (5)
Arrest of descent	5/100 (5)
Malpresentation	5/100 (5)
Repeat	31/100 (31)
Other	10/100 (10)
Maternal ICU admission	17/241 (7.1)
Maternal intubation	9/241 (3.7)
Maternal length of hospitalization (d)	
2 or less	64/241 (26.6)
3–7	161/241 (66.8)
More than 7	16/241 (6.6)
Maternal mortality	0/241 (0)

ICU, intensive care unit.

prematurity or low birth weight. Of the 236 liveborn neonates with documented SARS-CoV-2 test results, 230 (97.5%) tested negative for SARS-CoV-2 infection within 24–96 hours of life (Table 6).

Among the critically ill women, there was one maternal cardiac arrest due to respiratory failure in the setting of COVID-19 pneumonia, which resulted in urgent cesarean delivery. At the time of this writing, this patient remained intubated in the ICU more than 2 weeks later. Another patient underwent peripartum hysterectomy for a known morbidly adherent placenta and delivered emergently for an antepartum hemorrhage at 30 weeks of gestation; she was incidentally noted to have mild COVID-19 and had an uneventful postpartum course.

Two patients with severe COVID-19 had intrauterine fetal death at the time of hospital admission. One patient presented at 38 weeks of gestation with decreased fetal movement, symptoms of COVID-19, and imaging consistent with COVID-19 pneumonia. She did not require supplemental oxygen and was induced for vaginal delivery of a grossly normal-appearing male stillborn fetus (birth weight 13th percentile for age). The patient declined autopsy, pathology, genetics, and SARS-CoV-2 testing on the fetus. Placental pathology was unremarkable. The second stillbirth occurred at 29 weeks of gestation in the setting of fetal growth restriction (less than the 1st percentile) and new-onset hemolysis, elevated liver enzymes, and low platelet count (HELLP) syndrome with severe COVID-19 pneumonia.

In our cohort, BMI higher than 30 was the only variable associated with COVID-19 disease severity (P=.001) (Appendix 6, available online at http://links.lww.com/AOG/B962). Insurance type, age, race–ethnicity, and underlying medical conditions were not associated with COVID-19 severity. Women with severe and critical COVID-19 were more likely to deliver by cesarean (P<.001) and preterm (P=.01) (Appendix 6, http://links.lww.com/AOG/B962).

DISCUSSION

We report on a highly diverse patient population with laboratory-confirmed SARS-CoV-2 infection during delivery hospitalization at five New York City medical centers. Among pregnant women with documented SARS-CoV-2 infection before or during delivery hospitalization, 62.7% were asymptomatic.

Table 3. Association of Mode and Timing of Delivery With Coronavirus Disease 2019 (COVID-19) Severity

	COVID-19 Severity			
	Asymptomatic	Mild	Severe	Critical
Delivery mode				
Vaginal	68 (66.7)	42 (65.6)	30 (47.6)	1 (8.3)
Cesarean	34 (33.3)	22 (34.4)	33 (52.4)	11 (91.7)
Delivery timing				
Term	91 (89.2)	57 (89.1)	50 (82.0)	5 (41.7)
Preterm (less than 37 wk)*	11 (10.8)	7 (10.9)	11 (18.0)	7 (58.3)
Early preterm (less than 34 wk)	3 (2.9)	2 (3.1)	3 (4.9)	3 (25.0)

COVID-19, coronavirus disease 2019.
Data are n (%).
* Defined as the number of women who delivered liveborn neonates before 37 or 34 weeks of gestation (n=239); preterm delivery at less than 34 weeks of gestation is a subset of preterm delivery at less than 37 weeks.

This is a high number, with implications for infection prevention and control. Among symptomatic women, the most commonly reported symptom was cough (22.4%) followed by fever (19.1%) and shortness of breath (7.9%), similar to reports in the nonpregnant population.[21] Given the global spread of the pandemic and the high risk of exposure and transmission on labor and delivery units, it is the opinion of the authors that these numbers support universal testing for SARS-CoV-2 infection at the time of antepartum and delivery admission when possible. Accurately identifying patients with SARS-CoV-2 infection facilitates appropriate infection-prevention and control measures, including isolation and use of correct personal protective equipment (N95 mask, surgical mask, face shield or googles, gowns, and gloves), to deliver necessary medical care while protecting staff, other patients, family members, and newborns.

We noted that SARS-CoV-2 infection can evolve in disease manifestation and severity during delivery hospitalization. Care for women positive for SARS-CoV-2 infection must therefore take into account the potential for rapid progression of symptoms (in the form of fever, shortness of breath, hypoxia, or a combination of these) and worsening clinical status. With 7.7% of women with SARS-CoV-2 infection requiring ICU admission in a high-prevalence setting, labor and delivery units will be poised to provide high-quality care if they can anticipate the need for additional beds, resources, and interdisciplinary teamwork between the obstetric, critical care, and infectious disease teams. We report no cases of maternal mortality, an extremely rare event at baseline, among our SARS-CoV-2 cohort. This is reassuring when compared with the reports of increased maternal mortality with previous coronavirus infections (severe acute respiratory syndrome coronavirus and Middle East respiratory syndrome).[8]

With regards to mode of delivery, the overall cesarean birth rate of 41.5% (46.2% among nulliparous women) is high compared with the reported institutional cesarean birth rates for the study sites, as published by the New York State Department of Health (Montefiore Medical Center 37.3%, Mount Sinai Hospital 34.7%, NYC Health and Hospitals-Elmhurst Hospital 32.2%, New York University Langone Health 27.2%), with the exception of NewYork-Presbyterian Hospital-Columbia University (41.8%).[22] This was likely driven by the high incidence of cesarean births performed for worsening maternal respiratory status in patients with severe and critical disease.[23,24] Similarly, the preterm birth rate at less than 37 weeks of gestation in our cohort (14.6%) was higher than that in the general population

Table 4. Association of Cesarean Delivery Rate With Coronavirus Disease 2019 (COVID-19) Severity

COVID-19 Severity	Cesarean Deliveries	RR of Cesarean Delivery (95% CI)	*P* (*P*-Trend=.001)
Asymptomatic	34 (33.3)	Reference	
Mild	22 (34.4)	1.03 (0.67–1.6)	.90
Severe	33 (54.1)	1.62 (1.1–2.3)	.01
Critical	11 (91.7)	2.8 (2.0–3.8)	<.001

COVID-19, coronavirus disease 2019; RR, relative risk.
Data are n (%) unless otherwise specified.

Table 5. Association of Preterm Delivery Rate* With Coronavirus Disease 2019 (COVID-19) Severity

COVID-19 Severity	Preterm Delivery (Less Than 37 wk of Gestation)	RR of Preterm Birth (95% CI)	*P* (*P*-Trend=.001)
Asymptomatic	11 (10.8)	Reference	
Mild	7 (10.9)	1.01 (0.41–3.6)	.97
Severe	11 (18.0)	1.67 (0.8–3.6)	.19
Critical	7 (58.3)	5.41 (2.6–11.3)	<.001

COVID-19, coronavirus disease 2019; RR, relative risk.
Data are n (%) unless otherwise specified.
* Defined as the number of women who delivered liveborn neonates before 37 weeks of gestation.

(10.02%).[25] The higher rates of cesarean birth among women with severe and critical COVID-19 and the higher rates of preterm birth among women with critical COVID-19 are a reflection of the effect of COVID-19 severity on pregnant women, with implications for both maternal and perinatal morbidity and mortality. In the absence of population-level infection-prevalence data, further study will be required to appreciate the full extent of this association.

The question of why some individuals remain asymptomatic or have mild COVID-19 compared with severe or critical disease remains unanswered. The published literature to date suggests that the most prevalent comorbidities associated with COVID-19 severity in the nonpregnant population are hypertension and diabetes, followed by cardiovascular disease and respiratory diseases.[21] Although pregnant women are younger and healthier, with much lower prevalence of medical comorbidities, we have yet to understand how COVID-19 manifests in pregnancy and whether women with greater risk factors for severe maternal morbidity fare worse with SARS-CoV-2 infection. Our study looked at the association between COVID-19 severity and age, race–ethnicity, BMI, insurance type, hypertensive disorders, glucose intolerance, mode of delivery, and pregnancy length. In contrast to published data in nonpregnant populations,[21] we did not observe a relationship between these comorbidities and more severe disease in our cohort. However, we acknowledge that this is a descriptive study and was not powered to detect these differences. We did observe significant associations between disease severity and BMI, mode of delivery, and length of pregnancy. This suggests that, as we are seeing in the general population, pregnant women with BMIs higher than 30 should be considered a higher risk group for severe and critical COVID-19 (Lighter J, Phillips M, Hochman S, Sterling S, Johnson D, Francois F, et al. Obesity in patients younger than 60 years is a risk factor for COVID-19 hospital admission [letter]. Clin Infect Dis 2020 Apr 9 [Epub ahead of print]).

Taking into account the context of maternal and perinatal morbidity and mortality in the United States generally, and in New York City specifically, with wide racial disparities in both prevalence of medical comorbidities and adverse pregnancy outcomes, it is vital to examine SARS-CoV-2 infection in pregnancy through a social-determinants-of-health lens. Although our sample size is too small to draw conclusions on the differential effect of COVID-19 on pregnant women of color, the CDC has reported marked racial disparities in rates of COVID-19–related hospitalization and subsequent morbidity and mortality.[26] Future research must explore how societal inequities contribute to SARS-CoV-2 infection and COVID-19 morbidity and mortality and, in turn, how that reflects and exacerbates existing disparities in maternal and perinatal health.[27]

The question of vertical transmission of SARS-CoV-2 infection from mother to fetus is beyond the scope of this report. We report initial newborn testing but not a detailed analysis of the testing or comprehensive evaluation of the extent of vertical transmission, if at all. Newborns of women with SARS-CoV-2 infection were tested in the nursery or NICU with a nasopharyngeal swab at 24 hours of life, and this was repeated serially until 96 hours of life or discharge if sooner. Ongoing work is attempting to address the implications of these positive neonatal RT-PCR results–whether they reflect true viral infection due to vertical transmission, maternal contamination, or another source of infection or are false-positive results. In line with the observation that neonates have generally fared well during the SARS-CoV-2 pandemic, 97.5% of neonates born to women with SARS-CoV-2 infection tested negative for the virus. Although 25.7% of neonates required NICU admission and 5.8% were diagnosed with respiratory distress syndrome, these were related to low birth weight and prematurity. Ninety percent of all neonates were discharged from the hospital within 7 days of birth.

Our study is not without limitations. Our case series reflects the variation and evolution of screening

Table 6. Neonatal Outcomes of Women Who Tested Positive for Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Infection

Characteristic	Value
Live births*	245/247 (99.2)
Birth weight (g)	3,135 (2,840–3,490) [640–4,700]
Gestational age (wk)	39.0 (37.6–40.0) [24.7–41.6]
5-min Apgar score	9 (9–9) [0–9]
Neonatal sex	
Female	128/247 (51.8)
Male	119/247 (48.2)
Neonatal COVID-19 test result	
Positive	6/236 (2.5)
Negative	230/236 (97.5)
Resuscitation at delivery	70/233 (30.0)
NICU admission	61/237 (25.7)
Newborn complications	
Respiratory distress syndrome	14/241 (5.8)
Complications of prematurity or low birth weight	21/241 (8.7)
Sepsis	1/241 (0.4)
Congenital anomaly	8/241 (3.3)
None	191/241 (79.3)
Other	14/241 (5.8)
Length of newborn hospitalization (d)	
2 or less	153/245 (62.4)
3–7	65/245 (26.5)
More than 7	29/245 (11.8)

COVID-19, coronavirus disease 2019; NICU, neonatal intensive care unit.
Data are n/N (%) or median (interquartile range) [range].
* n=233 singleton and six twin births.

and testing policies and therefore includes both symptomatic and asymptomatic patients. Testing availability and reliability, as well as testing protocols, were not uniform across study sites and changed over the course of the study period as the pandemic evolved. The variation reflects the reality on the ground of iterative learning, differential hospital resources, test availability and reliability, and changing guidance from local, national, and international entities. We made the a priori decision to include all laboring women rather than just those admitted for delivery after universal testing was implemented and so did not separate them out in the analysis. This may skew the data toward more symptomatic SARS-CoV-2–positive women in the Montefiore Medical Center and New York University Langone Health cohorts. However, excluding Montefiore Medical Center and New York University Langone Health would drastically limit our sample size, especially in the Latinx and black subgroups. We present these data as a descriptive early snapshot of the pandemic in New York City. We acknowledge the limitations in terms of generalizability. Our goal with this analysis was to explore the potential relationship between COVID-19 severity and clinical outcomes. As this is a descriptive study, we did not power the study for any specific comparisons. The associations we observed need further study with a larger sample size or a control group or both, as well as adjustment for the many potential confounders that could affect the observed relationships.

In addition, the RT-PCR tests for SARS-CoV-2 infection have a reported false-negative rate of 20–67%.[28] Thus, even institutions embracing a universal testing policy for women admitted for delivery may miss a significant number of both symptomatic and asymptomatic SARS-CoV-2–positive patients. Although all symptomatic women were treated as persons under investigation regardless of the SARS-CoV-2 PCR result, it is likely that some number of asymptomatic women were missed. Additionally, we report here only on short-term maternal and neonatal outcomes. Because data collection was completed on April 20, 2020, long-term follow-up will require further study.

In summary, this early, albeit large, report of pregnancy outcomes for women with SARS-CoV-2 infection who delivered in New York City suggests that the known respiratory complications associated with severe and critical COVID-19 will lead to greater

numbers of maternal ICU admissions and cesarean and preterm births. Body mass index should be considered in assessing risk for severe and critical COVID-19 in pregnancy. Social determinants of health should be examined and used to risk-stratify patients to best address their needs with an equity framework. With appropriate care and resources, most women and newborns will do well, but the need for additional intensive care resources and ventilatory support should be considered in planning for the care of pregnant women during this ongoing pandemic. Our data support universal testing on admission for delivery in high-prevalence settings to promptly identify and care for the large percentage of asymptomatic women with SARS-CoV-2 infection (Sutton D, Fuchs K, D'Alton M, Goffman D. Universal screening for SARS-CoV-2 in women admitted for delivery [letter]. N Engl J Med 2020;382:2163–4). Universal testing will enhance care for women admitted for delivery, because those with asymptomatic infection can be monitored for progression to symptomatic disease of varying severity during their delivery hospitalization. It will also allow implementation of the appropriate infection-prevention and control measures to protect patients, newborns, health care workers, and family members. Until we have true global population prevalence data, adequate supplies of personal protective equipment, effective therapeutics, and a widely accessible vaccine, universal testing or much expanded targeted testing would be prudent, even outside infection epicenters such as New York City.

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