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Pregnancy and postpartum outcomes in a universally tested population for SARS-CoV-2 in New York City: A prospective cohort study

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Pregnancy outcomes of COVID19

Abstract

Objective: To describe differences in outcomes between pregnant women with and without COVID-19.

Design: Prospective cohort study of pregnant women consecutively admitted for delivery, and universally tested via nasopharyngeal (NP) swab for SARS-CoV-2 using reverse transcriptase polymerase chain reaction (RT-PCR). All infants of mothers with COVID-19 underwent SARS-CoV-2 testing.

Setting: Three New York City hospitals

Population: Pregnant women > 20 weeks' gestation admitted for delivery

Methods: Data were stratified by SARS-CoV-2 result and symptomatic status, and summarized using parametric and nonparametric tests.

Main Outcome Measures: Prevalence and outcomes of maternal COVID-19; obstetric outcomes; neonatal SARS-CoV-2; placental pathology.

Results:
Of 675 women admitted for delivery, 10.4% were positive for SARS-CoV-2, of whom 78.6% were asymptomatic. We observed differences in sociodemographics and comorbidities between women with symptomatic vs. asymptomatic vs. no COVID-19. Cesarean delivery rates were 46.7% in symptomatic COVID-19, 45.5% in asymptomatic COVID-19, and 30.9% without COVID-19 (p=0.044). Postpartum complications (fever, hypoxia, readmission) occurred in 12.9% of women with COVID-19 vs 4.5% of women without COVID-19 (p<0.001). No woman required mechanical ventilation, and no maternal deaths occurred. Among 71 infants tested, none were positive for SARS-CoV-2. Placental pathology

demonstrated increased frequency of fetal vascular malperfusion, indicative of thrombi in fetal vessels, in women with vs. without COVID-19 (48.3% vs 11.3%, p <0.001).

Conclusion:
Among pregnant women with COVID-19 at delivery, we observed increased cesarean delivery rates and increased frequency of maternal complications in the postpartum period. Additionally, intraplacental thrombi may have maternal and fetal implications for COVID-19 infections remote from delivery.

Funding: None

Keywords: SARS-CoV-2, COVID-19, pregnancy, vertical transmission, postpartum complications, placental pathology

Tweetable abstract
COVID-19 at delivery: more cesarean deliveries, postpartum complications, and intraplacental thrombi.

Introduction

On March 1, 2020, New York City reported its first case of coronavirus disease 19 (COVID-19), the respiratory illness caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). Three weeks later, the cases in New York City had risen to 9,045 cases[1]. While medical units rapidly adapted to care for patients with COVID-19, obstetric units continued to provide care to their typical volume of patients. In addition, obstetric units planned for the implications of maternal COVID-19 infection on maternal and newborn care[2]. In response to the exponential increase in COVID-19 cases in New York City, and the realization that COVID-19 symptoms overlapped with normal pregnancy symptoms, our hospital system recommended universal testing of all pregnant women admitted to Labor & Delivery.

Data on the impact of COVID-19 on pregnancy outcomes are emerging. A case series of 118 pregnant women from Wuhan, China, with suspected or confirmed COVID-19, demonstrated that 8% of women had severe disease.[3] Within the 118 women, 68 women delivered, 93% of whom had a cesarean delivery and 21% of whom delivered prematurely. No perinatal transmission events were documented. In a cohort of 161 pregnant women admitted to Labor & Delivery and universally tested for SARS-CoV-2 outside of New York City, the prevalence of SARS-CoV-2 was 20%.[4] A recent series of 64 severe or critically ill pregnant women from the United States demonstrated high rates of cesarean delivery and prematurity, as well as described the typical clinical course in these women.[5] Finally, a large cohort from the United Kingdom Obstetric Surveillance System (UKOSS) demonstrated greater morbidity due to COVID-19 among pregnant women with medical comorbidities and women of black or other ethnic minorities. In addition, there was an increased rate of prematurity and cesarean delivery, as well as critical illness, compared to a historical control group[6].

We report the results of a prospective cohort study among all pregnant women admitted to Labor & Delivery units at 3 academic and affiliated institutions in New York City, and

universally tested for SARS-CoV-2. We describe the clinical presentation, obstetric and neonatal outcomes, and placental pathology associated with COVID-19 in pregnancy, as compared to women without COVID-19 at the time of delivery.

Methods

We conducted a prospective cohort study of consecutive pregnant women greater than 20 weeks' gestation admitted to Labor and Delivery at 3 institutions in New York City: NewYork Presbyterian-Weill Cornell Medical Center, an academic tertiary care hospital, NewYork Presbyterian-Lower Manhattan Hospital, a community affiliate in Manhattan, and NewYork Presbyterian-Queens, a community teaching affiliate and tertiary care center in Queens, NY. Universal testing for SARS-CoV-2 was recommended on March 22, 2020, and implemented between March 22, 2020 and March 24, 2020 at each of 3 sites, as the capacity for testing was made available. Women underwent a nasopharyngeal (NP) swab for SARS-CoV-2 testing using a reverse transcriptase polymerase chain reaction (RT-PCR) assay on the day of admission to Labor and Delivery. Patients were tested on one of the following SARS-CoV-2 RT-PCR clinical testing platforms depending on availability, in order to ensure the fastest turn-around time: Altona (internally developed, Food and Drug Administration [FDA] emergency use authorization approved assay), Roche Cobas 6800 (FDA approved), and Cepheid Xpert Xpress (FDA approved). Daily hospital admissions logs were reviewed to ensure complete data capture of all delivered women.

Upon presentation to Labor and Delivery, women were evaluated for the following symptoms of COVID-19: self-reported fever, cough, sore throat, rhinorrhea, shortness of breath, diarrhea, other gastrointestinal symptoms, or myalgias. Obstetric management was not altered based on symptom status or a positive RT-PCR result, with the exception of the implementation of droplet and contact precautions.

Upon delivery, healthy neonates roomed in with mothers with a positive result for COVID-19, but were placed in an isolette 6 feet away from the mother, and mothers were instructed to

wear a mask at all times. Prior to breastfeeding, mothers performed hand hygiene and cleansed the breast. If the mother was unable to care for the neonate due to her clinical status, the infant was isolated in the newborn nursery. Neonates requiring a higher level of care were admitted to the neonatal intensive care unit as clinically indicated.

All infants of mothers with positive RT-PCR results for COVID-19 underwent a NP swab for SARS-CoV-2, initially on day of life zero. On April 1, 2020, a change in the clinical protocol was made to distinguish maternal contamination from established infection, and neonatal NP swabs were collected at 24 hours of life.

In light of the COVID-19 pandemic, all institutions in our hospital system offered early discharge for women and neonates with clinical stability, at 24 hours after vaginal delivery (typical length of stay 48 hours prior to COVID-19 pandemic) and 48 hours after cesarean delivery (typical length of stay 72 hours prior to COVID-19 pandemic). COVID-19 infection did not preclude early discharge if clinical stability was met.

For each woman, demographic (age, race, ethnicity, insurance status), clinical, obstetric, laboratory, and imaging data were abstracted from the electronic medical record at each institution and recorded in REDCap. Additional data was abstracted regarding the need for respiratory support, intensive care unit (ICU) care, and adjunctive therapies administered for COVID-19. For each neonate, clinical and laboratory data were abstracted, including results of SARS-CoV-2 testing as indicated. All maternal readmissions that occurred through April 27, 2020 were captured; follow-up is ongoing.

At one clinical site (Weill Cornell Medical Center), placental pathology was interpreted using standardized placental examination for all women with COVID-19. Data on placental pathology for asymptomatic women without COVID-19 who had another clinical indication for placental pathology was also performed per institutional protocol. Gross examination and sectioning of placentas was performed using standard procedures. Placentas were fixed in

10% formalin, processed and then embedded into paraffin blocks. Routine hematoxylin and eosin staining was performed, and all placentas from women with a positive RT-PCR result for SARS-CoV-2 were examined histologically by one perinatal pathologist (RNB). Lesions were diagnosed based on Amsterdam criteria[7] and scored whether the following categories of histologic lesions were present or absent: fetal vascular malperfusion, maternal vascular malperfusion, chorioamnionitis, chronic villitis, meconium staining, and umbilical cord abnormalities. This placental work is an extension of that previously reported, and 20 of the 29 placentas have been previously published as a series; in the current study we provide summative histologic findings in 29 placentas and compare these to placentas in SARS-CoV-2 negative women, in addition to reporting the placental pathology in the context of the full clinical presentation and outcome[8].

This study describes the findings from the first 28 days of universal testing for SARS-CoV-2 at each site. No sample size calculation was performed for this study. We calculated the prevalence of COVID-19 in pregnant women, stratified by symptom status, and report the maternal, obstetric, and neonatal outcomes associated with COVID-19 at the time of delivery. We also present the results of the pathologic examinations of 28 placentas of mothers with COVID-19 at one site, compared to a selection of placentas of women at that site without a positive result for SARS-CoV-2. These outcomes were developed by the study investigators, and no patients were involved in the study design or selection of outcomes. A core outcome set was not used for this study.

We used parametric and nonparametric descriptive statistics to examine these differences by group (symptomatic SARS-CoV-2, asymptomatic SARS-CoV-2, SARS-CoV-2 negative), using a *t-test* to compare means, a Wilcoxon rank-sum test to compare medians, and a chi-square test to compare categorical variables, with a Fisher's exact test for any variable with a cell <=5.

All data were analyzed using StataSE 14 (College Station, TX).

This study was approved by the institutional review board at Weill Cornell Medicine, protocol 20-03021682, on March 31, 2020. This study was not funded.

Results

Prevalence and clinical characteristics of COVID-19

Within the first 28 days of universal testing, 675 pregnant women were admitted for delivery, of whom 70 (10.4%) were positive by RT-PCR for COVID-19. Of all pregnant women with COVID-19, 55 (78.6%) were asymptomatic on presentation.

When the cohort was stratified by symptomatic COVID-19, asymptomatic COVID-19, and absence of COVID-19, we observed differences in demographics (age, race, ethnicity, and insurance status) and comorbidities (chronic hypertension, pregestational diabetes, and obesity) (Table 1).

Clinical presentation and maternal outcomes

Vital signs and admission laboratory studies among all women with COVID-19 at the time of delivery were normal on presentation (Table 2). Among the 15 pregnant women with symptomatic COVID-19, cough was the most common presenting symptom, occurring in 7 (46.7%) women. These women had few additional symptoms on admission, yet 5 (33.3%) developed additional symptoms intrapartum, the most common being fever.

Among the 55 pregnant women with asymptomatic COVID-19, 13 women (23.6%) reported symptoms that had resolved prior to presentation, and 7 women (12.7%) developed symptoms after admission, the most common also being intrapartum fever.

Only three women in the cohort developed hypoxia during the delivery admission. One woman admitted with symptomatic COVID-19 at 37 weeks' gestation was transferred to the intensive care unit (ICU) for hypoxia in the setting of multifocal pneumonia and pulmonary

edema. She was treated with hydroxychloroquine and antibiotics and had an uncomplicated spontaneous vaginal delivery of a healthy neonate on hospital day 3. Hypoxia resolved on postpartum day 3.

Two other women with COVID-19 developed hypoxia in the postpartum period. One symptomatic woman who underwent a cesarean delivery developed multifocal pneumonia and required oxygen support for 7 days postpartum while inpatient. Another woman with asymptomatic COVID-19 and preeclampsia with severe features developed dyspnea and pulmonary edema on the day of her cesarean delivery. She then developed fever on post-operative day 2, for which IV antibiotic and hydroxychloroquine therapy were administered, and hypoxia on post-operative day 3 requiring oxygen supplementation until post-operative day 5.

No woman required mechanical ventilation during the delivery hospitalization; there were no maternal deaths during the study period.

Obstetric outcomes

The median gestational age at admission was 39 weeks' gestation across all women from the three groups. A livebirth occurred among 15 (100%) women with symptomatic COVID-19, 54 (98.2%) women with asymptomatic COVID-19, and 599 (99.0%) women without COVID-19 (p=0.54) (Table 2). There was one fetal demise at 37 weeks' gestation in a woman with asymptomatic COVID-19 and poorly controlled type 2 diabetes. Placental pathology was normal, and the autopsy is pending. Of the 6 stillbirths among women without COVID-19, all occurred between 20 and 25 weeks' gestation.

There were no differences in the preterm birth rate less than 37 weeks gestation (p=0.16). Mode of delivery was statistically significantly different across the three groups, with cesarean deliveries occurring in 7 (46.7%), 25 (45.5%), and 187 (30.9%) women with

symptomatic COVID-19, asymptomatic COVID-19, and no COVID-19, respectively (p=0.044). There were no differences in the indication for cesarean delivery (p=0.83).

Although the frequency of intrapartum fever was not different across groups, rates of postpartum fevers differed, occurring in 5 (33.3%) of symptomatic women with COVID-19, 3 (5.5%) of asymptomatic women with COVID-19, and 17 (2.8%) of women without COVID-19.

The distribution of postpartum readmissions was also different by group, occurring in 1 (6.7%) woman with symptomatic COVID-19, 2 (3.6%) women asymptomatic COVID-19, and 9 (1.5%) women without COVID-19 (p=0.019). The three women with COVID-19 were readmitted within 7 days of discharge due to hypoxia and tachypnea, two of whom were asymptomatic upon delivery admission. All three women had chest imaging demonstrating multifocal pneumonia and required oxygen supplementation by nasal cannula. Two women received hydroxychloroquine therapy, one woman also received broad-spectrum antibiotics, and two women were discharged home on oxygen supplementation. The range of postpartum readmission lengths of stay was 3.4-4.1 days.

Overall, 9 (12.9%) women with COVID-19 infections had postpartum complications as described above – postpartum fever, postpartum hypoxia, or postpartum readmission for new onset hypoxia, as against 27 (4.5%) of women without COVID-19 infections (p<0.001).

Neonatal outcomes

A total of 73 infants were born to 70 mothers with SARS-CoV-2 infection, and 71 infants had a nasopharyngeal swab for SARS-CoV-2 performed (Table 3). No infants had a positive RT-PCR result for SARS-CoV-2 within 24 hours of birth.

There were no differences in birthweight, Apgar scores, or location of neonatal admission across all three groups of pregnant women. Although there were no neonatal readmissions

during the study period, due to the COVID-19 pandemic, all neonatal readmissions at this hospital system were diverted to another hospital not included in this study.

Placental pathology

Placental pathology was performed for 28/30 (93.3%) women with COVID-19 and 99/305 (32.5%) women without COVID-19 at one site (Table 4). Evidence of fetal vascular malperfusion was noted among 14/29 (48.3%) placentas of women with COVID-19, versus 12/106 (11.3%) placentas among women without COVID-19 ($p<0.001$). These placentas were noted to have thrombi in the fetal vessels. Meconium staining was also more frequent among women with COVID-19, occurring in 18/29 (62.1%) versus 33/106 (31.1%) of placentas of women without COVID-19 ($p=0.004$). There were no differences in the frequency of histologic chorioamnionitis by group ($p=0.92$) or chronic villitis by group ($p=0.36$).

Discussion

Main Findings

In this cohort of 675 pregnant women presenting for delivery and universally tested for SARS-CoV-2, 10.4% of women were positive. Although the clinical presentation of COVID-19 was asymptomatic in the majority of cases, new symptomatology or clinical worsening occurred within the first 7 days postpartum among 13% of women with COVID-19. There were no maternal deaths, and one woman was admitted to the ICU. Cesarean delivery was more common among women with COVID-19. No cases of neonatal transmission of SARS-CoV-2 were detected among 71 infants tested. Placental pathology demonstrated evidence of thrombosis in the fetal circulation of the placenta among 48% of women with COVID-19.

Strengths and Limitations

Our study has several strengths. First, this is a large prospective cohort study across 3 institutions in New York City, serving a diverse patient population, detailing the outcomes of pregnant women with COVID-19 infection alongside a contemporary cohort of uninfected

women. Second, we had complete data capture of obstetric and neonatal outcomes from women admitted during this time period, minimizing selection bias. Third, we were able to capture placental pathologic outcomes in a subset of women with COVID-19 at one site.

Our study is subject to limitations. While we report women with COVID-19 infection as being symptomatic or asymptomatic based on self-report at the time of admission, some women were possibly pre-symptomatic, and thus miscategorized. Women may have also withheld reporting their symptoms out of concern about implications of having COVID-19 infection. As the majority of women were asymptomatic on admission, additional laboratory evaluation of women with COVID-19 infection was seldom performed once the RT-PCR result was available. Therefore, we are not able to comment on the laboratory findings associated with symptomatic versus asymptomatic COVID-19 infection in pregnancy.

Additionally, we did not evaluate contact history among women who were SARS-CoV-2 negative. Therefore, women with negative RT-PCR results and a positive contact history may have been misclassified. Finally, the placental pathologist was not blinded to any clinical diagnosis in either the SARS-CoV-2 positive or SARS-CoV-2 negative cohorts, which may have led to biases in the interpretation of the placental pathology.

Interpretation

Differences in age and insurance status may reflect characteristics of individuals with less ability to practice physical distancing. The racial and ethnic differences noted are challenging to interpret due to a high rate of missing data. Similarly, although there appear to increased frequencies of chronic hypertension, pregestational diabetes, and obesity among women with COVID-19, consistent with risk factors for COVID-19 in non-pregnant populations as well as data from the UKOSS, conclusions about risk factors are hard to draw due to the small absolute numbers of patients represented[6,9].

We noted an increased cesarean delivery rate among women with COVID-19, despite no differences in the indications for cesarean delivery and no recommended changes in obstetric management due to COVID-19 status. Although the absolute rate of cesarean delivery was high, it remains lower than that seen in the Chinese case series, or in data from the UKOSS [3,6]. While the frequency of intrapartum fever was not statistically different by group, it is possible that the presence of intrapartum fever, which was treated as chorioamnionitis, may be associated with an increased risk of cesarean delivery. Additionally, differences in baseline comorbidities may also play a role in the differences in cesarean delivery rates. However, based on the data available, we are not able to know what ultimately led to an increased cesarean delivery rate among women with COVID-19, and this deserves further study.

We also observed no differences in the preterm birth rate between women with and without COVID-19. This is a notable difference from the initial high rate reported out of Wuhan, China[3]. Our findings also differ from data from the UKOSS, where preterm birth > 32 weeks gestation appeared more common among women with COVID-19 than a historical control group of women without COVID-19[6].

Although our experience demonstrates generally favorable outcomes for women during labor and for their neonates, we observed that the postpartum period is a vulnerable time for women with COVID-19 at the time of delivery, as noted by in the Chinese series[3]. Several mechanisms may coincide to lead to this observation. First, the normal physiology of the immediate postpartum period may predispose women to develop or have worsening in respiratory symptoms, given the autotransfusion at the time of delivery, increased vascular resistance with placental delivery, and intravascular fluid shifting that occurs within days of delivery. This physiologic response may intersect in a deleterious manner with the reported cytokine elaboration associated with COVID-19 infection, and further study on these mechanisms is necessary[10,11].

We also observed an increase in the frequency of postpartum fevers, and a trend toward increased intrapartum fevers, among women with symptomatic COVID-19 infections. Although women with peripartum fever are commonly presumed to have intrauterine infections, such fevers have previously been demonstrated to be attributable to a cytokine response[12,13]. Thus, the incidence of fevers may be non-infectious and herald the onset of other clinical symptoms of COVID-19.

Given our findings, postpartum women with COVID-19 infection may benefit from close outpatient monitoring via home pulse oximetry monitoring and frequent telehealth visits. Elucidating risk factors for postpartum readmission among this population is also important.

We also observed an increased frequency of fetal vascular malperfusion, a placental lesion characterized by thrombosis in fetal vessels and avascular villi, as well as an increased frequency of meconium-stained placentas. Fetal vascular malperfusion is associated with fetal demise, fetal growth restriction, oligohydramnios, and neonatal encephalopathy.[14] Although neonatal outcomes were overwhelmingly reassuring, we note that the vast majority of neonates were likely born in close temporal relationship to the acute COVID-19 infection, given the timing of this study with relation to the pandemic in New York City. The implications of these findings on neonatal outcomes that occur earlier in the pregnancy are unclear. Consideration for antenatal testing and serial growth ultrasounds may be warranted given these findings.

Given the observations of thromboses in the placenta, the known increased risks of venous thromboembolic disease (VTE) in the postpartum period, the demonstrated coagulopathy associated with severe COVID-19 infections[15,16], women with COVID-19 infections, even if asymptomatic, may be at increased risks for VTE events, and prophylactic anticoagulation postpartum may also be warranted, consistent with other recommendations.[17,18]

Conclusion

In our prospective cohort study of universal testing for SARS-CoV-2 at the time of delivery admission in New York City, maternal outcomes with COVID-19 infection peri-delivery were reassuring. However, the postpartum period may pose an increased risk for women with COVID-19 infection, and additional observation is warranted. Neonatal outcomes were reassuring, with no events of vertical transmission observed. In light of the placental pathologic findings, the implications on obstetric and neonatal outcomes when acute COVID-19 infection occurs remote from delivery are not known.

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Completed disclosure of interest forms are available to view online as supporting information.

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All authors agree with the final version, and agree to be accountable to the integrity of the data published.

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Ethics approval

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Table 1. Sociodemographic and clinical characteristics at the time of presentation for delivery, stratified by SARS-CoV-2 RT-PCR result and symptomatic status

	SARS-CoV-2 RT-PCR Positive		SARS-CoV-2 RT-PCR Negative	
	Symptomatic	**Asymptomatic**		p-value
	N=15	N=55	N=605	
Sociodemographics				
Age, median (IQR) years	30.5 (26.1-36.8)	31.4 (26.6-37.2)	34.0 (30.9-37.1)	0.012
Race, n (%)				<0.001
White	4 (26.7%)	11 (20.0%)	235 (38.8%)	
Black	2 (13.3%)	9 (16.4%)	25 (4.1%)	
Asian	2 (13.3%)	7 (12.7%)	196 (32.4%)	
Unknown	7 (46.7%)	28 (50.9%)	149 (24.6%)	
Ethnicity, n (%)				<0.001
Hispanic	4 (26.7%)	15 (27.3%)	50 (8.3%)	
Non-Hispanic	10 (66.7%)	23 (41.8%)	376 (62.1%)	
Unknown	1 (6.7%)	17 (30.9%)	179 (29.6%)	
Insurance, n (%)				<0.001
Public	7 (46.7%)	27 (49.1%)	157 (26.0%)	
Private	8 (53.3%)	28 (50.9%)	448 (74.0%)	
Site, n (%)				0.004
NYP-WCM	6 (40.0%)	24 (43.6%)	304 (50.2%)	
NYP-Queens	7 (46.7%)	25 (45.5%)	151 (25.0%)	
NYP-LMH	2 (13.3%)	6 (10.9%)	150 (24.8%)	
Clinical Characteristics				
Gravidity, median (IQR)	2.0 (2.0-5.0)	2.0 (1.0-3.0)	2.0 (1.0-3.0)	0.18
Parity, median (IQR)	1.0 (0.0-2.0)	0.0 (0.0-1.0)	1.0 (0.0-1.0)	0.25
Gestational age on admission, median (IQR) weeks	38.7 (37.4-39.9)	39.0 (37.6-39.6)	39.1 (38.4-39.7)	0.11
Indications for admission, n (%)				<0.001
Labor indications	7 (46.7%)	30 (54.5%)	262 (43.3%)	
Fetal indications	1 (6.7%)	4 (7.3%)	26 (4.3%)	
Scheduled delivery	3 (20.0%)	13 (23.6%)	258 (42.6%)	
COVID-19-like symptoms	2 (13.3%)	0 (0.0%)	0 (0.0%)	
Preterm labor or preterm premature rupture of membranes	1 (6.7%)	2 (3.6%)	25 (4.1%)	
Other	1 (6.7%)	6 (10.9%)	34 (5.6%)	

Comorbidities				
Chronic hypertension, n (%)	3 (20.0%)	0 (0.0%)	13 (2.1%)	0.006
Pre-eclampsia or gestational hypertension, n (%)	3 (20.0%)	8 (14.5%)	56 (9.3%)	0.14
Pregestational diabetes mellitus, n (%)	1 (6.7%)	3 (5.5%)	7 (1.2%)	0.021
Gestational diabetes mellitus, n (%)	3 (20.0%)	3 (5.5%)	54 (8.9%)	0.20
Asthma, n (%)	2 (13.3%)	4 (7.3%)	35 (5.8%)	0.26
Pre-pregnancy BMI ≥ 30 kg/m2[a], n (%)	5 (83.3%)	7 (22.6%)	50 (14.5%)	<0.001
Smoking, n (%)	1 (6.7%)	0 (0.0%)	4 (0.7%)	0.16

[a] Data incompletely available for this variable due to incomplete capture of pre-pregnancy BMI

Table 2. Maternal presentation of COVID-19 infection, and maternal and obstetric outcomes, stratified by SARS-CoV-2 RT-PCR result and symptomatic status

	SARS-CoV-2 RT-PCR Positive		SARS-CoV-2 RT-PCR Negative	
	Symptomatic	**Asymptomatic**		p-value
	N=15	N=55	N=605	
Maternal Presentation at Admission				
Temperature, mean (SD) °C	37.0 (0.7)	36.8 (0.3)	--	0.17
Heart rate, mean (SD) beats per minute	91.8 (11.1)	88.4 (17.3)	--	0.47
Respiratory rate, mean (SD) breaths per minute	19.5 (5.5)	18.0 (2.0)	--	0.11
Oxygen saturation, median (IQR) %	99.0 (97.0-100.0)	99.0 (98.0-100.0)	--	0.60
White blood cell count, mean (SD)	8.8 (2.4)	9.0 (3.1)	--	0.78
Platelet count, mean (SD)	231.8 (101.5)	207.9 (72.4)	--	0.30
Maternal Outcomes				
Need for respiratory support, n (%)	2 (13.3%)	1 (1.8%)	--	0.11
Abnormal chest imaging findings, n (%)	3 (20.0%)	2 (3.6%)	--	0.062
ICU admission, n (%)	1 (6.7%)	0 (0.0%)	--	0.21
Treatment administered, n (%)			--	0.45
Hydroxychloroquine	2 (13.3%)	3 (5.5%)	--	
Azithromycin	0 (0.0%)	2 (3.6%)	--	
None	13 (86.7%)	50 (90.9%)	--	
Obstetric Outcomes				
Livebirth, n (%)	15 (100.0%)	54 (98.2%)	599 (99.0%)	0.54
Preterm birth <37 weeks' gestation, n (%)	2 (13.3%)	9 (16.4%)	57 (9.4%)	0.16
Mode of delivery[a], n (%)				0.044
Vaginal delivery	8 (53.3%)	30 (54.5%)	417 (68.9%)	
Cesarean delivery	7 (46.7%)	25 (45.5%)	187 (30.9%)	
Indication for cesarean delivery, n (%)				0.83
Nonreassuring fetal status	1 (6.7%)	3 (5.5%)	23 (3.8%)	
Labor indications	2 (13.3%)	7 (12.7%)	33 (5.5%)	
Scheduled repeat	2 (13.3%)	6 (10.9%)	74 (12.2%)	
Multiple gestation	0 (0.0%)	2 (3.6%)	11 (1.8%)	
Malpresentation	0 (0.0%)	1 (1.8%)	13 (2.1%)	
Other	2 (13.3%)	6 (10.9%)	33 (5.5%)	
Multiple gestation, n (%)	0 (0.0%)	4 (7.3%)	15 (2.5%)	0.12

Intrapartum fever[b], n (%)	3 (27.3%)	4 (9.5%)	38 (8.1%)	0.093
Postpartum hemorrhage > 1000mL, n (%)	1 (6.7%)	2 (3.6%)	38 (6.3%)	0.74
Postpartum fever, n (%)	5 (33.3%)	3 (5.5%)	17 (2.8%)	<0.001
Etiology of postpartum fever, n (%)				<0.001
Endometritis	0 (0.0%)	0 (0.0%)	8 (1.3%)	
COVID-19	3 (20.0%)	1 (1.8%)	0 (0.0%)	
Endometritis or COVID-19, cannot differentiate	2 (13.3%)	2 (3.6%)	1 (0.2%)	
Other	0 (0.0%)	0 (0.0%)	8 (1.3%)	
Length of stay, median (IQR) days	3.6 (2.1)	2.6 (1.1)	2.5 (1.1)	<0.001
Postpartum readmission, n (%)	1 (6.7%)	2 (3.6%)	9 (1.5%)	0.019

a 1 woman who was SARS-CoV-2 negative had a dilation and evacuation <24 weeks gestation

b Denominator is women who labored – 11 women with symptomatic COVID-19 infection, 42 women with asymptomatic COVID-19 infection, and 469 women without COVID-19 infection

Table 3. Neonatal outcomes, stratified by maternal SARS-CoV-2 RT-PCR result and maternal symptomatic status

	Maternal SARS-CoV-2 RT-PCR Positive		SARS-CoV-2 RT-PCR Negative	
	Symptomatic	**Asymptomatic**		p-value
	N=15	N=58	N=614	
Birthweight, mean (SD) grams	3149.6 (862.6)	3060.9 (606.9)	3197.6 (558.0)	0.21
5-minute Apgar score, median (IQR)	9.0 (9.0-9.0)	9.0 (9.0-9.0)	9.0 (9.0-9.0)	0.96
Neonatal sex, n (%)				0.31
Male	10 (66.7%)	26 (44.8%)	315 (51.3%)	
Female	5 (33.3%)	32 (55.2%)	299 (48.7%)	
Location of neonatal dmission, n (%)				0.26
Well-baby nursery	11 (73.3%)	48 (82.8%)	537 (87.5%)	
Transitional care nursery	0 (0.0%)	1 (1.7%)	9 (1.5%)	
Neonatal intensive care unit	4 (26.7%)	9 (15.5%)	68 (11.1%)	
Result of neonatal SARS-CoV-2 RT-PCR[a], n (%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Neonatal length of stay, median (IQR) days	2.2 (1.9-3.4)	2.1 (1.6-2.7)	1.9 (1.4-2.3)	0.011

a The denominator is neonates who were tested – 14 neonates of women with symptomatic COVID-19 infection, 57 neonates of women with asymptomatic COVID-19 infection, and 3 neonates of 614 women with a negative SARS-CoV-2 RT-PCR result

Table 4. Placental pathologic findings, stratified by SARS-CoV-2 status

	SARS-CoV-2 RT-PCR positive	**SARS-CoV-2 RT-PCR negative**	**p-value**
	N=29[a]	N=106[b]	
Fetal vascular malperfusion, n (%)			<0.001
Absent	15 (51.7%)	94 (88.7%)	
Present	14 (48.3%)	12 (11.3%)	
Maternal vascular malperfusion, n (%)			0.82
Absent	21 (72.4%)	73 (68.9%)	
Present	8 (27.6%)	33 (31.1%)	
Histologic evidence of chorioamnionitis, n (%)			0.92
None	26 (89.7%)	90 (84.9%)	
Maternal response	1 (3.4%)	8 (7.5%)	
Fetal response	0 (0.0%)	1 (0.9%)	
Maternal and fetal response	2 (6.9%)	7 (6.6%)	
Chronic villitis, n (%)			0.36
Absent	24 (82.8%)	93 (87.7%)	
Low-grade	2 (6.9%)	9 (8.5%)	
High-grade	3 (10.3%)	4 (3.8%)	
Meconium staining of placenta, n (%)			0.004
Absent	11 (37.9%)	73 (68.9%)	
Present	18 (62.1%)	33 (31.1%)	
Umbilical cord abnormalities, n (%)			0.12
Absent	28 (96.6%)	89 (84.0%)	
Present	1 (3.4%)	17 (16.0%)	
Chorangiosis, n (%)			1.00
Absent	29 (100.0%)	105 (99.1%)	
Focal	0 (0.0%)	1 (0.9%)	
Other placental abnormalities, n (%)			1.00
None	26 (89.7%)	96 (90.6%)	
Other	3 (10.3%)	10 (9.4%)	

a Data is derived from 28 deliveries, including 1 delivery of a twin gestation, resulting in 29 placentas evaluated

b Data is derived from 99 deliveries, including 6 deliveries of twin gestations and 1 delivery of a triplet gestation, resulting in 106 placentas evaluated