Original Research

Universal Testing of COVID-19 Infection on a New Orleans, LA Labor and Delivery Unit

Vidda Moussavi, MD,[1] Tiffany C. Chang, MD,[1] Alison M. Key, MD,[1] Minmin Luo, MD,[1] Alice S. Tong, MD,[1] Chi Dola MD, MPH[1]

Author affiliations are listed at the end of this article.

Correspondence to:
Chi Dola, MD, MPH
1430 Tulane Ave, Box 8611
New Orleans, LA 70112
(cdola@tulane.edu)

Abstract

Background

The greater New Orleans area emerged as an early epicenter of the COVID-19 pandemic, with one of the highest infection and death rates per capita in the United States.[1] The first case of COVID-19 in an obstetric patient at Tulane Lakeside Hospital occurred on March 22, 2020. Given increasing concern for asymptomatic carriers, the labor and delivery unit implemented universal testing of all patients and their support partners starting on April 1, 2020.

Methods

A retrospective chart review of all obstetric encounters was performed to determine the incidence of COVID-19, characterize the natural history of COVID-19 and evaluate obstetric and neonatal outcomes.

Results

Over a 5 week period of universal testing, there were 12/254 (4.72%) confirmed cases of COVID-19; 58% of COVID-positive patients were asymptomatic. The majority of the symptomatic COVID-19 patients had a mild course of the infection, similar to results from a previous study.[2] As of completion of the study period, only 4 COVID-19-positive patients delivered; all of them had uncomplicated intra- and postpartum courses. There was no evidence of vertical transmission of COVID-19.

Conclusion

These results confirm the asymptomatic carrier rate is high and support the case for universal testing in high prevalence cities. Ultimately, universal testing allows for a timely identification of disease, initiation of isolation and contact precautions and appropriate allocation of personal protective equipment (PPE).

Keywords

SARS-CoV-2; COVID-19; coronavirus infections/diagnosis; coronavirus infections/epidemiology; infectious pregnancy complications; viral pneumonia; asymptomatic infections; clinical laboratory techniques/methods; molecular diagnostic techniques

Introduction

The novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), initially began as a cluster of pneumonia cases in Wuhan, China in late 2019.[3] It rapidly spread across China and the globe before the World Health Organization recognized it is as a pandemic on March 11, 2020.[4,5] There are now more cases in the United States than any other nation in the world.[6] Since the first documented coronavirus disease 2019 (COVID-19) case in the state of Louisiana on March 9, 2020, there have been 116,280 cases as of August 1, 2020. The majority of Louisiana COVID-19 cases are concentrated in densely populated areas, including the greater New Orleans community, with more than 24,000 cases in Jefferson and Orleans parishes alone.[7]

COVID-19 is caused by a betacoronavirus named SARS-CoV-2 virus. It is genetically similar to the coronaviruses that causes se-

vere acute respiratory syndrome (SARS)[8] and Middle East respiratory syndrome (MERS).[9] The primary means of transmission is by direct person-to-person contact via respiratory droplets, and infection results in respiratory illness that can range from asymptomatic to mild, to critical disease and, in severe cases, death. Respiratory tract infections in pregnancy have historically increased the risk of fatal maternal and neonatal outcomes.[8] SARS has been well known to result in maternal death, miscarriage, IUGR and preterm delivery.[9] MERS was similarly attributed to an increase risk of maternal death and stillbirth.[10] In addition, there were no cases of vertical transmission with SARS or MERS.[9-11] Although information regarding pregnancy outcomes is limited, early reports suggest that SARS-CoV-2 infection may have a more indolent course compared to SARS, MERS or the influenza virus.[8] According to the American College of Obstetrics & Gynecology (ACOG), pregnant women with COVID-19, therefore, do not appear to be at an increased risk of infection or at risk for severe morbidity.[12] Pregnant women with co-morbidities appear to have similar risk of morbidity as non-pregnant patients with comorbidities.[12]

On March 22, 2020, Tulane-Lakeside Hospital identified its first patient with COVID-19 infection. A 32-year-old gravida 8, para 3133 with type 2 diabetes mellitus at 22 weeks gestational age presented with fever, cough and elevated blood glucose. She was tested for SARS-CoV-2, and the patient was transferred to the intensive care unit (ICU) for management of diabetic ketoacidosis. Up until mid-March, our facility relied on state testing for COVID-19. As results were not received for 2–3 days, she was treated as a presumptive positive for COVID-19. SARS-CoV-2 polymerase chain reaction (PCR) testing returned positive 1 day after she was discharged home with precautions to self-quarantine.

Following this first case, several patients testing positive for SARS-CoV-2 were asymptomatic, which was consistent with other early reports suggesting that SARS-CoV-2 may have substantial community spread via asymptomatic individuals.[13,14] This diagnosis was further complicated by delayed test results. For example, a woman presented in active labor and delivered before her test resulted as positive after delivery. This delayed test result caused exposure, delayed isolation and neonate testing and also highlights the need for universal testing with a rapid turnaround time in all patients presenting in labor. A report from New York City raised similar concerns about asymptomatic presentations of the SARS-CoV-2 virus in the obstetric population.[15] On April 1, 2020, the labor unit initiated universal rapid testing of COVID-19 infection in all patients and support people presenting to the labor unit for delivery or triage. We take this opportunity to describe our early experiences with universal rapid testing of COVID-19 infection in a cohort of obstetrics patients and their support persons.

Materials and Methods
Study Design
A retrospective chart review was performed after approval was obtained from the institutional review board (IRB). Data was collected on patients tested for COVID-19 at Tulane-Lakeside Hospital's labor and delivery unit from April 1 to May 7, 2020. Tulane Lakeside Hospital is the obstetrics hospital for the Tulane Obstetrics and Gynecology residency program but also has admissions from community physicians. The hospital is located in one of Louisiana's parishes with the highest COVID-19 prevalence.[7]

Beginning in mid-March 2020, all patients presenting to the hospital were screened in the emergency department for COVID-19 symptoms and risks factors, including fever, cough, shortness of breath, recent travel and known sick contacts. Initially, RT-PCR (Roche Cobas 6800) testing was performed only for those with COVID-19 symptoms or known exposure.

Testing at our hospital was implemented in stages. (**Table 1**) During the first stage of testing beginning on April 1, 2020, RT-PCR testing was completed prior to a scheduled hospital admission for labor induction or cesarean delivery, regardless of symptoms, to allow results to be available before their procedure. These patients were tested via nasopharyngeal swab using the Roche Cobas 6800 analyzer.

In the second stage of testing, started on April 8, 2020, rapid testing via isothermal nucleic acid amplification using the Abbott ID NOW test

Table 1. Hospital protocol for COVID-19 testing.

Protocol	Date	Hospital Criteria for Testing
Limited Testing	March 22 - 31, 2020	Patients reporting symptoms of COVID-19, exposure to sick contacts, or recent travel to high prevalence areas*
Universal Testing	April 1-7, 2020	Patients admitted for labor or scheduled for induction of labor or cesarean delivery
	After April 8, 2020	All patients presenting to the labor unit for any complaint

*SARS-CoV-2 testing was performed on patients having at least one symptom.

was completed on all patients presenting to the labor and delivery unit for any complaints; testing was also performed on their support person if the patient required admission. The support person who tested positive was not allowed on the labor unit if the patient tested negative and the patient could elect another support person who would also be tested for COVID-19. In a situation when the patient tested positive, a positive labor support person was allowed to stay in the room with the patient.

Data Collection
Data collection included maternal demographics, medical and obstetric conditions, results of COVID-19 and other diagnostic testing and maternal outcomes. Neonatal data collection included demographics, APGAR scores, birth weight, SARS-CoV-2 testing results and postnatal course.

Descriptive and comparison analyses were performed. Student's t-test, chi-square test and Fischer test, when applicable, were performed to evaluate differences between COVID-19-positive and COVID-19-negative groups, with a p-value <0.05 considered significant. Analysis was conducted in Microsoft Excel (Microsoft, Redmond, WA, USA) and using IBM SPSS Statistics Software package (IBM, Armonk, NY, USA).

Results
Implementation of a Universal Testing Protocol
During the first stage of universal testing (April 1–7, 2020), only patients scheduled for labor induction, scheduled cesarean section or admitted for delivery were tested. However, following full implementation of universal testing on April 8, 2020, all patients presenting to the labor unit for triage or admission for any reasons were tested. (**Table 1**)

Results are available on 254 patients; 12 (4.7%) were COVID-19-positive and 242 (95.3%) were COVID-19-negative. Among the 12 COVID-19-positive women, 5 (41.7%) were symptomatic, while 7 (58.3%) were asymptomatic on presentation. Forty-three (16.9%) patients underwent PCR testing using the Roche Cobas analyzer, and 212 (83.1%) patients were tested using the Abbott ID NOW rapid platform. The Roche test resulted positive in 5/43 (11.6%) encounters and the Abbott ID in 7/212 (3.3%) encounters.

Patient Characteristics
We described a study population that is diverse in ethnicity: 20.2% Caucasian, 43.5% African American and 36.3% Hispanic and other ethnicity. They had a high mean BMI, 30.9 ± 7.0 kg/m2, with 12.6% meeting the BMI criteria for morbid obesity; 8.4% had hypertension, 5.7% had either gestational hypertension or preeclampsia, 3.4% had pre-existing diabetes and 6.1% had gestational diabetes.

The comparison of maternal demographics, obstetrical characteristics and neonatal outcomes between those who tested positive and those who tested negative for COVID-19 are presented in **Table 2**. No significant difference was noted between the 2 groups, except that COVID-19-positive women were significantly older than COVID-19-negative women (31.7 ± 6.7 vs 27.7 ± 6.0 years, respectively; p = 0.03). Characteristics of COVID-19-positive patients are presented in **Table 3**.

Table 2. Comparison of COVID-19-positive and -negative patients.

	COVID (+) (N=12)	COVID (-) (N=242)	P-value
Age	31.7 ± 6.7	27.7 ± 6.9	0.03
Gravidity	2.6 ± 1.8	2.8 ± 1.9	NS
Parity	1.3 ± 1.9	1.3 ± 1.3	NS
Race			
Caucasian	1 (8.3%)	52 (21.5%)	NS
African American	4 (33%)	105 (43.4%)	NS
Hispanic or other	7 (58%)	85 (35.1%)	NS
BMI	33.1 ± 7.7	30.8 ± 6.9	NS
Maternal condition			
Morbid obesity	2 (16.7%)	29 (12%)	NS
Pre-gestational diabetes	0	9 (3.7%)	NS
Gestational diabetes	1 (8.3%)	14 (5.8%)	NS
Chronic hypertension	3 (25%)	19 (7.8%)	0.07
Gestational hypertension/Preeclampsia	0	15 (6.2%)	NS
Gestational Age at testing	32.0 ± 7.2	32.2 ± 10.0	NS
Gestational Age at delivery	39.6 ± 0.5	37.2 ± 5.7	NS
Neonatal birthweight (grams)	3249.8 ± 11.3	3094.0 ±884.3	NS
Apgar score @ 1min	8.5 ± 0.6	7.5 ± 2.3	NS
Apgar score @ 5min	9.0 ± 0	8.4 ± 2.0	NS

Symptomatic COVID-19-Positive Patients

Symptomatic COVID-19 patients presented with fever (n=2), cough (n=4), shortness of breath (n=1) or other symptoms such as dizziness, syncope and loss of smell or taste (n=5). Two patients had chest X-rays and only 1 showed signs of reactive lung disease. (**Table 3**)

The first patient with symptoms of COVID-19 infection was admitted to our Obstetrics ICU for management of diabetic acidosis and not for her COVID-19 symptoms. Her COVID-19 test result did not return until after she was discharged. Other symptomatic patients had an indolent course as previously characterized by fever, cough, fatigue, myalgia, gastrointestinal symptoms or anosmia[16] and were discharged to home isolation after a brief hospital observation period with supportive care. None of the patients required ICU admission for critical care of COVID-19 symptoms. All symptomatic COVID-19 patients were still pregnant at the time of the submission of this report.

During follow-up 14 days after discharge, 4 of the 5 symptomatic COVID-19 patients reported improved or resolved symptoms. No data is available at the time of this report on the 1 patient. None had reported worsening COVID-19 symptoms as of the end of the study period.

Asymptomatic COVID-19-Positive Patients

Of the 7 women who tested positive for COVID-19 on universal screening and testing and were asymptomatic for symptoms of COVID-19, 4 presented to triage to be evaluat-

Table 3. Characteristics of COVID-19-positive patients.

Patient	Symptomatic	EGA	Chief complaint or reason for admission	Treatment	Delivered?	Neonates (APGARs; birth-weight)	Discharge/ Outpatient disposition
1	Yes	22 0/7	Fever, cough, shortness of breath, diarrhea, COVID-19-positive contact	Acetaminophen	No		Yes*
2	Yes	36 7/7	Loss of taste/smell, shortness of breath, COVID-19-positive contact	-	No		Yes†
3	Yes	26 4/7	Fever, cough, diarrhea, myalgia	Acetaminophen Guaifenesin	No		Yes†
4	Yes	20 6/7	Cough, myalgia	-	No		Yes†
5	Yes	28 3/7	Cough, sore throat	-	No		Yes†
6	No	39 4/7	Active labor	-	Yes	8/9; 3324g	No‡
7	No	38 0/7	Active labor	-	Yes	9/9; 3308g	No‡
8	No	28 0/7	Lower back pain	-	No		Yes†
9	No	27 0/7	Contractions	-	No		Yes†
10	No	38 1/7	Contractions	-	Yes	8/9; 3541g	No‡
11	No	38 6/7	Abdominal pain	-	No		Yes†
12	No	39 1/7	Scheduled external cephalic version	-	Yes	9/9; 2826g	No‡

*Patient was admitted to ICU for management of diabetic acidosis; COVID-19 test result returns after discharge home.

†Patient discharged home following short hospital observation period.

‡Admitted for delivery and postpartum care and not due to COVID-19 symptoms.

ed for abdominal pain or contractions. Labor was ruled out, and they were discharged home with precautions to self-quarantine. Two were admitted for labor and delivery at term. In addition, 1 patient was admitted for a scheduled external cephalic version and ultimately delivered by primary low-transverse cesarean section.

A comparison was made between the symptomatic and the asymptomatic COVID-19 cohorts. Except for a significant difference in maternal temperature on admission, no difference was noted in other vital signs and laboratory values. (**Table 4**)

Delivery outcomes: Only 4 asymptomatic COVID-19-positive women delivered during this study period—3 vaginal deliveries and 1 primary low transverse cesarean for non-cephalic presentation. Placental pathology of 1 asymptomatic COVID-19-positive patient was notable for acute chorioamnionitis. However, her intrapartum and postpartum courses revealed no evidence of infection.

None of the symptomatic COVID-19-positive women have delivered yet. With the exception of 1 patient with delayed test results, all COVID-19-positive patients delivered either in our dedicated COVID-19 labor and delivery room or a COVID-19 operating room with proper PPE.

Neonatal outcomes: Neonates from the 4 asymptomatic COVID-19 mothers who delivered had mean APGAR scores of 8.5± 0.6 and 9.0 + 0 at 1 and 5 minutes, respectively. (**Table 2**) Following COVID-19 diagnosis in the mother, contact and isolation precautions were im-

Table 4. Vital signs and laboratory results on presentation of all COVID-19-positive patients.

Vital Signs	Symptomatic (N=5)		Asymptomatic (N=7)		P-value
	Mean ± SD	Range	Mean ± SD	Range	
Temperature	100.2 ± 1.8	99.0-103.1	98.1 ± 0.1	97.9-98.2	0.05
Oxygen saturation	95.0 ± 4.8	87-99	95.5 ± 4.4	90-100	0.88
Respiratory rate	18.2 ± 1.8	16-20	18.0 ± 1.6	16-20	0.87
Heart rate	101.2 ± 17.0	78-120	78.3 ± 18.3	52-96	0.06
Initial Laboratory Values					
Hemoglobin	12.2 ± 0.9	11.1-13.0	11.8 ± 0.8	4.2-11.9	0.56
White blood cell count, x109/L	7.5 ± 3.7	4.6-13.1	7.6 ± 3.9	11.0-12.5	0.98
Absolute Count, x109/L					
Lymphocyte	1.9 ± 1.3	0.56-3.44	1.7 ± 0.2	1.46-1.81	0.75
Neutrophil	4.9 ± 2.4	3.15-8.39	5.8 ± 4.9	2.35-9.31	0.87
Eosinophil	0.0025 ± 0.0	0.00-0.01	0.1033 ± 0.0	0.07-0.18	0.12
Sodium, mmol/L	138.0 ± 3.4	133-140			
Aspartate aminotransferase, U/L	29.5 ± 13.7	21-50			
Alanine aminotransferase, U/L	30.0 ± 20.1	18-60			
Creatinine	0.65 ± 0.13	0.5-0.8			
C-reactive protein, mg/dL	4.1	4.1			
Lactate dehydrogenase, U/L	191.3 ± 7.8	181-199			
Procalcitonin, ng/mL	0.11 ± 0.06	0.07-0.18			

plemented, and the neonates were tested for SARS-CoV-2. No neonates tested positive for SARS-CoV-2 at either 24 or 48 hours. Support partners: To date, no support persons have tested positive for the virus.

Discussion

Principle Findings

COVID-19 is detected in asymptomatic parturients. Timely identification of these asymptomatic carriers in the setting of obstetrics care is important for early implementation of isolation and contact precautions, appropriate allocation of PPE and proper care of the neonate.

Results in the Context of What Is Known

Our study confirms previous findings that most cases of COVID-19, in both non-pregnant and pregnant populations, present with mild disease. In non-pregnant populations, the Center for Disease Control and Prevention in China found that 81% of COVID-19-positive cases had mild disease, defined as patients with or without mild pneumonia, 14% had severe disease

with dyspnea, hypoxia, and pneumonia and 5% had critical disease, including respiratory failure and shock.[2] Similar rates of mild respiratory disease, most commonly presenting with fever and cough, were also found in pregnant women.[2,14,17,18] Following delivery, there were no cases of severe pneumonia or maternal death in these patients.[17-20]

This retrospective chart review study identified the asymptomatic carrier rate of SARS-CoV-2 infection during a period of universal rapid testing. We observed reassuring maternal and fetal outcomes in pregnant women with COVID-19, both with and without symptoms. Prior to the universal testing period, our first COVID-19-positive patient was admitted to the ICU for the treatment of diabetic ketoacidosis and not for respiratory issues; her COVID-19-positive result returned after she was discharged. Following universal testing at our hospital, no COVID-19-positive patients required intensive care. Of the symptomatic COVID-19-positive patients, only 1 had signs of reactive lung disease on imaging.

The findings in this New Orleans hospital highlight the prevalence of asymptomatic COVID-19 on our labor unit, consistent with findings from other regions with a high incidence of COVID-19.[17] Studies from New York City, the initial epicenter of COVID-19 in the US, identified SARS-CoV-2 infection in 15.3% of patients[14] and asymptomatic infection in 32.6%[13] to 87.9%[14] of COVID-19 patients with universal testing.[14,20] While our COVID-19-positive rate of 4.7% is lower, which correlates to a lower infection rate in New Orleans compared to New York City,[21] our asymptomatic positive rate at 58.3% is comparable. Although the true number of asymptomatic cases is unknown, our studies highlight the importance of universal testing to identify asymptomatic carriers, especially in areas with higher rates of COVID-19.

We recognize the possibility that asymptomatic pregnant women could present at the beginning of their illness and, therefore, had not yet developed severe COVID-19 symptoms. Breslin et al. found that most asymptomatic women developed fever and symptoms throughout their hospitalization.[13] Wang et al. described a symptomatic patient who initially tested negative for COVID-19, and subsequent repeat COVID-19 testing and a CT scan confirmed she was COVID-19-positive.[22] However, in our study, all 4 COVID-19-positive patients who delivered remained asymptomatic and afebrile throughout hospitalization without the most common symptoms of fever and cough. Additionally, the majority of symptomatic COVID-19-positive patients improved or had resolution of symptoms 14 days after presentation. Although reassuring, these studies do not provide a comprehensive overview of the potential dangers of COVID-19. Despite recent reassuring findings about the absence of significant maternal or fetal risk, caution should still be advised.

Clinical Implications

Although this report and prior studies suggest reassuring outcomes for COVID-19-positive pregnant patients and their neonates, COVID-19 remains a major public health threat. Early COVID-19 diagnosis allows for timely identification of infectious patients, quick establishment of isolation and contact precautions and preservation of PPE resources. Universal testing also helps in informing neonatal testing, isolation from other infants and recommended separation or contact precautions from the mother during the infectious period.

These findings underscore the importance of universal testing and should encourage other facilities to pursue similar testing procedures. ACOG currently endorses universal testing in areas of wide community spread and where the number of asymptomatic presentations is likely high.[12] While this is appropriate for cities such as New Orleans, other cities may not have such a high prevalence of disease. Furthermore, if testing is not universally available, testing should be prioritized for symptomatic patients or those with a high suspicion of disease and/or comorbidities.

Research Implications

Many unanswered questions remain about COVID-19 and its effect on the peripartum period. Given the novel nature of this virus, the timing of maternal infection and the importance of fetal gestational age remains unknown. Future research on the effects of COVID-19 infection in first or second trimester gestation on neonatal outcomes is warranted.

Strengths and Limitations

Strengths: While most case series only evaluate COVID-19-positive patients, this study considered all women who were tested and evaluated the characteristics of COVID-19-negative patients. This COVID-19-negative control group served as a baseline to identify differences in maternal and neonatal outcomes. High rates of COVID-19 infection in the greater New Orleans area, combined with wider accessibility to testing, permitted ongoing surveillance of the obstetrics population. In addition, no other facility to our knowledge has initiated testing of support persons or developed an algorithm embedded into the intake process to safely address the support person testing positive. Although no support partners tested positive, an important example was set for all other labor units to test support people for COVID-19 universally. This also raises the question on the transmission of COVID-19 infection. Assuming the majority of the labor support persons for our patients have close contact with the patients, they somehow tested negative. Further research in the transmission of the disease is indicated. Can the negative test results be explained by the fact that the viral load in these

asymptomatic women is low, and therefore, the infectious nature of the disease is low?

Limitations: While the Abbott ID NOW test provides the fastest results—in 13 minutes or less—recent reports suggest that ID NOW might be the most inaccurate test.[23] Multiple reports of false negative results, including a false negative rate of 33.3–50%,[24] suggest that the 4.7% COVID-19 infection rate reported in our study is perhaps underreported.

A small sample size is another limitation of our study, resulting in a type II error where abnormal laboratory findings and more critically ill pregnant patients were not seen in our study sample.

Conclusion

A strategy of rapid universal testing of all patients and their support partner has obvious benefits. Universal testing identified many asymptomatic pregnant patients. Additionally, testing of support persons allowed loved ones to participate in the delivery process in a safe way that limits spread of the virus to health care workers and the community at large.

Conflicts of Interest

The authors declare they have no conflicts of interest.

Author Affiliations

1. Tulane University School of Medicine, New Orleans, LA

References

1. Louisiana Department of Health. Louisiana Coronavirus COVID-19. http://ldh.la.gov/Coronavirus/. Published 2020. Accessed April 26, 2020.

2. Wu Z, McGoogan JM. Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72 314 Cases From the Chinese Center for Disease Control and Prevention. *JAMA*. 2020;323(13):1239-1242. https://doi.org/10.1001/jama.2020.2648

3. Zhu N, Zhang D, Wang W, et al. A Novel Coronavirus from Patients with Pneumonia in China, 2019. *N Engl J Med*. 2020;382(8):727-733. https://doi.org/10.1056/nejmoa2001017

4. World Health Organization. WHO Director-General's remarks at the media briefing on 2019-nCoV on 11 February 2020. https://www.who.int/director-general/speeches/detail/who-director-general-s-remarks-at-the-media-briefing-on-2019-ncov-on-11-february-2020

5. World Health Organization. WHO Director-General's remarks at the media briefing on COVID-19 – 11 March 2020. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020

6. World Health Organization. Coronavirus. https://www.who.int/health-topics/coronavirus#tab=tab_1. Accessed May 17, 2020.

7. John Hopkins University and Medicine. Coronavirus Resource Center. https://coronavirus.jhu.edu/. Published 2020. Accessed May, 2020.

8. Schwartz DA. An Analysis of 38 Pregnant Women with COVID-19, Their Newborn Infants, and Maternal-Fetal Transmission of SARS-CoV-2: Maternal Coronavirus Infections and Pregnancy Outcomes [published online ahead of print, 2020 Mar 17]. *Arch Pathol Lab Med*. 2020;144(7):799-805. https://doi.org/10.5858/arpa.2020-0901-sa

9. Wong SF, Chow KM, Leung TN, et al. Pregnancy and perinatal outcomes of women with severe acute respiratory syndrome. *Am J Obstet Gynecol*. 2004;191(1):292-297. https://doi.org/10.1016/j.ajog.2003.11.019

10. Assiri A, Abedi GR, Al Masri M, Bin Saeed A, Gerber SI, Watson JT. Middle East Respiratory Syndrome Coronavirus Infection During Pregnancy: A Report of 5 Cases From Saudi Arabia. *Clin Infect Dis*. 2016;63(7):951-953. https://doi.org/10.1093/cid/ciw412

11. Schwartz DA, Graham AL. Potential Maternal and Infant Outcomes from (Wuhan) Coronavirus 2019-nCoV Infecting Pregnant Women: Lessons from SARS, MERS, and Other Human Coronavirus Infections. *Viruses*. 2020;12(2):194. Published 2020 Feb 10. https://doi.org/10.3390/v12020194

12. American College of Obstetricians and Gynecologists. Novel Coronavirus 2019 (COVID-19) Practice Advisory. https://www.acog.org/clinical/clinical-guidance/practice-advisory/articles/2020/03/novel-coronavirus-2019. Published 2020. Updated May 19, 2020. Accessed May 24, 2020.

13. Breslin N, Baptiste C, Gyamfi-Bannerman C, et al. Coronavirus disease 2019 infection among asymptomatic and symptomatic pregnant women: two weeks of confirmed presentations to an affiliated pair of New York City hospitals. *Am J Obstet Gynecol MFM*. 2020;2(2):100118. https://doi.org/10.1016/j.ajogmf.2020.100118

14. Sutton D, Fuchs K, D'Alton M, Goffman D. Universal Screening for SARS-CoV-2 in Women Admitted for Delivery [published online ahead of print Apr 13]. *N Engl J Med*. 2020. https://doi.org/10.1056/nejmc2009316

15. Breslin N, Baptiste C, Miller R, et al. Coronavirus disease 2019 in pregnancy: early lessons. *Am J Obstet Gynecol MFM*. 2020;2(2):100111. https://doi.org/10.1016/j.ajogmf.2020.100111

16. Guan WJ, Ni ZY, Hu Y, et al. Clinical Characteristics of Coronavirus Disease 2019 in China. *N Engl J Med*. 2020;382(18):1708-1720. https://doi.org/10.1056/nejmoa2002032

17. Li N, Han L, Peng M, et al. Maternal and neonatal outcomes of pregnant women with COVID-19 pneumonia: a case-control study [published online ahead of print, 2020 Mar 30]. *Clin Infect Dis*. 2020;ciaa352. https://doi.org/10.1093/cid/ciaa352

18. Chen H, Guo J, Wang C, et al. Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records. *Lancet*. 2020 Mar 7;395(10226):809-815. https://doi.org/10.1016/s0140-6736(20)30360-3

19. Liu W, Wang Q, Zhang Q, et al. Coronavirus disease 2019 (COVID-19) during pregnancy: a case series. *Preprints*. 2020;2020020373. https://www.preprints.org/manuscript/202002.0373/v1

20. Liu D, Li L, Wu X, et al. Pregnancy and Perinatal Outcomes of Women With Coronavirus Disease (COVID-19) Pneumonia: A Preliminary Analysis. *AJR Am J Roentgenol*. 2020;215(1):127-132. https://doi.org/10.2214/ajr.20.23072

21. New York State Department of Health. New York State Department of Health COVID-19 Tracker. https://covid19tracker.health.ny.gov/views/NYS-COVID19-Tracker/NYS-DOHCOVID-19Tracker-TableView?%3Aembed=yes&%3Atoolbar=no&%3Atabs=n. Published 2020. Accessed April 26, 2020.

22. Wang X, Zhou Z, Zhang J, Zhu F, Tang Y, Shen X. A Case of 2019 Novel Coronavirus in a Pregnant Woman with Preterm Delivery. *Clin Infect Dis*. 2020;71(15):844-846. https://doi.org/10.1093/cid/ciaa200

23. ID NOW COVID-19 Instructions for Use. IN190000 Rev. 3 2020/04. Scarborough, ME: Abbott Diagnostics Scarborough, Inc.; 2020. https://www.fda.gov/media/136525/download

24. Basu A, Zinger T, Inglima K, et al. Performance of Abbott ID NOW COVID-19 rapid nucleic acid amplification test in nasopharyngeal swabs transported in viral media and dry nasal swabs, in a New York City academic institution. *bioRxiv*. May 29, 2020;2020.05.11.089896. https://doi.org/10.1101/2020.05.11.089896