

# Symptoms and Critical Illness Among Obstetric Patients With Coronavirus Disease 2019 (COVID-19) Infection

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**OBJECTIVE:** To characterize symptoms and disease severity among pregnant women with coronavirus disease 2019 (COVID-19) infection, along with laboratory findings, imaging, and clinical outcomes.

**METHODS:** Pregnant women with COVID-19 infection were identified at two affiliated hospitals in New York City from March 13 to April 19, 2020, for this case series study. Women were diagnosed with COVID-19 infection based on either universal testing on admission or testing because of COVID-19–related symptoms. Disease was classified as either 1) asymptomatic or mild or 2) moderate or severe based on dyspnea, tachypnea, or hypoxia. Clinical and demographic risk factors for moderate or severe disease were analyzed and calculated as odds ratios (ORs) with 95% CIs. Laboratory findings and associated symptoms were compared between those

with mild or asymptomatic and moderate or severe disease. The clinical courses and associated complications of women hospitalized with moderate and severe disease are described.

**RESULTS:** Of 158 pregnant women with COVID-19 infection, 124 (78%) had mild or asymptomatic disease and 34 (22%) had moderate or severe disease. Of 15 hospitalized women with moderate or severe disease, 10 received respiratory support with supplemental oxygen and one required intubation. Women with moderate or severe disease had a higher likelihood of having an underlying medical comorbidity (50% vs 27%, OR 2.76, 95% CI 1.26–6.02). Asthma was more common among those with moderate or severe disease (24% vs 8%, OR 3.51, 95% CI 1.26–9.75). Women with moderate or severe disease were significantly more likely to have leukopenia and elevated aspartate transaminase and ferritin. Women with moderate or severe disease were at significantly higher risk for cough and chest pain and pressure. Nine women received ICU or step-down-level care, including four for 9 days or longer. Two women underwent preterm delivery because their clinical status deteriorated.

**CONCLUSION:** One in five pregnant women who contracted COVID-19 infection developed moderate or severe disease, including a small proportion with prolonged critical illness who received ICU or step-down-level care.

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On March 11, 2020, the World Health Organization declared the novel coronavirus disease 2019 (COVID-19) outbreak a pandemic.<sup>1</sup> The clinical spectrum of COVID-19 infection appears to be

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Each author has confirmed compliance with the journal's requirements for authorship.

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variable, ranging from asymptomatic infection or mild symptomatology to severe respiratory failure with multi-organ complications.<sup>2-4</sup> In the adult population, many risk factors for poor prognosis have been identified, including medical comorbidities and increasing age.<sup>5,6</sup> There are limited data on risk factors associated with COVID-19 symptomatology in the obstetric population in the United States.<sup>7-9</sup> Some early reports suggest that pregnant women may be less susceptible to the disease, presenting mainly with mild symptoms. However, prior pandemics have demonstrated infection to be associated with increased risk among pregnant women.<sup>10,11</sup> A report from China found that 8% of pregnant women with COVID-19 infection developed critical illness (Chen L, Li Q, Zheng D, Jiang H, Wei Y, Zou L, et al. Clinical characteristics of pregnant women with covid-19 in Wuhan, China [letter]. *N Engl J Med* 2020 Apr 17 [Epub ahead of print]).

New York City became an international epicenter of the outbreak, with the President approving a major disaster declaration in New York State on March 20, 2020. After initially asymptomatic obstetric patients with COVID-19 infection exposed a large number of health care workers to the virus at a tertiary care referral hospital in New York City, universal testing for all patients admitted for obstetric indications was initiated there and at an affiliated community hospital on March 22, 2020.<sup>12</sup> This approach facilitated identification of a relatively large number of women with COVID-19 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 Apr 13 [Epub ahead of print]). Given that symptomatology and associated risk factors among obstetric patients with COVID-19 infection are not well characterized in the United States, the purpose of this study was to analyze COVID-19 symptoms and associated risk factors as well as laboratory findings, imaging, and clinical outcomes among affected pregnant and postpartum women.

## METHODS

For this case series study, pregnant women with COVID-19 infection were identified at two hospitals in New York City from March 13 to April 19, 2020: NewYork-Presbyterian/Columbia University Irving Medical Center, a tertiary care referral center performing approximately 4,600 deliveries per year, and NewYork-Presbyterian/Allen Hospital, a community hospital performing approximately 2,300 deliveries per year. Patients were diagnosed with COVID-19 infection in one of two clinical scenarios: 1) they were tested after presenting with symptomatology concerning

for COVID-19 infection in the inpatient or outpatient setting or 2) they underwent universal testing on hospital admission to the obstetric service. Universal COVID-19 testing was initiated starting on March 22, 2020, for all women admitted to the labor unit for delivery, as well as for women admitted for antepartum indications and postpartum complications, with the purpose of improving identification, preventing exposure, and guiding clinical management (Sutton D et al. *N Engl J Med* 2020 Apr 13 [Epub ahead of print]). To identify infection, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) reverse-transcriptase real-time polymerase chain reaction testing was performed on nasopharyngeal samples collected by physicians or nurse practitioners. Use of these data for research purposes was approved by the Columbia University Institutional Review Board (AAAS9214).

In this analysis, patients with COVID-19 infection were categorized into two groups based on symptomatology and clinical findings present during the disease course. The first group consisted of asymptomatic or mildly symptomatic women. Mildly symptomatic women included those with symptoms limited to: 1) cough, 2) fever, 3) myalgia, 4) sore throat, 5) chest pain or pressure, 6) congestion, 7) headache 8) diarrhea, 9) nausea, and 10) loss of taste or smell. The second group consisted of women with moderate to severe symptomatology and findings and included women with one or more of the following: 1) dyspnea; 2) tachypnea, defined as respiratory rate of more than 30 breaths per minute; 3) hypoxia, defined by pulse oximetry lower than 93% on room air; and 4) lung infiltrates on chest X-ray accounting for more than 50% of lung volume within 48 hours of presentation. Patients with dyspnea but no evidence of hypoxia or clinical decompensation were classified as having moderate disease but could be managed as outpatients with close follow-up and regular surveillance of symptoms by a clinician. This follow-up included enrollment in a COVID-19 telehealth follow-up program, with video visits with a physician every 24–48 hours depending on the severity of symptoms. Patients were instructed to monitor their symptoms and to take their temperature and heart rate twice per day. Symptoms and findings were reviewed with a physician at each video visit. Patients with concerning symptoms, such as worsening dyspnea, difficulty completing full sentences, or increased work of breathing, were instructed to present to the triage for evaluation. Outpatients with 2 or more weeks of surveillance whose symptoms resolved or improved substantially were discharged from the program.



For the primary analysis, we evaluated demographic and medical risk factors associated with development of moderate or severe compared with no or mild symptoms and findings (Table 1). Demographic and medical factors and symptomatology were compared with the  $\chi^2$  or Fisher exact test, as appropriate. Odds ratios of exposures with 95% CIs were calculated for the outcomes of moderate or severe compared with no or mild symptoms. Several secondary analyses were performed. First, we sought to determine to what degree mild symptoms,

as listed above, were more likely to be present among women with mild compared with moderate or severe disease. Second, we evaluated the presence or absence of abnormal laboratory values for women with moderate or severe compared with asymptomatic or mild disease (Appendix 1, available online at <http://links.lww.com/AOG/B931>). Comparisons of abnormal laboratory findings between women with mild or asymptomatic compared with moderate or severe COVID-19 infection were performed with the  $\chi^2$  or Fisher exact test, as

**Table 1. Demographics Based on Coronavirus Disease 2019 Severity**

Characteristic	Mild or Asymptomatic (n=124)	Moderate or Severe (n=34)	P
Maternal age (y)			.22
Younger than 25	33 (27)	4 (12)	
25 to 34	59 (48)	17 (50)	
35 to 39	25 (20)	10 (29)	
40 or older	7 (6)	3 (9)	
Race			.80
Asian	5 (4)	0 (0.0)	
Black	19 (15)	4 (12)	
Hawaiian or Pacific Islander	2 (2)	0 (0.0)	
White	41 (33)	14 (41)	
Unknown or not specified	57 (46)	16 (47)	
Ethnicity			.56
Hispanic	80 (65)	25 (74)	
Non-Hispanic	37 (30)	7 (21)	
Missing	7 (6)	2 (6)	
BMI (kg/m <sup>2</sup> )*			.95
Less than 25	16 (13)	5 (15)	
25–29.9	44 (35)	13 (38)	
30–34.9	37 (30)	10 (29)	
35 or higher	27 (22)	6 (18)	
Medical condition			
Any condition	33 (27)	17 (50)	<.01
Asthma	10 (8)	8 (24)	.03
Chronic hypertension	5 (4)	3 (9)	.37
Gestational diabetes	6 (5)	1 (3)	1.00
Pregestational diabetes	3 (2)	1 (3)	1.00
Anemia	2 (2)	1 (3)	.52
Hypothyroidism	5 (4)	2 (6)	.64
Other <sup>†</sup>	7 (6)	4 (12)	.25
Gestational age at diagnosis (wk)			<.01
Less than 14	6 (5)	1 (3)	
14 to less than 28	24 (19)	11 (32)	
28 to less than 34	22 (18)	13 (38)	
34 to less than 37	11 (9)	3 (9)	
37–42	61 (49)	6 (18)	
Postpartum	0 (0)	0 (0)	
Insurance			.44
Medicaid	88 (71)	21 (62)	
Commercial	34 (27)	13 (38)	
Missing	2 (2)	0 (0)	
Sick exposures	50 (40)	16 (47)	.35

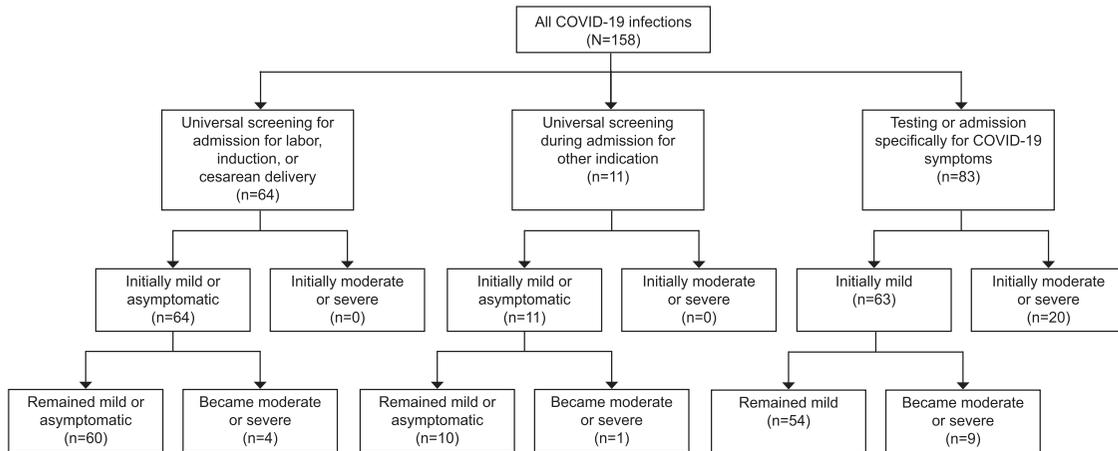
BMI, body mass index.

Data are n (%) unless otherwise specified.

\* Calculated on admission or at the time of diagnosis.

<sup>†</sup> Pituitary tumor, multiple sclerosis, thromboembolism, hyperthyroidism, connective tissue disease.





**Fig. 1.** Clinical setting and symptoms of coronavirus disease 2019 (COVID-19) infection diagnoses. This figure demonstrates indications for testing that led to COVID-19 infection diagnosis, as well as clinical symptoms.

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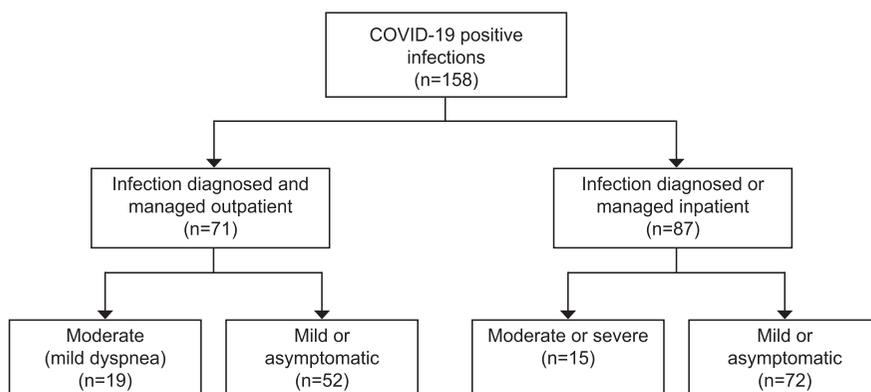
indicated. As a sensitivity analysis, we compared abnormal laboratory values only between women with mild disease and those with moderate or severe disease. Third, we evaluated hospital and clinical courses of inpatients who developed moderate or severe symptomatology and required inpatient hospitalization. We analyzed the sequence of when they developed symptomatology, whether they became hypoxic, whether they received intensive care unit (ICU) or step-down-level care, whether clinical decompensation required delivery, and how many days they were hospitalized. For hospitalized women with moderate or severe COVID-19 infection, we additionally analyzed chest X-ray findings and risk for adverse outcomes, including acidemia, sepsis, stroke, thromboembolism, and acute renal failure. All analyses were performed with SAS 9.4.

## RESULTS

A total of 158 pregnant women with COVID-19 infection were included in the analysis. Thirty-four women had moderate or severe disease (22%), and

124 had mild or asymptomatic disease (78%). Sixty-four women (41%) were diagnosed during universal testing on admission for delivery, 11 women (7%) were diagnosed during universal testing on admission for another obstetric indication, and the remaining 83 (53%) were diagnosed after being tested because of COVID-19-related symptoms (Fig. 1). Of the 158 women with COVID-19 infection, 87 (55%) were inpatients at some time during the disease course and 71 underwent outpatient management (45%) (Fig. 2). Of the 71 who were managed as outpatients, 19 (26.8%) had moderate disease severity based on the presence of dyspnea. Of the 63 women who were asymptomatic at diagnosis, one developed moderate or severe disease. In comparison, of 75 women with mild symptoms at diagnosis, 13 developed moderate or severe disease (Fig. 3).

Comparing women with mild or asymptomatic disease with those with moderate or severe disease, the two groups did not differ significantly based on



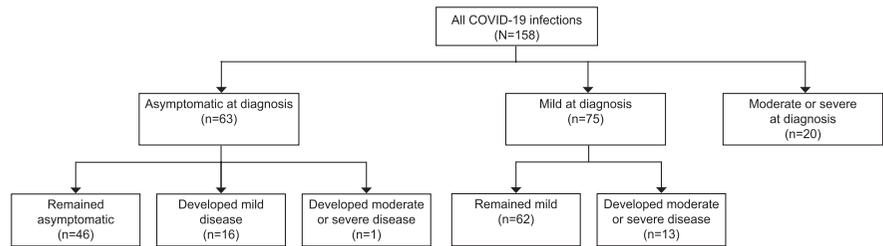
**Fig. 2.** Inpatient compared with outpatient management of coronavirus disease 2019 (COVID-19) infection. This figure demonstrates obstetric patients diagnosed with COVID-19 infection based on whether the infection was diagnosed or managed inpatient.

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**Fig. 3.** Progression of coronavirus disease 2019 (COVID-19) infection symptoms and findings from status at diagnosis. This figure demonstrates symptoms and disease progression of COVID-19 diagnosis.

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maternal age, race or ethnicity, body mass index (BMI, calculated as weight in kilograms divided by height in meters squared), or payer (Table 1). Women with moderate or severe disease were significantly more likely to have an underlying medical condition (50% vs 27%, odds ratio 2.76, 95% CI 1.26–6.02) and to have a diagnosis of asthma (24% vs 8%, odds ratio 3.51 95% CI 1.26–9.75). Women with moderate or severe disease were significantly more likely to be diagnosed earlier in pregnancy ( $P<.01$ ). Likelihood of documented sick exposures did not differ significantly between groups. Evaluating symptoms both on presentation and at any time during the disease course, women with moderate or severe disease were at higher risk for cough and chest pain and pressure (Tables 2 and 3). Evaluating laboratory values, women with moderate or severe disease were significantly more likely to have elevated aspartate aminotransferase levels, leukopenia, and elevated ferritin levels compared with women with mild or asymptomatic disease. Significant differences in risk of abnormal values for alanine aminotransferase, lactate dehydrogenase, procalcitonin, erythrocyte sedimentation rate, troponins, interleukin-6, serum creatinine, prothrombin time, platelets, lymphocytes, and D-dimers were not found between the groups (Appendix 1, <http://links.lww.com/AOG/B931>). When analyses were repeated comparing women with mild disease alone with those with moderate or severe disease, similar findings were noted.

Of 15 women with moderate or severe disease who were hospitalized, nine received step-down or ICU-level care. Eleven of the 15 women with moderate or severe disease were hypoxic, of whom 10 received respiratory support short of intubation (including oxygen through nasal cannula, high-flow nasal cannula, nonrebreather mask, and Venturi mask); one patient underwent intubation to receive general anesthesia in a cesarean delivery complicated by postpartum hemorrhage (Table 4). The mean duration of time from onset of symptoms to ICU or step-down care was 3.7 days (SD 4.0). The

mean total length of stay for the 15 hospitalized women with moderate or severe disease was 6.4 days (SD 6.1). The duration of ICU or step-down-level care varied significantly: five women received 3 days or less of ICU or step-down-level care, and the remaining four women received 9, 10, 10, and 16 days, respectively (Fig. 4). Two women underwent preterm delivery—at 31 and 36 weeks of gestation—for maternal decompensation. One woman was readmitted postpartum 5 days after discharge from delivery and received 6 days of supplemental oxygen for hypoxia. Overall, 14 of the 15 women had abnormal chest X-ray findings, two women had sepsis, and one woman had acute renal failure. No women developed stroke, thromboembolism, or cardiomyopathy (Table 4). Nineteen women with moderate disease severity (based on the presence of dyspnea but no other concerning findings) were managed at home with regular telehealth visits, close monitoring of symptoms, vital sign surveillance, and triage evaluation as needed but did not require hospitalization during their infection course.

**Table 2.** Development of Symptoms at Any Time in Disease Course

Symptom	Symptom Severity		P
	Mild	Moderate or Severe	
Cough	54 (69)	31 (92)	.02
Dyspnea	0 (0)	32 (94)	<.01
Myalgia	24 (31)	12 (35)	.63
Sore throat	11 (14)	2 (6)	.34
Chest pain or pressure	5 (6)	7 (21)	.04
Congestion	17 (22)	8 (24)	.84
Headache	10 (13)	4 (12)	1.00
Diarrhea	3 (4)	4 (12)	.20
Nausea	5 (6)	6 (18)	.09
Loss of taste or smell	9 (12)	1 (3)	.28
Fever	44 (56)	22 (65)	.41

Data are n (%) unless otherwise specified.



**Table 3. Symptoms at Time of Presentation and Coronavirus Disease 2019 Swab**

Symptom at Time of Swab	Symptom Severity		P
	Mild	Moderate or Severe	
Cough	48 (62)	29 (85)	<.01
Dyspnea	0 (0)	25 (74)	<.01
Myalgia	23 (29)	12 (35)	.54
Sore throat	10 (13)	2 (6)	.34
Chest pain or pressure	4 (5)	7 (21)	.02
Congestion	16 (21)	8 (24)	.72
Headache	10 (13)	4 (12)	1.00
Diarrhea	3 (4)	3 (9)	.37
Nausea	4 (5)	6 (18)	.06
Loss of taste or smell	8 (10)	1 (3)	.15
Fever	32 (63)	19 (56)	.15

Data are n (%) unless otherwise specified.

## DISCUSSION

In this descriptive study of obstetric patients with COVID-19 infection, the large majority of women had mild or no symptoms and one in five women developed moderate or severe symptoms. A majority of patients with mild dyspnea and no other concerning findings were safely managed as outpatients. A significant minority had hypoxia requiring respiratory support and ICU or step-down-level care.

This experience largely mirrors findings in the adult nonpregnant population.<sup>13</sup>

These findings have a number of implications for clinical management. First, in locales with high rates of COVID-19 infection, processes will need to be in place for outpatient surveillance of clinically stable women diagnosed with infection, with pathways for care escalation (including hospitalization) if concerning symptoms or findings develop. In our system, we

**Table 4. Clinical Characteristics of Admitted Patients With Moderate or Severe Coronavirus Disease 2019 Infection (n=15)**

Characteristic	n (%)
Dyspnea	13 (87)
Tachypnea	8 (53)
Hypoxia	11 (73)
Acute kidney injury	1 (7)
Sepsis	2 (13)
Acidemia	6 (40)
Stroke	0 (0)
Thromboembolism	0 (0)
Cardiomyopathy	0 (0)
ICU or step-down care	9 (60)
Respiratory support for hypoxia (without intubation)	10 (67)
Oxygen through nasal cannula alone	4 (27)
Oxygen through nasal cannula and nonrebreather mask	2 (13)
Oxygen through nasal cannula, nonrebreather mask, and Venturi mask	3 (20)
Oxygen through nasal cannula, nonrebreather mask, Venturi mask, and high-flow cannula	1 (7)
Intubation	1 (7)
Chest X-ray with infiltrates in more than 50 of lung volume within 48 h of presentation	0 (0)
Chest X-ray findings	
Unilateral consolidation	3 (20)
Bilateral infiltrates	11 (73)
No chest X-ray performed	1 (7)

Tachypnea was defined as a respiratory rate of more than 30 breaths per minute. Hypoxia was defined by pulse oximetry lower than 93% on room air. Acidemia was defined as arterial pH less than 7.35. Acute renal failure was defined as increase in serum creatinine to more than 1.5 times baseline. Proning was not used as part of the approach to respiratory support in this study.



Hospital day		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Patient	GA																							
1	37 1/7	†	†				D																	
2	40 5/7	†	†		D				R						D									
3	37 5/7		†	†			±																	D
4	38 2/7		†	†			D																	
5	37 0/7		†	†																				
6	31 5/7	†			D																			
7	32 5/7	†			D																			
8	30 6/7	†		D	R	D																		
9*	34 0/7			×	R		×																	
10	30 1/7	†	D																					
11	25 5/7	†											D											
12*	36 3/7											D												
13	32 5/7	†		D																				
14*	31 1/7																							D
15*	36 3/7			D																				

Asymptomatic Symptomatic Symptomatic hypoxia requiring oxygen ICU or step-down level care  
 † COVID-19 diagnosis D discharge R readmission Delivery ± acute kidney injury  
 × left hospital against medical advice \* known COVID-19 infection prior to admission

**Fig. 4.** Inpatient course of patients hospitalized with moderate or severe symptoms. This figure demonstrates the clinical courses and events of hospitalized patients with moderate or severe symptoms. GA, gestational age; ICU, intensive care unit. Patients 12 and 14 underwent delivery owing to deterioration of maternal status.

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created a COVID-19 telehealth clinic that included virtual visits and easy-to-follow algorithms for triaging symptoms and transitioning between outpatient and inpatient care. When a patient tested positive for COVID-19 infection or had symptoms clinically suspicious for COVID-19 and was awaiting test results, the clinical team caring for her alerted a dedicated tracking team through a centralized email address; she was then added to an electronic medical record list for transparency and information sharing. Contingency planning may need to include resources and space allocated for obstetric patients with severe disease who may require unusually prolonged ICU or step-down-level care. In our cohort, women with medical conditions such as asthma were more likely to develop moderate or severe disease. However, many women with these

risk factors remained mild or asymptomatic, and half of the women with severe or moderate disease did not have underlying medical conditions. In our analysis, demographic factors such as age, BMI, and payer were not significant risk factors.

The results of our analysis align with a case series of 118 pregnant women with COVID-19 infection in China (Chen L et al. *N Engl J Med* 2020 Apr 17 [Epub ahead of print]). In the Chinese study, 8% had severe disease based on the presence of hypoxia compared with the 7% who were hypoxic in our study. In the Chinese cohort, the majority of the patients developed severe features after delivery and one patient underwent noninvasive mechanical ventilation. In comparison, seven pregnant patients in our cohort were hypoxic and received oxygen supplementation before delivery.



Of these patients, in only two cases was delivery initiated secondary to maternal status. The cause of this difference is unclear; it is possible that a lower clinical threshold was present in China for delivering women with COVID-19 infection. Multiple studies in the adult population have examined possible risk factors for severe COVID-19 symptomatology and adverse outcomes: increased age and underlying conditions such as diabetes mellitus, hypertension, chronic obstructive pulmonary disease, coronary artery disease, cerebrovascular disease, chronic renal disease, and smoking were associated with high risk for hospital admission and ICU care.<sup>13–17</sup> Because pregnant women are generally younger and healthier than the patients at highest risk for COVID-19–related mortality, medical conditions may be associated with less attributable risk in the obstetric population.

Strengths of this study include the ability to analyze a relatively large number of patients with infection, in part because of universal COVID-19 testing on admission. Given the large proportion of high-risk patients, we were able to make meaningful comparisons demonstrating increased likelihood of medical comorbidities among patients who developed moderate or severe symptoms. The sample was also adequate to demonstrate that patients with more severe respiratory symptoms were more likely to have other associated symptoms and some abnormal laboratory findings. Weaknesses of the study include that we were likely underpowered to demonstrate whether modest differences were present for a number of outcomes, risk factors, and disease characteristics. We were not able to report on relatively rare cardiovascular or neurologic complications or thromboembolism. An additional weakness of this analysis is that women were tested for COVID-19 infection both for symptoms and admission screening. It is possible that we overestimated the proportion (but not absolute number) of women with COVID-19 infection who develop moderate or severe symptoms. For example, there may have been some women with COVID-19 infection early in pregnancy who were asymptomatic or mildly symptomatic and were not tested; if women with moderate or severe symptoms in the first and second trimesters were more likely to be diagnosed than asymptomatic women, this ascertainment could bias our results. Finally, these data were collected retrospectively from clinical docu-

mentation, and the presence of some mild COVID-19–associated symptoms could have been underascertained if they were not queried for and documented by the health care professional.

In conclusion, this study found that one in five pregnant women who contracted COVID-19 infection developed moderate or severe disease, including a small proportion with prolonged critical illness who received ICU or step-down–level care.

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#### PEER REVIEW HISTORY

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