Letters

RESEARCH LETTER

Clinical Characteristics and Outcomes of Hospitalized Women Giving Birth With and Without COVID-19

Physiologic adaptations and changes in immune regulation may increase the risk of morbidity and mortality in pregnant women with respiratory infections.[1,2] The effects of coronavirus disease 2019 (COVID-19) in pregnancy have not been fully delineated. We compared the clinical characteristics and outcomes of hospitalized women who gave birth with and without COVID-19.

Methods | Women giving birth and discharged between April 1 and November 23, 2020, were identified by *International Statistical Classification of Diseases and Related Health Problems,*

Table 1. Baseline Characteristics of Pregnant Women Giving Birth by Coronavirus Disease 2019 (COVID-19) Status

Characteristic	No. (%)		*P* value
	Without COVID-19 (n = 400 066)	With COVID-19 (n = 6380)	
Age, mean, y	29.1 (5.8)	28.3 (6.2)	<.001
Age, category, y			
≤24	92 181 (23.0)	1897 (29.7)	<.001
25-34	233 663 (58.4)	3368 (52.8)	
35-44	73 314 (18.3)	1097 (17.2)	
≥45	908 (0.2)	18 (0.3)	
Race/ethnicity			
Black, non-Hispanic	57 584 (15.0)	1091 (17.6)	<.001
Hispanic	67 654 (17.7)	2634 (42.6)	
Other/unknown	38 761 (10.1)	739 (11.9)	
White, non-Hispanic	218 735 (57.2)	1723 (27.8)	
Black and/or Hispanic	125 238 (31.3)	3725 (58.4)	
Discharge month			
April	66 056 (16.5)	778 (12.2)	<.001
May	67 330 (16.8)	1017 (15.9)	
June	63 684 (15.9)	948 (14.9)	
July	66 610 (16.6)	1454 (22.8)	
August	65 442 (16.4)	1228 (19.2)	
September	53 485 (13.4)	697 (10.9)	
October	17 307 (4.3)	252 (3.9)	
November	152 (0.0)	6 (0.1)	
Region			
Midwest	90 994 (22.9)	982 (15.4)	<.001
Northeast	58 990 (14.8)	1581 (24.9)	
South	182 971 (46.0)	3055 (48.0)	
West	65 015 (16.3)	740 (11.6)	
Setting			
Urban hospital	345 776 (86.9)	5696 (89.6)	<.001
Teaching hospital	191 810 (48.2)	3706 (58.3)	
Trimester			
Second	3420 (0.9)	88 (1.4)	<.001
Third	393 246 (98.3)	6243 (97.8)	
Missing data	3400 (0.9)	49 (0.8)	
Comorbidity			
Obesity	60 428 (15.1)	1094 (17.1)	<.001
Morbid obesity	15 925 (4.0)	289 (4.5)	.03
Hypertension	19 117 (4.8)	288 (4.5)	.33
Gestational hypertension	29 584 (7.4)	381 (6.0)	<.001
Diabetes	5716 (1.4)	132 (2.1)	<.001
Gestational diabetes	38 066 (9.5)	667 (10.5)	.01
Pulmonary disease	24 687 (6.2)	329 (5.2)	<.001
Smoking	18 606 (4.7)	92 (1.4)	<.001
Renal disease	1073 (0.3)	27 (0.4)	.02

Tenth Revision (ICD-10) codes within the Premier Healthcare Database, an all-payer database encompassing approximately 20% of US hospitalizations.[3] Race and ethnicity were self-reported, and COVID-19 status (*ICD-10* code U07.1), comorbidities, and in-hospital outcomes were identified using *ICD-10* and billing codes (eTables 1 and 2 in the Supplement). Discharge disposition and in-hospital death were reported in all patients.

Data were collected and deidentified by Premier Inc, which curates the Premier Healthcare Database, then analyzed at Brigham and Women's Hospital in Boston, Massachusetts. The Mass General Brigham Institutional Review Board approved the study protocol and waived the requirement for patient informed consent. Multivariable logistic regression was used to derive a propensity model estimating the probability of COVID-19 (eMethods in the Supplement). Associations between COVID-19 and in-hospital outcomes were examined using propensity score-adjusted regression. Factors associated with in-hospital death or mechanical ventilation use among pregnant women with COVID-19 were identified using forward stepwise logistic regression (eMethods in the Supplement). Analyses were conducted using Stata, version 15.0 (Stata Corp) with a 2-tailed *P* value less than .05 considered significant. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.[4]

Supplemental content

Results | Among the 406 446 women hospitalized for childbirth over the 8 months of the study, 6380 (1.6%) had COVID-19. Compared with pregnant women without COVID-19 (n = 400 066), the women with COVID-19 were younger and more often Black and/or Hispanic and with diabetes and obesity (**Table 1**).

Of the 6380 women with COVID-19 who gave birth, 6309 (98.9%) were discharged to home, 212 (3.3%) needed intensive care, 86 (1.3%) needed mechanical ventilation, and 9 (0.1%) died in the hospital (**Table 2**). Although in-hospital mortality was low, it was significantly higher in the women with

Table 2. In-Hospital Outcomes of Pregnant Women Giving Birth According to Coronavirus Disease 2019 (COVID-19) Status

Outcome	No. (%)		*P* value	Unadjusted OR (95% CI)	Adjusted OR (95% CI)[a]
	Without COVID-19 (n = 400 066)	With COVID-19 (n = 6380)			
Cesarean delivery	109 865 (27.5)	1847 (28.9)	.01	1.08 (1.02-1.14)	1.07 (1.02-1.13)
Preterm labor	16 137 (4.0)	332 (5.2)	<.001	1.31 (1.17-1.46)	1.19 (1.06-1.33)
Preterm birth[b]	23 234 (5.8)	459 (7.2)	<.001	1.26 (1.14-1.38)	1.17 (1.06-1.29)
Stillbirth	1289 (0.3)	34 (0.5)	.003	1.66 (1.18-2.33)	1.23 (0.87-1.75)
Preeclampsia	27 078 (6.8)	564 (8.8)	<.001	1.36 (1.22-1.46)	1.21 (1.11-1.33)
Eclampsia	288 (0.1)	8 (0.1)	.12	1.74 (0.86-3.52)	1.56 (0.77-3.16)
HELLP syndrome	989 (0.2)	33 (0.5)	<.001	2.10 (1.48-2.97)	1.96 (1.36-2.81)
Myocardial infarction	18 (0.0)	8 (0.1)	<.001	27.90 (12.13-64.20)	30.89 (12.56-75.99)
Stroke	14 (0.0)	0	.64	NA	NA
VTE	268 (0.1)	15 (0.2)	<.001	3.52 (2.09-5.92)	3.43 (2.01-5.82)
Thrombotic event[c]	300 (0.1)	22 (0.3)	<.001	4.61 (2.99-7.11)	4.47 (2.87-6.96)
Intensive care	1747 (0.4)	212 (3.3)	<.001	7.84 (6.78-9.06)	6.47 (5.55-7.55)
Mechanical ventilation	212 (0.1)	86 (1.3)	<.001	25.77 (20.03-33.15)	23.70 (17.95-31.29)
Renal replacement therapy	238 (0.1)	12 (0.2)	<.001	NA	NA
Chest imaging[d]	4122 (1.0)	748 (11.7)	<.001	NA	NA
Discharge disposition					
Home	398 388 (99.6)	6309 (98.9)	<.001	NA	NA
Postacute care	197 (0.0)	13 (0.2)		NA	NA
Death	20 (0.0)	9 (0.1)		28.26 (12.86-62.08)	26.07 (11.26-60.38)
Hospice	74 (0.0)	1 (0.0)		NA	NA
Other	1387 (0.3)	48 (0.8)		NA	NA
Length of stay, mean, d	2.4 (2.5)	2.8 (3.4)	<.001	NA	NA
Length of stay, category, d			<.001	NA	NA
≤2	267 177 (66.8)	4099 (64.3)		NA	NA
3	91 690 (22.9)	1387 (21.7)		NA	NA
>3	41 199 (10.3)	894 (14.0)		NA	NA

Abbreviations: HELLP, preeclampsia with hemolysis, elevated liver enzymes, low platelet count; NA, not applicable; OR, odds ratio; VTE, venous thromboembolism.

[a] Adjusted for propensity score, which estimates the probability of COVID-19 as a function of 15 baseline covariates: age, race/ethnicity, geographic region, urban population, teaching hospital, discharge month, trimester, hypertension, gestational hypertension, diabetes, gestational diabetes, kidney disease, pulmonary disease, tobacco use, and obesity. The propensity score was defined as the logit of the predicted probability of COVID-19 status.

[b] Preterm birth was defined as preterm labor with childbirth, premature rupture of membranes with subsequent childbirth, preterm newborn, or a newborn with a very low birth weight.

[c] Thrombotic event was defined as the composite of myocardial infarction, ischemic stroke, venous thromboembolism, or arterial thrombosis.

[d] Chest imaging included radiography, computed tomography, and computed tomography angiography of the chest.

COVID-19 than in those without COVID-19 (141 [95% CI, 65-268] vs 5.0 [95% CI, 3.1-7.7] deaths per 100 000 women). Rates of myocardial infarction and venous thromboembolism (VTE) were higher in the women with COVID-19 who gave birth than in those without COVID-19 (myocardial infarction: 0.1% vs 0.004%; VTE: 0.2% vs 0.1%; $P < .001$). COVID-19 was associated with higher odds of preeclampsia (adjusted odds ratio [aOR], 1.21 [95% CI, 1.11-1.33]) and preterm birth (aOR, 1.17 [95% CI, 1.06-1.29]) but not with significantly higher odds of stillbirth (aOR, 1.23 [95% CI, 0.87-1.75]). Use of chest imaging, intensive care treatment, and mechanical ventilation was higher among the women who gave birth with COVID-19 compared with those without COVID-19 (Table 2).

Among women with COVID-19 who gave birth, age (OR, 1.91 [95% CI, 1.31-2.77] per 10 years), morbid obesity (OR, 3.85 [95% CI, 2.05-7.21]), diabetes (OR, 4.51 [95% CI, 2.10-9.70]), kidney disease (OR, 21.57 [95% CI, 7.73-60.10]), eclampsia (OR, 116.1 [95% CI, 22.91-588.50]), thrombotic events (OR, 45.10 [95% CI, 17.13-118.8]), and stillbirth (OR, 7.88 [95% CI, 2.39-25.98]) were associated with higher odds of mechanical ventilation use or in-hospital death.

Discussion | In a large national cohort of US women hospitalized for childbirth, we found that absolute rates of death and adverse events in those diagnosed with COVID-19 were low, as might be expected in a young population in whom the disease may have been detected incidentally. Although the absolute risk differences were small, in-hospital death, VTE, and preeclampsia were considerably higher among women who gave birth with COVID-19 than in those without COVID-19. The present findings confirm previously reported mortality rates and indicate a higher risk of VTE in women diagnosed with COVID-19 in the setting of childbirth.[5,6] Limitations include potential misclassification by *ICD-10* codes, lack of confirmatory testing and imaging findings, information on disease severity, the inability to distinguish asymptomatic from symptomatic COVID-19 cases, low event rates, and residual confounding.

The higher rates of preterm birth, preeclampsia, thrombotic events, and death in women giving birth with COVID-19 highlight the need for strategies to minimize risk. As studies investigating therapies for COVID-19 have largely excluded pregnant women, the data also underscore the importance of including this population in clinical trials of treatments and vaccines.

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