Characteristics and treatment of hospitalized pregnant women with Coronavirus Disease 2019, COVID-19

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Research Article

Keywords: Coronavirus Disease 2019, vaccination, systemic steroids, remdesivir, pregnancy, treatment

Posted Date: May 9th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1522990/v1

Abstract

Objective

Describe the vaccination status, treatment, and outcomes of hospitalized, symptomatic pregnant women with Coronavirus Disease 2019 (COVID-19) and estimate whether treatment differs by pregnancy status among treatment-eligible (i.e., requiring supplemental oxygen per National Institutes of Health guidelines) women.

Methods

During January–November 2021, the COVID-19-Associated Hospitalization Surveillance Network completed medical chart abstraction for a probability sample of 2,715 hospitalized women aged 15–49 years with laboratory-confirmed SARS-CoV-2 infection. Of these, 1,950 women had symptoms of COVID-19 upon admission; 336 were pregnant. We calculated weighted prevalence estimates of demographic and clinical characteristics, vaccination status, and outcomes among pregnant women with symptoms of COVID-19 upon admission. We used propensity score matching to estimate prevalence ratios (PR), and 95% confidence intervals (CI) of treatment-eligible patients who received remdesivir or systemic steroids by pregnancy status.

Results

Among 336 hospitalized pregnant women with symptomatic COVID-19, 39.6% were non-Hispanic Black, 24.8% were Hispanic or Latino, and 61.9% were aged 25–34 years. Among those with known COVID-19 vaccination status, 92.9% were unvaccinated. One-third (32.7%) were treatment-eligible. Among treatment-eligible pregnant women, 74.1% received systemic steroids and 61.4% received remdesivir. Among those that were no longer pregnant at discharge (n = 180), 5.4% had spontaneous abortions and 3.5% had stillbirths. Of the 159 live births, 29.0% were pre-term. Among a propensity score-matched cohort of treatment-eligible hospitalized women of reproductive age, pregnant women were less likely than non-pregnant women to receive remdesivir (PR 0.82, 95% CI 0.69–0.97) and systemic steroids (PR 0.80, 95% CI 0.73–0.87).

Conclusion

Most hospitalized pregnant patients with symptomatic COVID-19 were unvaccinated. Hospitalized pregnant patients were less likely to receive recommended remdesivir and systemic steroids compared to similar hospitalized non-pregnant women. Our results underscore the need to identify opportunities for improving COVID-19 vaccination, implementation of treatment of pregnant women, and the inclusion of pregnant women in clinical trials.

Introduction

Despite a higher risk for severe clinical outcomes from Coronavirus Disease 2019 (COVID-19), pregnant women less frequently receive COVID-19 vaccination.[1–3] Pregnant women with COVID-19 are also at increased risk for adverse pregnancy outcomes including preterm birth and stillbirth.[2,4] The National Institutes of Health (NIH) provides COVID-19 treatment guidelines for hospitalized adults.[5] These guidelines recommend dexamethasone, a systemic steroid, and remdesivir, an antiviral drug that received emergency use authorization (EUA) from the Food and Drug Administration in May 2020 (including among pregnant patients), to prevent COVID-19 progression among hospitalized patients who require supplemental oxygen.[6] The guidelines also recommend alternative corticosteroids if dexamethasone is not available.[5] The Society for Maternal-Fetal Medicine supports the NIH COVID-19 treatment guidelines and recommends that remdesivir and dexamethasone be offered to pregnant patients with COVID-19 who require oxygen or mechanical ventilation.[7] However, the extent to which these guidelines are followed in hospitalized pregnant patients with COVID-19 is unknown.

The primary objective of this analysis was to describe the demographic and clinical characteristics, vaccination status, use of remdesivir and systemic steroids, and in-hospital outcomes of hospitalized pregnant patients with symptomatic laboratory-confirmed SARS-CoV-2 infection from January–November 2021 using data from the COVID-19-Associated Hospitalization Surveillance Network (COVID-NET). A secondary objective was to compare the prevalence of receiving remdesivir or systemic steroids among treatment-eligible women of reproductive age who were hospitalized with COVID-19 by pregnancy status using propensity score matching.

Methods

Data Source & Study Design

COVID-NET conducts population-based surveillance of laboratory-confirmed COVID-19-associated hospitalizations in 99 counties across 14 states (California, Colorado, Connecticut, Georgia, Iowa, Maryland, Michigan, Minnesota, New Mexico, New York, Ohio, Oregon, Tennessee, and Utah).[8,9] COVID-19-associated hospitalizations are defined as hospitalizations for which a positive real-time reverse transcription-polymerase chain reaction or rapid antigen detection test result for SARS-CoV-2 is obtained either during hospitalization or within the 14 days preceding admission among patients residing in the COVID-NET catchment area.[10] Using methods previously described,[8] each month clinical data were collected on a representative sample of persons hospitalized with COVID-19 stratified by age and site. To select sampled patients, random numbers were generated and assigned to each hospitalized patient. Sampling weights were based on the probability of selection; sample sizes vary by surveillance month, site, and age group and were based on the total number of patients identified in each of these strata. Some sites collected full information on all pregnant patients, including non-sampled pregnant patients.

Detailed demographic and clinical data on sampled patients were abstracted from patient medical records by trained surveillance officers using a standardized case report form. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy (45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.).

Inclusion and exclusion criteria

For analyses of pregnant patients, we included both sampled and non-sampled pregnant patients aged 15–49 years with complete medical chart abstraction who were admitted during January 1–November 30, 2021. We included non-sampled pregnant patients from a specific site if full medical chart information was collected on all pregnant women in that site for that month. If a site did not collect all pregnancy information on non-sampled patients, their original sample weight was applied and only sampled patients were included in analyses. The inclusion of non-sampled patients allowed COVID-NET to retain a representative sample while allowing for more precise estimates regarding pregnancy data.

We excluded individuals who did not have a complete medical chart review. We also excluded women who did not have COVID-19 symptoms recorded at admission to limit the scope of this analysis to women with at least mild disease; COVID-NET patients can include asymptomatic infections detected through routine laboratory testing of pregnant women at admission. Additionally, pregnant patients with asymptomatic COVID-19 with signs and symptoms of preterm labor (< 37 weeks gestation) may be treated with systemic steroids to promote fetal lung maturity.[11] Women were considered symptomatic for COVID-19 if their medical chart documented they had either respiratory or non-respiratory symptoms at admission (Table S1) or developed clinical manifestations of COVID-19 during hospitalization as indicated by a discharge diagnosis of pneumonia, acute respiratory failure, or acute respiratory distress syndrome.

For analyses of treatment-eligible women by pregnancy status, we included all symptomatic women aged 15–49 years who were hospitalized January–November 2021. We then further restricted our sample to those who were eligible for therapeutic treatment with remdesivir and systemic steroids per NIH criteria.[5] Being “treatment-eligible” was defined as having an oxygen saturation less than 94% on admission, receiving supplemental oxygen on admission (nasal cannula, face mask, continuous positive airway pressure [CPAP], or bilevel positive airway pressure [BIPAP], high flow nasal cannula, invasive mechanical ventilation, non-rebreather mask), or during the hospital stay (mechanical ventilation, extracorporeal membrane oxygenation [ECMO], BIPAP/CPAP, or high flow nasal cannula). Because COVID-NET does not collect data on nasal cannula or face mask use in the ICU, we additionally classified three pregnant patients who were admitted to the ICU as treatment-eligible, even if higher-level oxygen support was not specifically noted.

Variable specification

Socio-demographic characteristics: COVID-NET collects data on the following socio-demographic characteristics: age, race and Hispanic or Latino ethnicity group, and smoking status (current, former vs.

never or unknown). COVID-19 treatment and clinical outcomes have been shown to differ by race and ethnicity so describing race ethnicity is critical to identify disparities.[12] All demographic data, including race and ethnicity, were primarily self-reported, and were obtained from multiple sources, including notifiable disease, laboratory, and hospital databases.[12] Race and ethnicity were based on National Center for Health Statistics (NCHS) bridged race categories: Hispanic or Latino, non-Hispanic American Indian or Alaska Native, non-Hispanic Asian or Pacific Islander, non-Hispanic Black, and non-Hispanic White.[13] We also included a category for people who identified as more than one or unknown race and ethnicity. If an individual did not have ethnicity information they were categorized as non-Hispanic.[14]

Underlying medical conditions & pregnancy characteristics: COVID-NET abstracted information on underlying medical conditions for all sampled patients (Table S2). Among pregnant patients, COVID-NET collected gestational age in weeks at the time of hospital admission based on the medical record, which were used to classify patients by first (< 14 weeks), second (14 to 27 weeks), and third (≥ 28 weeks) trimester. Information on pregnancy-associated conditions (gestational diabetes, hypertensive disorders of pregnancy including pre-eclampsia and gestational hypertension, intrauterine growth restriction, or unknown pregnancy-complications) and plurality (singleton, multiple, or unknown) was also collected. Among women who were no longer pregnant at discharge, COVID-NET ascertained mode of delivery (cesarean section, vaginal, or unknown) and the following birth outcomes: live birth (including healthy and ill newborns and newborns who died after birth), fetal loss (including spontaneous abortion, stillbirth, and induced abortion), or unknown. A spontaneous abortion was defined as intrauterine death at less than 20 weeks gestational age and a stillbirth was an intrauterine death at or greater than 20 weeks gestational age. Live born infants were further classified as preterm (less than 37 gestational weeks gestational) or term (≥ 37 gestational weeks).

Vaccination status: COVID-19 vaccination status (doses, dates administered, and product) was determined from state immunization information systems for all sampled COVID-NET patients. Fully vaccinated adults with a COVID-19–associated hospitalization were persons who had received the second dose of a two-dose COVID-19 vaccine series or a single dose of a one-dose product ≥ 14 days before the specimen collection date of the positive SARS-CoV-2 test result associated with their hospitalization. Adults whose positive SARS-CoV-2 test date was ≥ 14 days after the first dose of a two-dose series and < 14 days after receipt of the second dose were considered partially vaccinated. If the SARS-CoV-2 test date was not available, hospital admission date was used. Adults without documented receipt of any COVID-19 vaccine dose before the test date were considered unvaccinated. One site did not collect vaccination information and was excluded from analysis including vaccination status. COVID-NET methods for determining vaccination status have been described previously[15].

In-hospital clinical interventions & outcomes: Information on oxygen saturation at admission, supplemental oxygen received at admission, highest level of respiratory support received during hospitalization (invasive mechanical ventilation, BIPAP/CPAP, high flow nasal cannula, or ECMO), other clinical interventions (vasopressor, renal replacement therapy/dialysis), ICU admission, and in-hospital

death was collected. Information on in-hospital COVID-19 treatment with remdesivir, systemic steroids, tocilizumab, casirivimab/imdevimab, convalescent plasma, and baricitinib was also collected.

Statistical Analysis

Analyses were conducted using SAS statistical software (version 9.4; SAS Institute, Cary, NC). Unweighted sample size (n), weighted percentages, and 95% confidence intervals (CI) accounting for the age- and site-stratified sampling were used to describe demographic and clinical characteristics, interventions, and in-hospital clinical outcomes among all symptomatic pregnant patients hospitalized with COVID-19 in our sample. We compared characteristics between included symptomatic and excluded asymptomatic pregnant patients using bivariate log-linked Poisson generalized estimating equations that accounted for clustering by COVID-NET site and complex sample weights. To describe differences in demographic characteristics and underlying medical conditions among treatment-eligible pregnant women by whether they did or did not receive treatment, we calculated adjusted prevalence ratios for each characteristic from log-linked Poisson generalized estimating equations, accounting for the complex sample design of our study and clustering by site. In a separate sensitivity analysis, we described differences in treatment-eligible pregnant women excluding women with pre-term births since those women may have received systemic steroids for other indications (i.e. to promote fetal lung maturity). Variances were estimated using Taylor series linearization method.

To compare prevalence of treatment with remdesivir and systemic steroids between treatment-eligible pregnant and non-pregnant women, we conducted propensity score matching to balance pregnant and non-pregnant women on demographic and underlying medical conditions.[16,17] First, we calculated propensity scores for each patient using multivariable logistic regression to estimate the probability of pregnancy based on baseline covariates, among all women regardless of pregnancy status. The model included the following covariates: age group, site, race and Hispanic ethnicity group, and underlying medical conditions (asthma, chronic lung disease not including asthma, cardiovascular disease, diabetes, thyroid dysfunction, hypertension, liver disease, and neurologic disease) and complex sampling weight. Second, to match pregnant and non-pregnant women, we used a SAS macro to do nearest-neighbor 1 to 1 matching without replacement in which the algorithm matches a pregnant woman to the non-pregnant woman with the closest propensity score.[18] Using generalized estimating equation models, we compared characteristics between pregnant and non-pregnant women prior to and after propensity score matching to identify statistically significant differences in characteristics using a type I error rate of 5%. Finally, using the matched dataset, we estimated the prevalence ratio of COVID-19 treatment comparing treatment-eligible pregnant and non-pregnant women using log-linked binomial generalized estimating equations to account for clustering of hospitalizations within COVID-NET sites. In these models we adjusted for month and accounted for complex sample weights. To determine the robustness of our findings, we also conducted sensitivity analyses using two alternate methods (multivariable regression and inverse probability treatment weights [IPTW][16]) to assess the association between pregnancy status and COVID-19 treatment. These two methods are further described in the supplement (Table S5).

Results

Characteristics of hospitalized symptomatic pregnant patients with COVID-19

Among 21,848 hospitalized women aged 15-49 years with COVID-19 identified from January–November 2021, medical chart reviews were completed for 2,715 of 2,800 sampled patients, of which 905 were pregnant (Figure 1). Of these pregnant women, 336 (37.0%) had symptoms of COVID-19. Compared to asymptomatic pregnant women with COVID-19, symptomatic pregnant women were more likely to be American Indian/Alaska Native, Black non-Hispanic, or in the first trimester of pregnancy (Table S3). Asymptomatic women were more likely to be in the third trimester. Of the symptomatic women, 123 (32.7%) were treatment eligible (Figure 1).

Of the 336 symptomatic pregnant women, the median age was 27.9 years (interquartile range: 23.0-33.0). The largest race/ethnicity group was non-Hispanic Black (39.6%) followed by Hispanic or Latino (24.8%) (Table 1). One-third (32.6%) had an underlying medical condition; asthma (12.5%) and hypertension (8.9%) were the most prevalent underlying conditions. Most (70.7%) were hospitalized during the third trimester and fewer during the first (10.0%) or second (19.3%) trimesters. Most pregnancies were singleton (90.7%). The most common pregnancy-associated conditions were hypertensive disorders of pregnancy (10.3%) and gestational diabetes (5.9%). The median hospital length of stay was three days (interquartile range: 2-5) overall and four days for patients in the ICU (interquartile range: 3-16) (data not shown).

Of the 336 symptomatic pregnant women, 333 (98.5%) had known COVID-19 vaccination status; 92.9% (n=322) were unvaccinated, 2.2% (n=2) were partially vaccinated, and only 4.9% (n=9) were fully vaccinated (Table 1). Among the nine fully vaccinated pregnant women, three had more than one underlying medical condition (including one immunocompromised). The patient with an immunocompromising condition was the only fully vaccinated patient to require oxygen but did not receive remdesivir or systemic steroids. No fully vaccinated pregnant women were admitted to the ICU. Eight of the nine fully vaccinated women gave birth during their hospitalization; seven were term live births, one was a preterm live birth, and one pregnancy ended by induced abortion.

Approximately half of the symptomatic pregnant women were no longer pregnant at discharge (n=180; 51.9%). Of these pregnancies, 88.2% ended in live births, 3.5% ended in stillbirth, and 5.4% ended in spontaneous abortion (Table 2). Of the 159 live births, 29.0% were pre-term. There were no in-hospital maternal deaths. Of pregnant women, 12.6% were admitted to the ICU and 6.6% required invasive mechanical ventilation. Over one-third (38.2%) of all symptomatic pregnant women in the sample received systemic steroids (36.1%) or remdesivir (27.4%). Among those symptomatic pregnant women receiving systemic steroids, the most frequently administered was dexamethasone (90.1%). Among those receiving dexamethasone and that had a live birth (n=39), 55.0% had pre-term births (data not shown). Other COVID-19-specific treatments received were tocilizumab (4%), casirivimab/imdevimab (1.3%), convalescent plasma (1.3%), and baricitinib (0.5%).

Receipt of Remdesivir or Systemic Steroids among Treatment-Eligible Pregnant Women Hospitalized with COVID-19

Among the 123 pregnant women who were treatment-eligible, 22.2% did not receive either remdesivir or systemic steroids (Table 3). The most frequently received treatment was systemic steroids (74.1%), followed by remdesivir (61.4%); the most used systemic steroid was dexamethasone (91.6%) (data not shown). Compared to treatment-eligible pregnant women in the youngest age category (15-24 years), women aged 35-49 years were more likely to receive treatment (PR=1.98, 95% CI: 1.04-3.76). Compared to non-Hispanic White women, non-Hispanic Black (PR=1.30, 95% CI: 1.00-1.68) women and women of other race/ethnicities had greater prevalence of receiving treatment (PR=1.54, 95% CI: 1.21-1.96). Women with any underlying medical condition were also more likely to receive treatment compared to women without an underlying medical condition (PR=1.27, 95% CI: 1.07-1.51). In a sensitivity analysis, excluding those with pre-term births, only pregnant patients 35-49 years (PR=1.94, 95% CI: 0.94-4.01) were more likely to receive treatment compared to pregnant patients 15-24 years of age.

Differential Receipt of Remdesivir or Systemic Steroids among Treatment-Eligible Women of Reproductive Age Hospitalized with COVID-19 by Pregnancy Status

Prior to propensity score matching, pregnant women who were treatment-eligible were younger and less likely to have underlying medical conditions compared to women who were not pregnant (Table S4). In the propensity score-matched cohort of 116 pregnant and 116 non-pregnant women, the distributions of demographic and clinical characteristics were similar. The only statistically significant difference remained for the youngest age group: in the matched cohort pregnant women (17.8%) were more likely than non-pregnant women (8.0%) to be 15-24 years of age.

In the matched cohort, remdesivir was administered to 61.9% (95% CI 47.5-75.0%) and 80.6% (95% CI 69.9-88.7%) of pregnant and non-pregnant women, respectively. Systemic steroids were administered to 74.3% (95% CI 61.3-84.8%) of pregnant women (Table 4). The most frequently administered systemic steroid was dexamethasone (91.5%), which is also used to promote fetal lung maturity in the management of preterm labor. Among those receiving dexamethasone and that had a live birth (n=22), 89.1% had pre-term births (data not shown). Among non-pregnant women, 94.0% (95% CI 88.0-97.6%) received systemic steroids, of which dexamethasone was most commonly administered (97.7%). Results from adjusted models showed that pregnant women had lower prevalence of treatment with remdesivir (PR 0.82, 95% CI 0.69-0.97) and systemic steroids (PR 0.80, 95% CI 0.73-0.87) compared to non-pregnant women (Table 4). All sensitivity analyses with various methods for adjustment had prevalence ratios of similar direction and magnitude, though the precision varied (Table S5). The prevalence ratio for receipt of remdesivir was 0.77 (95% CI 0.65-0.91) from multivariable regression and was 0.87 (95% CI: 0.78-0.98) from doubly robust inverse probability treatment weighting. The prevalence ratio for receipt of systemic steroids was 0.68 (95% CI: 0.55-0.85) from multivariable regression and was 0.87 (95% CI: 0.82-0.93) from doubly robust inverse probability treatment weighting.

Discussion

In this investigation of hospitalized, symptomatic pregnant women with COVID-19 and nearly all unvaccinated, we identified adverse outcomes including ICU admission, stillbirths, and spontaneous abortions. Approximately one-in-five treatment-eligible pregnant patients did not receive remdesivir or systemic steroids.[5] Among our propensity-score matched cohort of treatment-eligible women hospitalized with COVID-19, pregnant women were 18% less likely to receive remdesivir and 21% less likely to receive systemic steroids than non-pregnant women.[19]

Although clinical presentation, in-hospital disease outcomes, and severity among hospitalized pregnant patients are well documented[2,20,21], most prior studies have not described vaccination status or treatment in hospitalized pregnant patients. The vast majority (>90%) of symptomatic pregnant women who were hospitalized for COVID-19 in 2021 in this network were unvaccinated, and those (n=9) with breakthrough infections experienced milder disease (only one was treatment-eligible and non were admitted to the ICU). This is consistent with multiple studies that have shown that COVID-19 vaccines are highly effective in preventing hospitalization in pregnant women.[22-25] In addition, vaccination is not associated with pregnancy loss, preterm birth or small for gestational age infants.[26] Furthermore, maternal COVID-19 vaccination has been associated with a reduced risk of COVID-19 hospitalization among infants less than six months of age.[27] Low coverage of vaccination in pregnant women (11.1%) compared to non-pregnant women (24.9%) has been shown in non-hospitalized women; vaccination completion was even lower in our sample of hospitalized pregnant patients.[28] While vaccination coverage in pregnant women is increasing, it remains low, with an estimated 67.8% of pregnant women fully vaccinated as of February 5, 2022.[29] Low vaccination coverge in pregnant women could be due to a variety of factors including theoretical concerns about safety stemming from the lack of inclusion in clinical trials and potential for greater vaccine hesistancy among healthcare providers and pregnant women.

Among completed pregnancies during hospitalization, the 3.5% stillbirth rate is higher than the known prepandemic stillbirth rate of 0.59%[30], but is similar to a recent analysis which found that 2.7% of hospital deliveries with a COVID-19 diagnosis from July—September 2021 resulted in stillbirth.[4] Additionally, in our analysis nearly one-third of livebirths were preterm. This is consistent with a meta-analysisin which preterm birth was associated with COVID-19 during pregnancy.[2]

This study was conducted after the effectiveness and safety of treatments for COVID-19 were established.[31] Previous studies have shown remdesivir to be effective in preventing severe disease in pregnant patients.[32,33] However, very little is known about treatment patterns in hospitalized pregnant women. We found that not all treatment-eligible women receive remdesivir or systemic steroids and that there is evidence of differential use of these treatments in pregnant and non-pregnant women. The reasons for differential treatment practices by pregnancy status are unknown but may be related to severity of disease, lack of availability of treatment protocols during pregnancy, lack of familiarity by providers with initiation of treatment during pregnancy, potential concerns about fetal safety by providers

or patients leading them to decline recommended therapy, or perceived risks because pregnant women are generally excluded from clinical trials of new treatment protocols.

Our observational study required robust methods to limit biases since pregnant women hospitalized with COVID-19 are systematically different than non-pregnant women (e.g., non-pregnant women are more likely to be older and have underlying conditions in our study). To minimize confounding, we limited our sample to symptomatic women that required supplemental oxygen and thus, for whom, treatment was recommended. We also used propensity score matching to balance comparison groups. Despite these methods, there may be residual confounding. Reassuringly, sensitivity analysis with a variety of regression and propensity score methods to adjust for confounding yielded similar results. A second limitation is COVID-19 cases might have been missed because of testing practices and test availability. Third, information on obesity as an underlying pre-pregnancy condition was not available, so this underlying health condition could not be described. Fourth, information was abstracted from medical charts and might not be complete. For example, only one oxygen saturation value and corresponding support was provided per hospitalization outside of ICU stays. Fifth, we could not establish the indications for the use of systemic steroid; which are also used to promote fetal lung maturity in the management of preterm labor so the actual use rates of systemic steroids for COVID-19 treatment may be even lower. Finally, any maternal deaths after discharge were not captured.

This study addresses important gaps in the literature. Despite current recommendations, most symptomatic pregnant women hospitalized with COVID-19 were unvaccinated and one-fifth of treatment-eligible hospitalized pregnant patients did not receive recommended treatment, underscoring the need for increased targeted communication about and improved processes for the vaccination and treatment of pregnant women. Additional qualitative or quantitative research exploring factors that influence health care systems, provider practice patterns, and hospital protocols specific to the treatment of hospitalized pregnant women with COVID-19 would be informative. Additional studies focused on the safety and efficacy of COVID-19 treatment during pregnancy and the potential maternal and infant benefits would be critically important. In the future, the voluntary inclusion of pregnant patients in clinical studies of new treatment protocols could prevent disparities in access to recommended care for pregnant patients.[34]

Tables

Table 1. Characteristics of hospitalized pregnant women with symptomatic COVID-19*

Variable	Unweighted n Overall n=336	Weighted %	(95% CI)
Age group			
15-24 years	100	20.6	(14.9-27.4)
25-34 years	179	61.9	(53.0-70.2)
35-49 years	57	17.5	(11.6-24.9)
Race/ethnicity			
American Indian or Alaska Native, non-Hispanic	8	2.4	(0.6-6.3)
Asian or Pacific Islander, non-Hispanic	26	5.2	(2.8-8.7)
Black, non-Hispanic	90	39.6	(29.8-50.1)
Hispanic or Latino	87	24.8	(17.9-32.8)
White, non-Hispanic	102	22.3	(15.7-30.1)
None of the above[†]	23	5.6	(2.8-10.0)
Vaccine status[‡]			
Unvaccinated	322	92.9	(83.2-98.0)
Partially vaccinated	2	2.2	(0.1-9.9)
Fully vaccinated	9	4.9	(0.9-14.0)
Underlying medical conditions[§]			
Any condition or conditions	123	32.6	(24.7-41.3)
Asthma	38	12.5	(7.6-19.2)
Hypertension	30	8.9	(4.5-15.4)
Chronic metabolic disease[‖]	21	4.7	(1.8-9.7)
Cardiovascular disease[‖]	15	3.0	(1.3-5.7)
Diabetes	10	2.6	(0.5-7.9)
Neurologic condition	13	2.5	(1.0-5.0)
Thyroid dysfunction	13	2.1	(0.7-4.9)
Other disease	10	1.8	(0.6-4.0)
Liver disease	7	0.9	(0.2-2.6)
Chronic lung disease[‖]	2	0.1	(0.0-1.3)
Smoking			
Current smoker	19	7.7	(3.4-14.6)
Former smoker	43	8.9	(5.3-13.8)
Not a smoker/Unknown smoking history	274	83.4	(76.1-89.2)
Pregnancy trimester at hospital admission			
First	30	10	(5.3-16.7)
Second	65	19.3	(12.6-27.7)
Third	241	70.7	(61.5-78.8)
Current pregnancy plurality			
Singleton pregnancy	309	90.7	(82.7-95.8)
Multiple pregnancy	7	1.1	(0.2-3.3)
Unknown	20	8.2	(3.3-16.4)
Pregnancy-associated conditions[§]			
Any condition or conditions	70	19.0	(12.1-27.7)
Hypertensive disorders of pregnancy	44	10.3	(6.2-15.9)
Unknown	22	6.8	(3.0-13.0)
Gestational diabetes	25	5.9	(3.2-9.6)
Intrauterine growth restriction	9	4.5	(0.5-15.4)

Abbreviation: CI= Confidence Interval

[*]Data are from the COVID-19-Associated Hospitalization Surveillance Network. COVID-NET, 14 states, January–November 2021.

[†]The none of the above category includes multiracial, non-Hispanic and unknown racial categories.

[‡]Three patients are missing vaccination status because one site did not collect that information.

[§]Underlying medical conditions and pregnancy-associated conditions percent columns do not add up to 100% since multiple options could be chosen per patient.

[‖]Chronic metabolic disease does not include diabetes or thyroid dysfunction, cardiovascular disease does not include hypertension, and chronic lung disease does not include asthma.

Table 2. Symptoms, interventions, and outcomes of hospitalized pregnant women with symptomatic COVID-19[*]

Variable			Unweighted n	Weighted %	(95% CI)
			Overall n=336		
Symptoms on admission					
Cough			179	59.9	(50.7-68.6)
Shortness of breath			147	49.3	(39.8-59.0)
Fever			123	36.2	(27.4-45.9)
Congestion/rhinorrhea			58	18.5	(12.2-26.2)
Loss of taste/smell			56	16.9	(10.4-25.3)
Abdominal pain			70	15.8	(10.6-22.3)
Sore throat			34	8.8	(5.3-13.7)
New clinical discharge diagnosis					
Acute respiratory distress syndrome			11	2.3	(0.9-4.7)
Acute respiratory failure			61	19.8	(12.5-28.9)
Pneumonia			89	31.8	(22.7-42.1)
Sepsis			11	2.0	(0.7-4.5)
Interventions					
High flow nasal cannula[†]			24	7.5	(4.0-12.8)
BIPAP/CPAP[†]			7	1.4	(0.4-3.6)
Invasive mechanical ventilation[†,‡]			22	6.6	(3.2-11.8)
Vasopressor			34	11.1	(5.0-20.5)
Renal replacement therapy or dialysis			1	0.3	(0.0-1.8)
COVID-19 treatments					
Remdesivir			94	27.4	(19.7-36.2)
Systemic steroids			137	36.1	(27.6-45.2)
Dexamethasone		120	91.0	(81.2-96.7)	
Hydrocortisone		4	6.2	(1.3-16.9)	
Methylprednisolone		14	7.1	(3.0-13.8)	
Prednisolone		1	0.4	(0.0-3.5)	
Prednisone		3	1.3	(0.1-5.0)	
Betamethasone		4	0.9	(0.0-4.2)	
Tocilizumab			12	4.0	(1.5-8.6)
Casirivimab/Imdevimab (REGN-COV2)			7	1.3	(0.4-3.3)
Convalescent plasma			2	1.3	(0.1-5.7)
Baricitinib			2	0.5	(0.1-2.0)
Severe outcomes					
ICU admission			44	12.6	(7.8-19.0)
In-hospital maternal death			0	0	(.-.)
Pregnancy status at discharge[§]					
Still pregnant			155	48.1	(38.5-57.8)
No longer pregnant			180	51.9	(42.2-61.5)
Live birth		159	88.2	(89.1-94.3)	
Term	114	69.4	(53.9-82.3)		
Preterm (<37 weeks gestational age)	36	29.0	(16.2-44.8)		

Unknown	9	1.6	(0.3-5.0)					
Induced abortion		1	0.3	(0.0-2.6)				
Stillbirth		11	3.5	(1.3-7.3)				
Spontaneous abortion		5	5.4	(1.1-15.2)				
Unknown		4	2.6	(0.5-7.6)				
Mode of delivery[‖]								
Vaginal	105	56.5	(43.4-68.9)					
Cesarean Section	68	36.8	(25.2-49.5)					
		Unknown		7		6.8	(1.8-16.5)	

Abbreviations: CI=Confidence Interval, ECMO=extracorporeal membrane oxygenation, BIPAP/CPAP=bilevel positive airway pressure/continuous positive airway pressure, ICU=intensive care unit

[*]Data are from the COVID-19-Associated Hospitalization Surveillance Network. COVID-NET, 14 states, January–November 2021.

[†]Mutually exclusive of other oxygen support categories. The highest level of oxygen support was chosen for each patient (invasive mechanical ventilation > BiPAP/CPAP > high flow nasal cannula).

[‡] Five (0.9%, 95% CI 0.2-2.6%) patients that received mechanical ventilation also received extracorporeal membrane oxygenation (ECMO).

[§]1 missing pregnancy status at discharge.

[‖]Among the 180 that gave birth.

Table 3. Characteristics of treatment-eligible hospitalized pregnant women with COVID-19 by receipt of treatment[*]

Overall		**Received treatment[†]**		**No treatment**		**PR[‡]**	**95% CI**	**p-value**
(n=123, 32.7%)		**(n=87, 77.8%)**		**(n=36, 22.2%)**				
Variable	**n**	**Weighted %**	**n**	**Weighted %**	**n**	**Weighted %**		
Age group								
15-24 years	28	17.4	14	11.2	14	39.2	ref	-	-
25-34 years	71	64.3	53	68.3	18	50.4	1.43	(0.82-2.50)	0.202
35-49 years	24	18.2	20	20.5	4	10.4	1.98	(1.04-3.76)	0.038
Race/ethnicity								
Black, non-Hispanic	25	26.0	19	27.8	6	19.8	1.30	(1.00-1.68)	0.049
Hispanic	24	23.0	16	21.7	8	27.6	1.23	(0.90-1.67)	0.192
White, non-Hispanic	44	26.1	25	20.7	19	44.8	ref	-	-
None of the above[§]	30	24.9	27	29.7	3	7.8	1.54	(1.21-1.96)	<.001
Underlying medical conditions								
Yes	50	29.5	38	32.2	12	19.8	1.27	(1.07, 1.51)	0.006
No	73	70.5	49	67.8	24	80.2	ref	-	-

Abbreviations: COVID-19=coronavirus disease 2019, PR=prevalence ratio, CI=confidence interval, ref=reference group

*Data are from the COVID-19-Associated Hospitalization Surveillance Network. COVID-NET, 14 states, January–November 2021.

†Treatment includes receipt of remdesivir (n=63, 61.4%) or systemic steroids (n=83, 74.1%).

‡Model adjusted for month, age group, race/ethnicity group, and any underlying condition.

§None of the above category includes American Indian/Alaska Native, non-Hispanic; Asian/Pacific Islander, non-Hispanic; multiracial, non-Hispanic; and unknown racial categories. These categories were collapsed in models due to small cell sizes.

Table 4. COVID-19 treatment among propensity-matched* symptomatic and treatment-eligible women†

Outcome	Prevalence				Multivariable model‡		
	Pregnant (n=116, 50%)		Non-pregnant (n=116, 50%)				
	n	Weighted %, (95% CI)	n	Weighted %, (95% CI)	PR	95% CI	p-value
Remdesivir							
No	56	38.1, (25.0-52.5)	33	19.4, (11.3-30.1)	ref		
Yes	60	61.9, (47.5-75.0)	83	80.6, (69.9-88.7)	0.82	(0.69-0.97)	0.024
Systemic Steroids							
No	37	25.7, (15.2-38.7)	17	6.0, (2.4-12.0)	ref		
Yes	79	74.3, (61.3-84.8)	99	94.0, (88.0-97.6)	0.80	(0.73-0.87)	<.001

Abbreviations: COVID-19=coronavirus disease 2019, PR=prevalence ratio, CI=confidence interval, ref=reference group

*Propensity score models to create propensity score adjusted for age group, race and ethnic group, site, asthma, chronic lung disease not including asthma, cardiovascular disease, diabetes, thyroid dysfunction, hypertension, liver disease, and neurologic disease and complex sample weights. To match pregnant and non-pregnant women, we used nearest neighbor 1 to 1 matching without replacement.

†Data are from the COVID-19-Associated Hospitalization Surveillance Network. COVID-NET, 14 states, January–November 2021.

‡Generalized estimating equation model to estimate PR comparing pregnant to non-pregnant women adjusted for month and accounted for clustering by site and complex sample weights.

Declarations

Acknowledgments

We acknowledge with gratitude the clinicians and surveillance officers at the COVID-NET sites included in this study. We also wish to acknowledge the following people: Onika Anglin (COVID-NET Surveillance Team, Centers for Disease Control and Prevention; General Dynamics Information Technology); Jennifer L. Milucky (COVID-NET Surveillance Team, Centers for Disease Control and Prevention); Sherry Quach,

BA,Ashley O. Coates, MPH, Monica J. Napoles, BA, (California Emerging Infections Program);Jordan Surgnier, MPH, Sarah McLafferty, MPH, Millen Tsegaye, MHA, Madelyn Lensing, MPH, Isaac Armistead, MD, MPH, (Colorado Department of Public Health and Environment); Ann Basting, BS, Tessa Carter, MPH, Maria Correa, MPH, Daewi Kim, MBS, Carol Lyons, MPH, Amber Maslar, MPA, Julie Plano, MS, (Connecticut Emerging Infections Program, Yale School of Public Health); Katelyn Ward, MPH, Allison Roebling, DVM, MPH, Chandler Surell, MPH, Jana Manning, MPH, Asmith Joseph, MPH, Marina Bruck, MPH, Grayson Kallas, MPH, Rayna Ceaser, BS, Stephanie Lehman, RN, BSN, Hope Wilson, MPH, Johanna Hernandez, MPH, Sabrina Hendrick, MPH, Annabel Patterson, MPH, (Divison of Infectious Diseases, School of Medicine, Emory University; Georgia Emerging Infections Program, Georgia Department of Public Health; Foundation for Atlanta Veterans Education and Research, Veterans Affairs Medical Center); Jim Collins, MPH, RS, Shannon Johnson, MPH, Justin Henderson, MPH, Sue Kim, MPH, Libby Reeg, MPH, Alexander Kohrman, MPH, Val Tellez Nunez, MPH, Sierra Peguies-Khan, MPH, (Michigan Department of Health and Human Services); Kathy M. Angeles, MPH, Molly Bleecker, MA, Nancy Eisenberg, MPH, Emily B. Hancock, MS, Sarah A. Khanlian, MPH, Sarah Lathrop, DVM, PhD, Wickliffe Omondi, MPH, Francesca Pacheco, BS, Mayvilynne Poblete, MA, MPH, Dominic Rudin, BS, Sarah Shrum Davis, MA, MPH, (New Mexico Emerging Infections Program); Cory Cline, MPH, Melissa Judson, MPH, Sunshine Martinez, CBCS, CMAA, EHR, Mark Montoya, MPH, Florent Nkouaga, MA, Jasmyn Sanchez, Daniel M. Sosin, MD, MPH, Kelly Plymesser, RN, (New Mexico Department of Health); Jennifer Akpo, MPH, Celina Chavez, BSN, RN, Murtada Khalifa, MBBS, Alesia Reed, BSN, RN, Yassir Talha, MBBS, (CDC Foundation/New Mexico Department of Health); Grant Barney, MPH, Adam Rowe, BA, Kerianne Engesser, MPH, (New York State Department of Health); Sophrena Bushey, MHS, Christine Long, MPH, Kevin Popham, MPH, Maria Gaitan, BS, Virgnia Cafferky, BS, Thomas Peer, DrPH, (University of Rochester School of Medicine and Dentistry); Ann Salvator, MS, Julie Freshwater, MPH, PhD, Denise Ingabire-Smith, MPH, CLS (ASCP), Rebekah Sutter, BSN, RN, (Ohio Department of Health); Sam Hawkins, MPH, (Public Health Division; Oregon Health Authority); Tiffanie Markus, PhD, Karen Leib, RN, Katie Dyer, Terri McMinn, Danielle Ndi, MPH, Anise Elie, MPH, RN, BSN, Kathy Billings, MPH, Manideepthi Pemmaraju, BBS, MPH, Bentley Akoko, MD, MPH, Victoria Umutoni, MPH, (Vanderbilt University Medical Center); Amanda Carter, BS, Andrea Price, LPN, Ashley Swain, CHES, Caitlin Shaw, BS, Keegan McCaffrey, BS, Laine McCullough, MPH, Melanie Crossland, MPH, Ryan Chatelain, MPH, (Salt Lake County Health Department).

The findings and conclusions in this report are those of the authors do not necessarily represent the official position of the US Department of Health and Human Services, the US Public Health Service Commissioned Corps, the Centers for Disease Control and Prevention, or the authors' institutions.

This work was supported by the Centers for Disease Control and Prevention through an Emerging Infections Program cooperative agreement (CK17-1701) and through a Council of State and Territorial Epidemiologists cooperative agreement (NU38OT000297-02-00). No other disclosures were reported. Competing interests: No other competing interests were reported by the authors.

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Figures

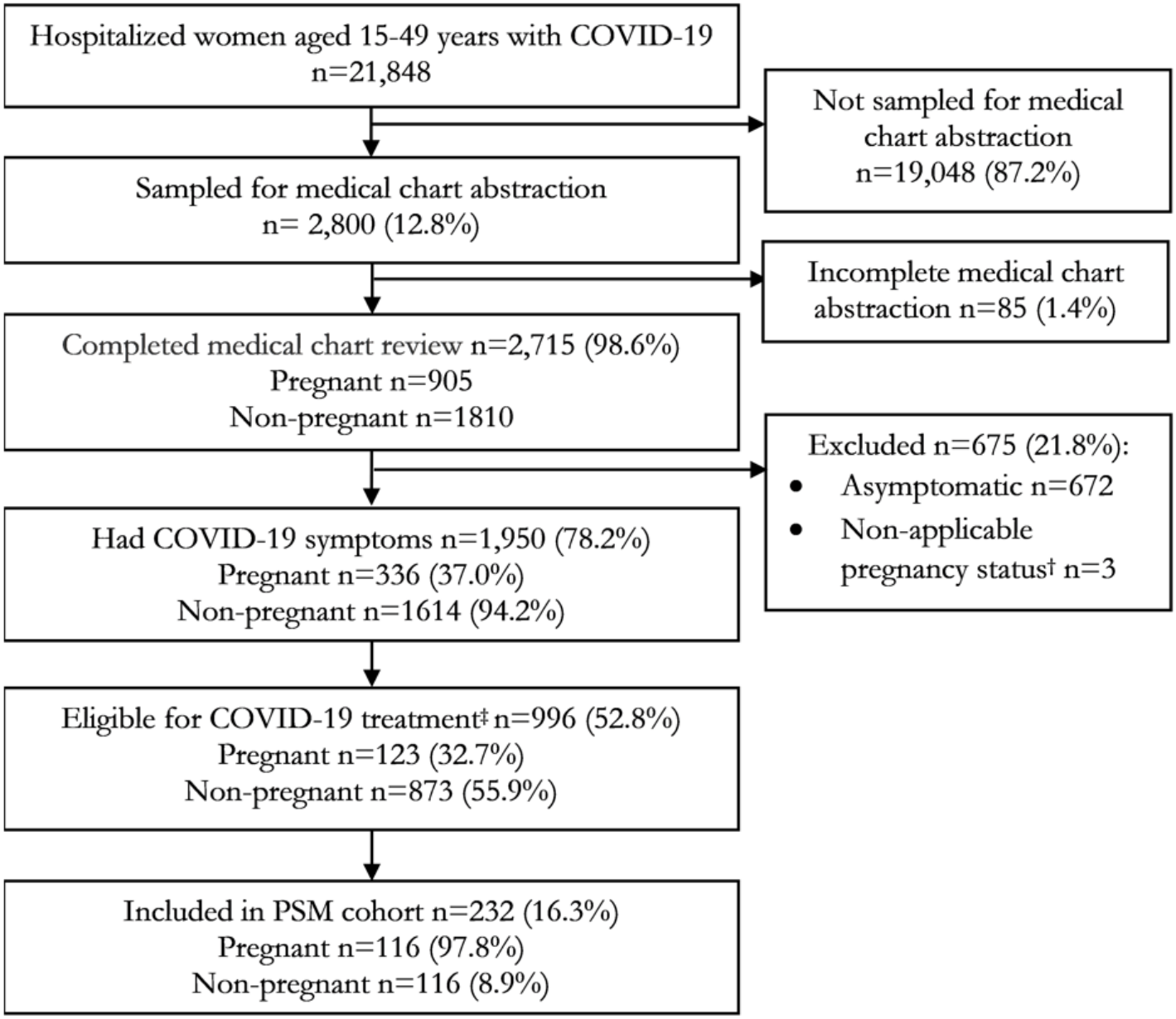

Figure 1

Flow chart for hospitalized, symptomatic women*

*COVID-19-Associated Hospitalization Surveillance Network, COVID-NET, 14 states, January–November 2021.All percentages are weighted, except for the percent sampled and not sampled for medical chart abstraction. All percentages are percent included or excluded from prior denominator.

†Post-partum (n=2) or post-termination (n=1).

‡Being treatment-eligible was defined as an oxygen saturation less than 94% on admission, receiving supplemental oxygen on or during the hospital stay. Because COVID-NET does not collect data on nasal cannula or face mask use in the ICU, we additionally classified three pregnant patients who were admitted to the ICU as treatment-eligible, even if they did not receive higher-level oxygen support.

Abbreviations: COVID-19= Coronavirus Disease 2019, PSM=propensity score matched

Supplementary Files

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