Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Clinical outcomes in patients with COVID-19 and gynecologic cancer: A society of gynecologic oncology COVID-19 and gynecologic cancer registry study

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HIGHLIGHTS

- Patients with gynecologic cancer and COVID-19 are at risk for hospitalization, delay of cancer treatment, and death.
- Racial disparities exist in hospitalizations of patients with gynecologic cancer and COVID-19.
- Active malignancy was associated with a 5-fold increase in the odds of 30-day mortality after COVID-19 diagnosis.

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ABSTRACT

Objectives. Patients with gynecologic malignancies may have varied responses to COVID-19 infection. We aimed to describe clinical courses, treatment changes, and short-term clinical outcomes for gynecologic oncology patients with concurrent COVID-19 in the United States.

Methods. The Society of Gynecologic Oncology COVID-19 and Gynecologic Cancer Registry was created to capture clinical courses of gynecologic oncology patients with COVID-19. Logistic regression models were employed to evaluate factors for an association with hospitalization and death, respectively, within 30 days of COVID-19 diagnosis.

Results. Data were available for 348 patients across 7 institutions. At COVID-19 diagnosis, 125 patients (36%) had active malignancy. Delay ($n = 88$) or discontinuation ($n = 10$) of treatment due to COVID-19 infection occurred in 28% with those on chemotherapy (53/88) or recently receiving surgery (32/88) most frequently delayed. In addition to age, performance status, diabetes, and specific COVID symptoms, both non-White race (adjusted odds ratio (aOR) = 3.93, 95% CI 2.06–7.50) and active malignancy (aOR = 2.34, 95% CI 1.30–4.20) were associated with an increased odds of hospitalization. Eight percent of hospitalized patients (8/101) died of COVID-19 complications and 5% (17/348) of the entire cohort died within 30 days after diagnosis.

Conclusions. Gynecologic oncology patients diagnosed with COVID-19 are at risk for hospitalization, delay of anti-cancer treatments, and death. One in 20 gynecologic oncology patients with COVID-19 died within 30 days after diagnosis. Racial disparities exist in patient hospitalizations for COVID-19, a surrogate of disease severity. Additional studies are needed to determine long-term outcomes and the impact of race.

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1. Introduction

The World Health Organization (WHO) declared the outbreak of novel coronavirus (COVID-19) a global pandemic on March 11, 2020 [1]. Since then, its effects have been far-reaching, with over 504 million cases and 6.2 million deaths worldwide as of April 15, 2022 [2]. As of the same date, the United States of America had 80.5 million known infections and over 987,000 deaths, with 66% of the population fully vaccinated [3]. Symptoms of COVID-19 vary widely among those infected, with some experiencing only mild symptoms or having asymptomatic disease and others requiring intensive medical care [4,5]. The case-fatality ratio ranges from 1 to 8% worldwide, with the US having a ratio of 1.6% [6]. It is well-known that patients with older age and comorbidities such as hypertension, diabetes, and coronary artery disease have a higher risk of developing severe COVID-19 disease [7,8]. Blood type and Rh status may also play a role in COVID-19 infection and severity [9–11]. A recent systematic review demonstrated a higher fatality rate in cancer patients with COVID-19 (23.4%) as compared to patients with COVID-19 who did not have cancer (5.9%) [12].

Gynecologic oncology patients are a heterogenous group with varying illness severity, health status, and ages with the majority being diagnosed after age 60 [13]. Older age combined with comorbid conditions place many gynecologic oncology patients in a high-risk group for COVID-19 infection [14]. Additionally, the treatments for gynecologic cancers (e.g. major surgery, chemotherapy, radiation therapy) could further exacerbate these risks, but this has yet to be specifically studied in gynecologic oncology patients. Delay or alteration of gynecologic oncology treatment plans because of the necessary reduction of many healthcare services during the pandemic potentially further complicates this picture [15].

Understanding the complex interplay of gynecologic cancer and COVID-19 infection will allow patients and their providers to approach treatment plans with nuanced care. In this study, our objective was to describe clinical course, treatment changes, and short-term clinical outcomes for gynecologic oncology patients with concurrent COVID-19 infection in the US. To do this, we drew data from geographically diverse institutions with varying COVID-19 case density and identified factors significantly associated with poorer outcomes.

2. Methods

This retrospective cohort study included all patients with gynecologic cancer and COVID-19 infection treated at seven distinct healthcare facilities across Minnesota, New York, Pennsylvania, Tennessee, Louisiana, and Georgia between March 11, 2020 and December 5, 2021. Patients were identified by procuring a list of all patients with COVID-19 and cross-matching this with patients who ever had a diagnosis of gynecologic cancer. COVID-19 infection was defined by laboratory testing (molecular or serological) or radiologic findings (chest x-ray or CT chest) [16]. All patients with both diagnoses were considered eligible and were entered into a data collection tool created as part of the Society of Gynecologic Oncology (SGO) COVID-19 and Gynecologic Cancer Registry. (Supplement) Patients with "active malignancy" were those identified by their provider to be undergoing any cancer therapy at the time of their COVID-19 diagnosis. The registry was developed by members of the SGO COVID-19 Task Force and included the following items deemed pertinent for both gynecologic cancer and COVID-19: patient demographics, comorbidities, gynecologic cancer diagnoses and therapies, symptoms at initial COVID-19 diagnosis, hospitalization for initial COVID-19 infection, and vital status within 30 days after the COVID-19 diagnosis. In addition, data were collected on cancer treatment delays (with duration), discontinuations, and alterations. Once the data collection items were created and vetted by the SGO COVID-19 Task Force, Mayo Clinic Institutional Review Board (IRB) approval was obtained and the data collection was conducted using an online data collection tool [17]. Each individual site obtained IRB approval and executed data use agreements before collecting de-identified patient-level data for each patient at their site that met the study inclusion criteria. All data were entered into the collection tool by one person at each institution.

Statistical analysis was performed using SAS version 9.4 software package (SAS Institute, Inc.; Cary, NC), Data were descriptively summarized using standard descriptive statistics. Univariate and multivariable logistic regression models were fit to evaluate patient characteristics for an association with an increased odds of hospitalization and death, respectively, within 30 days of COVID-19 diagnosis. Firth's bias correction was applied in models in which the covariate of interest had a zero-cell issue. Multivariable modelling was performed for inference instead of for prediction, and therefore we chose to consider all variables with $p < 0.20$ based on the univariate analyses and use variable selection methods to identify a final model. Both stepwise and backward variable selection methods identified the same final set of variables. Results from the models were summarized using odds ratios and corresponding 95% confidence intervals (CI). All calculated p-values were two-sided and p-values <0.05 were considered statistically significant.

3. Results

Data were collected for 348 gynecologic oncology patients with a COVID-19 diagnosis across seven institutions. All practices described themselves as urban, with 81% in an academic tertiary care center. Baseline patient characteristics are presented in Table 1, with subclassification by cancer type and stage in the supplemental table. At the time of COVID-19 diagnosis, 125 patients (36%) were identified by their provider as having active malignancy. Among all 348 patients, 127 had been diagnosed with gynecologic cancer in the last 12 months. Delay ($n = 88$) or discontinuation ($n = 10$) of cancer treatment due to COVID-19 infection occurred in 28%, median 3–4 weeks delay. Chemotherapy was most frequently delayed (60%, $n = 53/88$), followed by surgery (36%, $n = 32/88$).

One-fourth (n = 88) of patients were asymptomatic at the time of COVID-19 infection, and the most frequently reported presenting symptoms at the initial COVID-19 diagnosis included cough/shortness of breath (54%, $n = 189$), fever (39%, $n = 136$), and fatigue/malaise (27%, $n = 94$) (Table 2).

In total, 20% ($n = 68$) of gynecologic oncology patients required supplemental oxygen and 29% ($n = 101$) were hospitalized (5% in the intensive care setting, n = 18). Twelve patients (3%) required ventilator support. Thirty-five percent (n = 13/37) of patients who were actively receiving chemotherapy at the time of their COVID-19 diagnosis were hospitalized for COVID-19 illness severity. On univariate analysis, older age, Eastern Cooperative Oncology Group performance status (ECOG PS) 2+, having 2+ comorbid conditions, non-White race, and having active malignancy were significantly associated ($p < 0.05$) with an increased odds of being hospitalized with COVID-19. In addition, certain comorbid conditions such as hypertension, diabetes mellitus, and pulmonary embolism were significantly associated with an increased odds of hospitalization. Among the symptoms at initial COVID-19 diagnosis, presentation with fatigue/malaise, fever, cough/shortness of breath, or GI symptoms were each associated with an increased odds of hospitalization (Table 3). On multivariable analysis, advancing age, non-White race, ECOG PS 2+, diabetes, cough/shortness of breath, GI symptoms, and active gynecologic malignancy were all independently associated with an increased odds of hospitalization (Table 4). As shown in Table 4, non-White race was associated with nearly a 4-fold increase in the odds of hospitalization (adjusted odds ratio (aOR) 3.93, 95% CI 2.06–7.50). Although delay or discontinuation of treatment was more common among non-White patients compared to White patients, the difference was not significant (34% (34/101) vs. 26% (64/246), $p = 0.15$).

In terms of mortality, 8% ($n = 8/101$) of hospitalized patients died of COVID-19 complications within 30 days after their COVID-19 diagnosis and 5% ($n = 17/348$) of the entire cohort died within 30 days after

Table 1
Baseline characteristics at the time of the COVID-19 diagnosis.

Characteristic	$N = 348$
Age at COVID-19 diagnosis (years), median (IQR)	62 (52, 70)
Race, N (%)	
White	246 (70.7)
Non-White*	102 (29.3)
Ethnicity, N (%)	
Not Hispanic or Latino	297 (85.3)
Hispanic or Latino	28 (8.0)
Unknown/not reported	23 (6.6)
ECOG performance status prior to infection, N (%)	
0–1	246 (70.7)
2+	28 (8.0)
Unknown	74 (21.3)
Smoking status, N (%)	
Never	230 (66.1)
Former	101 (29.0)
Current	17 (4.9)
Rh blood type, N (%)	
Rh+	225 (64.7)
Rh-	31 (8.9)
Unknown	92 (26.4)
ABO blood type, N (%)	
A	97 (27.9)
AB	16 (4.6)
B	40 (11.5)
O	102 (29.3)
Unknown	93 (26.7)
Comorbidities, N (%)	
0–1	133 (38.2)
2+	215 (61.8)
Comorbidity, N (%)	
Asthma	36 (10.3)
Atrial fibrillation	20 (5.7)
Chronic renal insufficiency/CKD	22 (6.3)
Cirrhosis	2 (0.6)
Congestive heart failure	10 (2.9)
COPD/emphysema	10 (2.9)
Coronary artery disease	25 (7.2)
Diabetes mellitus	91 (26.1)
ESRD, on dialysis	3 (0.9)
History of solid organ transplant	4 (1.1)
Hypertension	159 (45.7)
Immune suppression	48 (13.8)
Inflammatory bowel disease	2 (0.6)
Obesity	144 (41.4)
Obstructive sleep apnea	22 (6.3)
Pulmonary embolism	23 (6.6)
Rheumatologic/autoimmune disease	30 (8.6)
GO diagnosis, N (%)	
Low grade endometrial	115 (33.1)
High grade serous ovarian	76 (21.8)
High grade endometrial	48 (13.8)
Cervical	47 (13.5)
Vulvar	13 (3.7)
Mucinous, endometrioid or clear cell ovarian	11 (3.2)
Low grade serous ovarian	10 (2.9)
Other**	28 (14.1)
Active malignancy	125 (35.9)

* Non-White includes Black/African American, Asian, Native Hawaiian or Other Pacific Islander, and Mixed.
** Other includes uterine sarcoma, non-epithelial ovarian, and Gestational Trophoblastic Disease.

COVID-19 diagnosis. The results of the univariate analysis evaluating factors associated with death within 30 days after COVID-19 diagnosis are presented in Table 5. Based on multivariable analysis, older age (aOR 1.27 per 5-year increase, 95% CI 1.03–1.57) and active malignancy (aOR 6.18, 95% CI 1.91–19.94), were associated with an increased odds of death within 30 days of COVID-19 diagnosis.

Table 2
Symptoms at initial COVID-19 diagnosis.

Symptom	N (%)
Fatigue/malaise	94 (27.0)
Fever	136 (39.1)
Cough/shortness of breath	189 (54.3)
Myalgias/arthralgias	47 (13.5)
Sore throat	24 (6.9)
Headache	38 (10.9)
Anosmia/ageusia	26 (7.5)
Rhinorrhea	32 (9.2)
GI symptoms*	50 (14.4)
LFT abnormalities	1 (0.3)
Cardiac involvement	1 (0.3)
Conjunctivitis	1 (0.3)
None (asymptomatic)	88 (25.3)
Unknown	4 (1.1)

Abbreviations: GI, gastrointestinal; LFT, abnormal liver function test.
* Nausea, vomiting, diarrhea, abdominal discomfort, and/or abdominal pain.

Twelve patients in our cohort required intubation, of which five did not receive it. Of the patients who required intubation, 67% (8/12) died within 30 days after their COVID-19 diagnosis. In the group that underwent intubation, 43% (3/7) died within 30 days after diagnosis.

4. Discussion

We demonstrate that gynecologic oncology patients with COVID-19 are at risk for several undesirable short-term clinical outcomes, such as hospitalization, delay of cancer treatment, and death. We also uncovered differences in hospitalization between gynecologic oncology patients of White and non-White race. These results create a sense of urgency to further explore the long-term oncologic outcomes of gynecologic oncology patients diagnosed with COVID-19, as well as the effects of race on cancer and COVID-19 outcomes in this population.

Advances in the vaccination and disease treatment strategies for SARS-CoV-2 have reduced the need for mechanical ventilation and allowed additional patients to be treated in the outpatient setting [18–20]. Clinical trials for treatments include many different agents, and despite available therapies, cancer patients remain at increased risk of hospitalization [19,21–24]. Cancer patients who require hospitalization for advanced COVID-19 care have an increased risk of death in cancer-wide and gynecologic oncology-specific studies with similar case fatality rates. [14,25] In one investigation, treatment with chemotherapy further increased the probability of hospitalization [26].

Across various types of cancer including gynecologic, treatment delays reduce overall survival [27,28]. Inevitable interruptions to cancer treatment schedules during the pandemic may be caused by necessary operational changes in healthcare systems, shortage of anti-cancer medications, or based upon patient-level factors such as symptomatic COVID-19 requiring quarantine. At three hospitals in New York City, 39% of gynecologic oncology patients experienced a delay, change, or cancellation to their cancer treatment during the first two months of the pandemic [29]. Investigators at the University of Michigan quantified survival estimates for cancer treatment delay in patients with COVID-19 and found that individual patients had significant differences in effect of delay based on their age, cancer type, and cancer stage [30].

We were alarmed to find that 8% of hospitalized gynecologic oncology patients with COVID-19 died of COVID-19 complications within 30 days of their COVID-19 diagnosis and 5% of the overall cohort died within 30 days of their COVID-19 diagnosis. This is especially true since our study included the time both before and during vaccine availability without differentiating which patients received vaccines. The study period also spanned several emerging treatment approaches. A study of 121 gynecologic oncology patients at six New York City hospitals during the first seven weeks of the pandemic found an even higher

Table 3
Univariate analysis of factors evaluated for an association with hospitalization for COVID-19^.

Characteristic	No. of patients hospitalized	Unadjusted OR (95% CI)	P
Age at COVID-19 diagnosis (years)	–	1.21 (1.10, 1.32)‡	<0.001
Race			0.008
White	61/245 (24.9%)	Reference	
Non-white	40/102 (39.2%)	1.95 (1.19, 3.18)	
Ethnicity			0.39
Not Hispanic or Latino	86/296 (29.1%)	Reference	
Hispanic or Latino	6/28 (21.4%)	0.67 (0.26, 1.70)	
Unknown/not reported	9/23 (39.1%)	1.57 (0.66, 3.76)	
ECOG performance status prior to infection			0.004
0–1	60/245 (24.5%)	Reference	
2+	15/28 (53.6%)	3.56 (1.60, 7.90)	
Unknown	26/74 (35.1%)	1.67 (0.96, 2.92)	
Smoking status			0.86
Never	67/230 (29.1%)	Reference	
Former	30/100 (30.0%)	1.04 (0.62, 1.74)	
Current	4/17 (23.5%)	0.75 (0.24, 2.38)	
Rh blood type			0.18
Rh+	66/225 (29.3%)	Reference	
Rh-	13/31 (41.9%)	1.74 (0.81, 3.76)	
Unknown	22/91 (24.2%)	0.77 (0.44, 1.34)	
ABO blood type			0.49
A	28/97 (28.9%)	Reference	
AB	6/16 (37.5%)	1.48 (0.49, 4.46)	
B	9/40 (22.5%)	0.72 (0.30, 1.70)	
O	35/102 (34.3%)	1.29 (0.71, 2.35)	
Unknown	23/92 (25.0%)	0.82 (0.43, 1.57)	
Comorbidities			0.04
0–1	30/132 (22.7%)	Reference	
2+	71/215 (33.0%)	1.68 (1.02, 2.75)	
Comorbidity*			
Asthma	4/36 (11.1%)	0.28 (0.10, 0.80)	0.02
Atrial fibrillation	7/20 (35.0%)	1.34 (0.52, 3.45)	0.55
Chronic renal insufficiency/CKD	8/22 (36.4%)	1.43 (0.58, 3.51)	0.44
Congestive heart failure	4/10 (40.0%)	1.65 (0.46, 5.98)	0.45
COPD/emphysema	5/10 (50.0%)	2.51 (0.71, 8.87)	0.15
Coronary artery disease	10/25 (40.0%)	1.69 (0.73, 3.91)	0.22
Diabetes mellitus	38/91 (41.8%)	2.20 (1.33, 3.64)	0.002
Hypertension	56/159 (35.2%)	1.73 (1.08, 2.76)	0.02
Immune suppression	12/48 (25.0%)	0.79 (0.39, 1.58)	0.50
Obesity	37/143 (25.9%)	0.76 (0.47, 1.23)	0.27
Obstructive sleep apnea	7/22 (31.8%)	1.15 (0.45, 2.90)	0.77
Pulmonary embolism	12/23 (52.2%)	2.88 (1.23, 6.77)	0.02
Rheumatologic/autoimmune disease	9/30 (30.0%)	1.05 (0.46, 2.38)	0.91
GO diagnosis			0.44
Ovarian	31/97 (32.0%)	Reference	
Endometrial	42/163 (25.8%)	0.74 (0.43, 1.28)	
Other**	28/87 (32.2%)	1.01 (0.54, 1.88)	
Symptoms at initial COVID-19 diagnosis*			
Fatigue/malaise	35/94 (37.2%)	1.68 (1.02, 2.78)	0.04
Fever	53/135 (39.3%)	2.21 (1.38, 3.54)	0.001
Cough/shortness of breath	81/188 (43.1%)	5.26 (3.03, 9.12)	<0.001
Myalgias/arthralgias	10/47 (21.3%)	0.62 (0.30, 1.30)	0.21
Sore throat	5/24 (20.8%)	0.62 (0.23, 1.72)	0.36
Headache	6/38 (15.8%)	0.42 (0.17, 1.04)	0.06
Anosmia/ageusia	2/26 (7.7%)	0.19 (0.04, 0.81)	0.02
Rhinorrhea	3/32 (9.4%)	0.23 (0.07, 0.77)	0.02
GI symptoms***	28/50 (56.0%)	3.91 (2.11, 7.24)	<0.001
Active malignancy			0.02
No	55/222 (24.8%)	Reference	
Yes	46/125 (36.8%)	1.77 (1.10, 2.84)	

Abbreviations: CI, confidence interval; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; ECOG, Eastern Cooperative Oncology Group; ESRD, end-stage renal disease; GO, gynecologic oncology; GI, gastrointestinal; LFT, abnormal liver function test; OR, odds ratio.
^ Based on 347 of the 348 patients with known status of hospitalization.
‡ Odds per 5-year increase in age.
* Only considering those with a prevalence >2%.
** Other includes uterine sarcoma, non-epithelial ovarian, cervical, vulvar, and Gestational Trophoblastic Disease.
*** Nausea, vomiting, diarrhea, abdominal discomfort, and/or abdominal pain.

Table 4
Multivariable analysis of factors evaluated for an association with hospitalization for COVID-19^.

Characteristic	Adjusted OR (95% CI)	P
Age at COVID-19 diagnosis (years)	1.17 (1.05, 1.30)‡	0.006
Race		0.001
White	Reference	
Non-white	2.95 (1.53, 5.71)	
Asthma	0.16 (0.05, 0.54)	0.003
Diabetes mellitus	2.81 (1.44, 5.51)	0.003
Pulmonary embolism	3.55 (1.26, 10.01)	0.02
Symptoms at initial COVID-19 diagnosis		
Cough/shortness of breath	9.43 (4.70, 18.92)	<0.001
Headache	0.25 (0.08, 0.78)	0.02
Anosmia/ageusia	0.10 (0.02, 0.57)	0.01
GI symptoms*	6.65 (2.82, 15.68)	<0.001
Active malignancy		0.009
No	Reference	
Yes	2.26 (1.22, 4.18)	

Abbreviations: CI, confidence interval; OR, odds ratio.
^ Based on 347 of the 348 patients with known status of hospitalization.
‡ Odds per 5-year increase in age.
* Nausea, vomiting, diarrhea, abdominal discomfort, and/or abdominal pain.

case fatality rate of 14%, with no survivors among patients requiring mechanical ventilation [25]. An updated analysis of the same population demonstrated similar results [31]. These data highlight that outcomes of unvaccinated gynecologic oncology patients may be even more dire than illustrated here.

A study published in the *New England Journal of Medicine* reported on the racial and ethnic differences in outcomes of patients with COVID-19 and although only 9.1% of the entire cohort had a cancer diagnosis, they found that Black patients comprised the majority (76.9%) of those hospitalized, despite representing only 31% of the entire cohort [32]. Racial disparity also existed in our cancer population, with gynecologic oncology patients of non-White race having an increased risk of hospitalization for COVID-19 in our multivariate analysis, a surrogate for disease severity. The increased hospitalization among patients of non-White race also parallels findings demonstrated in patients without cancer diagnoses [32]. Racial differences in delay of cancer treatment have been reported for many years [33]. In our study, we did not find a significant difference between White and non-White patients for delay or discontinuation of cancer treatment during COVID-19, but our study may have been underpowered to detect this difference and this is an area which would benefit from further investigation. A systematic review published one year after the declaration of SARS-CoV-2 outbreak as a pandemic illustrated an increased mortality rate in patients of non-White race but no difference in case fatality, indicating that the cause is likely related to a complex confluence of exposure and health care access but not susceptibility [34]. Future studies incorporating collection or attribution of socioeconomic status data using tools such as the Harvard Public Health Disparities Geocoding Project will be instrumental in analyzing this complex disparity [35,36].

Strengths of our study include its multi-institutional nature, with a large population of gynecologic oncology patients from varying locations and demographics. Patients in this cohort also represent the full spectrum of gynecologic oncology treatments, including surgery, chemotherapy, radiation therapy, targeted therapies, immunotherapy, and hormone therapy. The relatively short timeline in which the data were collected allowed for consistency in treatment approaches for each gynecologic oncology diagnosis.

Of course, our investigation is not without several limitations. The rapidly evolving landscape of COVID-19 infection, testing, and treatment presents a challenge for result interpretation, as does the limited time frame of follow-up. As a result, we may not have identified all gynecologic oncology patients with COVID-19 in each practice if the COVID-19 testing was done elsewhere. COVID-19 tests were in short

Table 5
Univariate analysis of factors evaluated for an association with death within 30 days after COVID-19 diagnosis^.

Characteristic	No. of deaths within 30 days	Unadjusted OR (95% CI)	P
Age at COVID-19 diagnosis (years)	–	1.21 (1.01, 1.46)‡	0.04
Race			0.28
White	10/244 (4.1%)	Reference	
Non-white	7/102 (6.9%)	1.72 (0.64, 4.66)	
Ethnicity			0.42
Not Hispanic or Latino	15/295 (5.1%)	Reference†	
Hispanic or Latino	0/28 (0.0%)	0.32 (0.02, 5.72)	
Unknown/not reported	2/23 (8.7%)	2.10 (0.50, 8.82)	
ECOG performance status prior to infection			0.20
0–1	9/245 (3.7%)	Reference	
2+	3/28 (10.7%)	3.15 (0.80, 12.39)	
Unknown	5/73 (6.8%)	1.93 (0.63, 5.95)	
Smoking status			0.78
Never	11/229 (4.8%)	Reference†	
Former	6/100 (6.0%)	1.30 (0.48, 3.54)	
Current	0/17 (0.0%)	0.54 (0.03, 10.40)	
Rh blood type			0.90
Rh+	11/224 (4.9%)	Reference	
Rh-	1/30 (3.3%)	0.67 (0.08, 5.36)	
Unknown	5/92 (5.4%)	1.11 (0.38, 3.30)	
ABO blood type			0.90
A	4/96 (4.2%)	Reference	
AB	1/16 (6.3%)	1.53 (0.16, 14.67)	
B	1/39 (2.6%)	0.61 (0.07, 5.59)	
O	5/102 (4.9%)	1.19 (0.31, 4.55)	
Unknown	6/93 (6.5%)	1.59 (0.43, 5.81)	
Comorbidities			0.79
0–1	7/132 (5.3%)	Reference	
2+	10/214 (4.7%)	0.88 (0.33, 2.36)	
Comorbidity*			
Asthma	1/36 (2.8%)	0.53 (0.07, 4.08)	0.54
Atrial fibrillation	2/20 (10.0%)	2.31 (0.49, 10.86)	0.29
Chronic renal insufficiency/CKD	3/22 (13.6%)	3.50 (0.93, 13.22)	0.07
Congestive heart failure	0/10 (0.0%)	0.87 (0.04, 17.71)†	0.93
COPD/emphysema	0/10 (0.0%)	0.87 (0.04, 17.71)†	0.93
Coronary artery disease	2/25 (8.0%)	1.77 (0.38, 8.23)	0.46
Diabetes mellitus	6/91 (6.6%)	1.57 (0.56, 4.36)	0.39
Hypertension	9/158 (5.7%)	1.36 (0.51, 3.61)	0.54
Immune suppression	1/46 (2.2%)	0.40 (0.05, 3.05)	0.37
Obesity	3/143 (2.1%)	0.29 (0.08, 1.03)	0.05
Obstructive sleep apnea	0/22 (0.0%)	0.39 (0.02, 7.14)†	0.53
Pulmonary embolism	2/23 (8.7%)	1.96 (0.42, 9.12)	0.39
Rheumatologic/autoimmune disease	1/30 (3.3%)	0.65 (0.08, 5.05)	0.68
GO diagnosis			0.55
Ovarian	5/96 (5.2%)	Reference	
Endometrial	6/162 (3.7%)	0.70 (0.21, 2.36)	
Other**	6/88 (6.8%)	1.33 (0.39, 4.53)	
Symptoms at initial COVID-19 diagnosis*			
Fatigue/malaise	2/94 (2.1%)	0.34 (0.08, 1.53)	0.16
Fever	9/135 (6.7%)	1.81 (0.68, 4.82)	0.23
Cough/shortness of breath	11/188 (5.9%)	1.57 (0.57, 4.36)	0.38
Myalgias/arthralgias	0/47 (0.0%)	0.17 (0.01, 2.96)†	0.22
Sore throat	0/24 (0.0%)	0.36 (0.02, 6.47)†	0.49
Headache	0/38 (0.0%)	0.22 (0.01, 3.81)†	0.30
Anosmia/ageusia	0/25 (0.0%)	0.34 (0.02, 6.17)†	0.47
Rhinorrhea	0/32 (0.0%)	0.26 (0.02, 4.64)†	0.36
GI symptoms***	3/49 (6.1%)	1.32 (0.36, 4.77)	0.67
Active malignancy			0.005
No	5/222 (2.3%)	Reference	
Yes	12/124 (9.7%)	4.65 (1.60, 13.53)	

Abbreviations: CI, confidence interval; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; ECOG, Eastern Cooperative Oncology Group; ESRD, end-stage renal disease; GO, gynecologic oncology; GI, gastrointestinal; LFT, abnormal liver function test; OR, odds ratio.

^ Based on the 346 of 348 patients who had an answer for the question "If it has been >30 days from COVID-19 diagnosis, was the patient alive 30 days after diagnosis?"

‡ Odds per 5-year increase in age.

† Firth's bias correction applied due to zero cell issue.

* Only considering those with a prevalence >2%.

** Other includes uterine sarcoma, non-epithelial ovarian, cervical, vulvar, and Gestational Trophoblastic Disease.

*** Nausea, vomiting, diarrhea, abdominal discomfort, and/or abdominal pain.

supply for sections of this study, and thus a small number of our patients were diagnosed by a combination of symptoms and classic chest imaging findings [16]. Pertinent outcomes determined at the start of the data collection period may not reflect subsequently determined important topics such as persistent symptoms, reinfection, and impact of delayed treatment on cancer specific outcomes. While we did not collect data on sequencing of therapy, another area of future study may include changes in practice patterns due to COVID-19, such as the decision to proceed with neoadjuvant chemotherapy for ovarian cancer rather than primary debulking surgery. Future studies focusing on long-term oncologic and functional outcomes for gynecologic oncology patients who contract COVID-19 will be critical in determining best approach moving forward, as will comparison of patients with COVID-19 and gynecologic cancer to separate groups with only one of the two diagnoses.

The optimal treatment of gynecologic oncology patients with COVID-19 will continue to evolve. Providers should remain vigilant as the pandemic pivots with new variants and our knowledge for combating it expands. Caution with cancer treatment administration in the setting of COVID-19 will continue to be important, as will a strong emphasis on vaccination and booster administration for all eligible patients. Thoughtful inquiry into the causes and possible solutions for racial disparities must be at the forefront of all future discoveries.

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CRediT authorship contribution statement

Gretchen E. Glaser: Conceptualization, Methodology, Software, Validation, Investigation, Writing – original draft, Visualization, Project administration, Funding acquisition. **Olivia D. Lara:** Investigation, Writing – review & editing. **Bhavana Pothuri:** Conceptualization, Investigation, Writing – review & editing. **Carolina Gomez Grimaldi:** Investigation, Writing – review & editing. **Lauren S. Prescott:** Investigation, Writing – review & editing. **Spyridon A. Mastroyannis:** Investigation, Writing – review & editing. **Sarah Kim:** Investigation, Writing – review & editing. **Adam C. ElNaggar:** Investigation, Writing – review & editing. **Diogo Torres:** Investigation, Writing – review & editing. **Lesley B. Conrad:** Investigation, Writing – review & editing. **Michaela McGree:** Formal analysis, Data curation, Writing – review & editing. **Amy Weaver:** Formal analysis, Data curation, Writing – review & editing. **Warner K. Huh:** Conceptualization, Methodology, Funding acquisition, Writing – review & editing, Supervision. **David E. Cohn:** Writing – review & editing, Supervision. **S. Diane Yamada:** Writing – review & editing. **Amanda N. Fader:** Conceptualization, Methodology, Investigation, Writing – original draft, Visualization, Supervision, Project administration, Funding acquisition.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ygyno.2022.09.017.

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