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.

GYNECOLOGY

Outcomes of gynecologic cancer surgery during the COVID-19 pandemic: an international, multicenter, prospective CovidSurg-Gynecologic Oncology Cancer study

Christina Fotopoulou, MD; Tabassum Khan, MD; Juraj Bracinik, PhD; James Glasbey, MD; Nadeem Abu-Rustum, MD; Luis Chiva, MD; Anna Fagotti, MD, PhD; Keiichi Fujiwara, MD, PhD; Rahel Ghebre, MD, MPH; Murat Gutelkin, MD; Thomas O. Konney, MD; Joseph Ng, MD; Rene Pareja, MD; Rajkumar Kottayasamy Seenivasagam, MD; Jalid Sehouli, MD, PhD; Shylasree T. S. Surappa, MD; Aneel Bhangu, MD, PhD; Elaine Leung, MD, PhD; Sudha Sundar, MD, PhD; On behalf of the CovidSurg Gynecological Cancer Collaborators

BACKGROUND: The CovidSurg-Cancer Consortium aimed to explore the impact of COVID-19 in surgical patients and services for solid cancers at the start of the pandemic. The CovidSurg-Gynecologic Oncology Cancer subgroup was particularly concerned about the magnitude of adverse outcomes caused by the disrupted surgical gynecologic cancer care during the COVID-19 pandemic, which are currently unclear.

OBJECTIVE: This study aimed to evaluate the changes in care and short-term outcomes of surgical patients with gynecologic cancers during the COVID-19 pandemic. We hypothesized that the COVID-19 pandemic had led to a delay in surgical cancer care, especially in patients who required more extensive surgery, and such delay had an impact on cancer outcomes.

STUDY DESIGN: This was a multicenter, international, prospective cohort study. Consecutive patients with gynecologic cancers who were initially planned for nonpalliative surgery, were recruited from the date of first COVID-19-related admission in each participating center for 3 months. The follow-up period was 3 months from the time of the multidisciplinary tumor board decision to operate. The primary outcome of this analysis is the incidence of pandemic-related changes in care. The secondary outcomes included 30-day perioperative mortality and morbidity and a composite outcome of unresectable disease or disease progression, emergency surgery, and death.

RESULTS: We included 3973 patients (3784 operated and 189 nonoperated) from 227 centers in 52 countries and 7 world regions who were initially planned to have cancer surgery. In 20.7% (823/3973) of the patients, the standard of care was adjusted. A significant delay (>8 weeks) was observed in 11.2% (424/3784) of patients, particularly in those with ovarian cancer (213/1355; 15.7%; $P<.0001$). This delay was associated with a composite of adverse outcomes, including disease progression and death (95/424; 22.4% vs 601/3360; 17.9%; $P=.024$) compared with those who had operations within 8 weeks of tumor board decisions. One in 13 (189/2430; 7.9%) did not receive their planned operations, in whom 1 in 20 (5/189; 2.7%) died and 1 in 5 (34/189; 18%) experienced disease progression or death within 3 months of multidisciplinary team board decision for surgery. Only 22 of the 3778 surgical patients (0.6%) acquired perioperative SARS-CoV-2 infections; they had a longer postoperative stay (median 8.5 vs 4 days; $P<.0001$), higher predefined surgical morbidity (14/22; 63.6% vs 717/3762; 19.1%; $P<.0001$) and mortality (4/22; 18.2% vs 26/3762; 0.7%; $P<.0001$) rates than the uninfected cohort.

CONCLUSION: One in 5 surgical patients with gynecologic cancer worldwide experienced management modifications during the COVID-19 pandemic. Significant adverse outcomes were observed in those with delayed or cancelled operations, and coordinated mitigating strategies are urgently needed.

Key words: complications, COVID-19, delay, gynecologic cancer, pandemic, surgery

Introduction

The COVID-19 pandemic took the entire world off guard and led numerous healthcare systems to redesign their clinical services for the reallocation of available resources and accommodate the changes in treatment priorities.[1–8] This study was conducted when little was known about the true magnitude of the virus and when effective therapeutic strategies were lacking.[2–6]

Women with gynecologic cancers were among the most affected populations during the pandemic, and patients appealed for more robust provision of high standard care, even in times of crisis.[9] The pandemic has particularly challenged surgical care delivery for those with more advanced or relapsed disease, where surgery can be life-prolonging but not curative. Surgeries were being delayed or replaced by systemic or palliative care options that had previously been associated with poorer and less favorable outcomes.[10] Moreover, other COVID-19-related events such as delayed diagnosis through the repeatedly imposed lockdowns, increased perioperative complications and mortality through the active COVID-19, and exhausted healthcare resources such as theater space and intensive care capacity were also observed.[1–7,11]

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AJOG at a Glance

Why was this study conducted?

This is a large, prospective, international, gynecologic cancer cohort study summarizing the treatment alternations and their related impact on patients who were planned to have cancer surgery during the initial period of the COVID-19 pandemic (early 2020).

Key findings

In 20.7% (823/3973), care plans were changed compared with prepandemic practice, including operating in alternative hospitals, changes to perioperative systematic treatments, significant delay (>8 week; 11.2%; 424/3784), and cancellation (7.9%; 189/2430), which were associated with more frequent adverse outcomes.

What does this add to what is known?

With significant contribution in gynecologic cancer cases from low- and middle-income countries (26.9%; 1067/3973), this study provided important global data on the magnitude of care changes and the associated adverse outcomes experienced by patients with gynecologic cancer during the early stages of a global pandemic, which could be used to leverage resources for the ongoing mitigating strategies worldwide.

This study aimed to assess the early impact of the pandemic-related modifications to clinical management on the outcomes in surgical gynecologic cancer patients. We hypothesized that the COVID-19 pandemic had led to a delay in surgical cancer care, especially in patients who required more extensive surgery, and such delay had an impact on cancer outcomes. This study is an international prospective multicenter analysis of patients with gynecologic cancers treated during the pandemic.

Materials and Methods

Study design

This was a multicenter, international, prospective cohort study analyzing the clinical and surgical outcomes of patients with gynecologic cancer who had or were planned to have treatment as first line during the COVID-19 pandemic era. The study was part of the wider GlobalSurg-CovidSurg Consortium (https://globalsurg.org/CovidSurg/)—an umbrella study encompassing all solid cancer types and aiming to explore the impact of COVID-19 in surgical patients and services across multiple specialties.[12,13] The study was prospectively registered (NCT04384926) and designed to inform clinical care as the pandemic evolves; the short study period encouraged wider participation at the time that resources were severely restricted owing to the competing needs to the pandemic.

Before the start of the study, each cancer group had the opportunity to add additional questions on the Case Report Form (CRF) to support the need to explore the impact of the COVID-19 pandemic particularly relevant to them. The gynecologic cancer group was particularly concerned about the impact of the pandemic on treatment adjustments and the subsequent clinical outcomes. The related outcomes are stated as secondary outcomes in this report to be consistent with the main CovidSurg-Cancer study.

Equivalent results of other cancer types and generic methods applying to all cancers (eg, inclusion criteria and patient identification) have been published previously.[14] This study included hospitals that included all patients discussed for surgery regardless of whether they were operated on or not.

Any hospital that performed elective cancer surgery and was affected by the COVID-19 pandemic, was eligible to participate. The participating hospitals were identified by local principal investigators. Study approvals for participating hospitals were secured by local principal investigators before entry into the study and data collection. The study protocol was either registered as a clinical audit with institutional review or a research study obtaining ethical committee approval, depending on local and national requirements. Investigators were invited to identify a start date, representing the start of the emergence of COVID-19 in their respective hospitals.

All consecutive adult (age≥18 years) surgical patients with multidisciplinary team (MDT) decisions supporting surgery were captured by the participating centers (local principal investigators) from that point for the next 3 months (representing the first peak period of the COVID-19 pandemic). Only centers confirming the complete inclusion and follow-up of all nonoperated patients (labeled as "Group 1 hospitals" by the CovidSurg study team) were included in analyses comparing operated and nonoperated patients. The definition of lockdown stringency and the level of COVID-19 burden areas (classified as a median of at least 25 cases per 100,000 per 14 days, representing the World Health Organization [WHO] recommendations at the time of the study) were previously described.[13,14]

Patients and procedures

Inclusion criteria:

1. Patients who underwent surgery for gynecologic cancer with curative or life-prolonging intent during the COVID-19 pandemic

or

2. Patients with gynecologic cancer who would have been planned for curative or life-prolonging cancer surgery in the pre-COVID-era but had their surgery delayed or cancelled after multidisciplinary team discussions.

Exclusion criteria:

1. Patients who were planned for palliative surgery or nonsurgical treatments

2. Patients who were suspected of having or were confirmed to have SARS-CoV-2 infection at the time of the MDT decisions.

Consecutive eligible patients were identified from MDT meetings, operating lists, and outpatient or virtual clinics. The day of surgery was defined as day zero, with patients followed up for 30 days postoperatively using routine follow-up pathways. COVID-19 diagnosis was made through nasopharyngeal swab and polymerase chain reaction, computed tomography thorax, or clinical symptoms consistent with COVID-19.

Patients who had a therapeutic operation for suspected cancer that was subsequently shown to be a preinvasive or benign lesion after histologic examination and full organ resection (eg, high-grade dysplasia or carcinoma in situ) were still included in this study. Elective surgery was defined as any surgery booked in advance of a planned admission to hospital.[15] The primary outcomes of the cross-specialty COVIDSurg study were the 30-day postoperative pulmonary complications (COVID-19 infection, pneumonia, acute respiratory distress syndrome, and unexpected ventilation), and they were previously reported.[13]

Key study outcomes of the gyneco-oncological cohort

The primary outcome of this analysis was as follows:

- The incidence of pandemic-related changes in care

The secondary outcomes were as follows:

1. 30-day postoperative morbidity and mortality rates
2. Postoperative hospital stay and critical care utilization rates
3. Proportion of patients with the time between the decision for surgery to the date of surgery of >8 weeks. In the United Kingdom, the national target for providing cancer treatments from the time of the decision made by the MDT is 31 days (approximately 4 weeks). The 8-week cutoff was chosen to represent a significant delay in the time to surgery, as a recent meta-analysis suggested that a treatment delay for >4 weeks was associated with poorer cancer outcomes in a range of non-gynecologic cancers.[10]
4. Proportion of nonoperated patients with progression to incurable disease or death by 3 months after decision for surgery
5. A composite outcome of unresectable disease or disease progression (eg, upstaging), emergency surgery, and death to measure the potential impact of any treatment delays or adjustment

Data collection and follow-up

Patients were recruited from the date of first COVID-19-related admission in each participating center for 3 months, as identified by the local investigators. The follow-up period was extended to 3 months from the time of study entry (when care decision was made) for each participant.

Anonymized data were collected online and stored on a secure server running the Research Electronic Data Capture (REDCap) web application[16] based in the University of Birmingham, United Kingdom. The CRF of the CovidSurg-GO is presented as Supplemental Figure.

Statistical analysis

The study was conducted according to guidelines set by the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for observational studies.[17] Chi-square tests were used to compare differences in categorical data apart from when cell sizes were small, when the Fisher exact tests were used. Continuous nonparametric data are presented as medians and interquartile ranges, and median differences between groups were compared using the Mann−Whitney *U*-test. Missing data are included in summary tables when applicable. Analysis was performed used Stata SE version 16.1 (StataCorp, College Station, TX) and open-source data science tools (Pandas Data Frame [Open-Source Software] and Python [Open-Source Software] using Juptyer notebook). The collected data were checked for consistency, cleaned, and exported. Vectorized operations were used when possible to archive fast turnaround time during the debugging phase. For visualization, the Matplotlib and Seaborn packages were used.

Results

Patients and tumor-related characteristics

We recruited a total of 3973 patients from 227 centers across 52 countries with the following geographic distribution: 2402 patients (60%) from Europe and Central Asia, 484 (12%) from Latin America & Caribbean, 376 (10%) from East Asia & Pacific, 277 (7%) from South Asia, 244 (6%) from North America, 160 (4%) from the Middle East and North Africa, and 24 (1%) from Sub-Saharan Africa (Table 1). Only 189 patients did not undergo surgery (4.8%); these were excluded from all analyses pertaining to surgical data alone.

Almost half (n=1949; 49%) of the patients were ≥60 years old. Most of the patients had either uterine or ovarian cancer (n= 3270; 82%), were from high-income countries (n=2906; 73%), were either overweight or obese (n=2332; 59%), had a performance status of 0 (n=2448; 62%), had an American Society of Anaesthesiologists (ASA) grade of 1 or 2 (n=3193; 80%), and an International Federation of Gynaecology and Obstetrics (FIGO) stage 1 cancer (n=2173; 55%). The patient- and tumor-related characteristics are summarized in Table 1 and Supplemental Tables 1 and 2.

Approximately 1 in 13 (189/2430; 7.9%) operations were cancelled (Table 2). Those in low- and middle-income countries (LMICs; 36/156; 23%) who had stage 3 or 4 cancers (81/705; 11.5%), those in areas where there was a full lockdown (153/1339; 11%), and those in areas with low COVID-19 burden (53/321; 16%) were associated with a higher proportion of nonoperated patients. Table 2 includes only Group 1 hospitals, as they were the only ones that also included a nonoperated cohort to

TABLE 1
Demographics and cancer related characteristics of all included patients—surgical and nonsurgical (n = 3973)[a]

	Uterus (n=1811)	Ovary (n=1459)	Cervix (n=462)	Vulva/vagina (n=235)	Total (n=3973)
Age (y)					
17–19	1 (0.1)	12 (0.8)	0 (0)	0 (0)	13 (0.3)
20–29	7 (0.4)	65 (4.5)	24 (5.2)	4 (1.7)	100 (2.5)
30–39	56 (3.1)	113 (7.8)	122 (26.4)	7 (3.0)	299 (7.5)
40–49	175 (9.7)	265 (18.2)	144 (31.2)	22 (9.4)	608 (15.3)
50–59	473 (26.1)	380 (26.1)	99 (21.4)	52 (22.1)	1004 (25.3)
60–69	554 (30.6)	380 (26.1)	42 (9.1)	49 (20.9)	1027 (25.9)
70–79	421 (23.3)	198 (13.6)	27 (5.8)	58 (24.7)	705 (17.7)
80–89	119 (6.6)	46 (3.2)	4 (0.9)	41 (17.5)	210 (5.3)
>90	5 (0.3)	0 (0)	0 (0)	2 (0.9)	7 (0.2)
Region					
Europe & Central Asia	1122 (62.0)	820 (56.2)	272 (58.9)	188 (80.0)	2408 (60.6)
Latin America & Caribbean	201 (11.1)	180 (12.3)	85 (18.4)	18 (7.7)	484 (12.2)
East Asia & Pacific	178 (9.8)	141 (9.7)	53 (11.5)	4 (1.7)	376 (9.5)
South Asia	74 (4.1)	177 (12.1)	18 (3.9)	8 (3.4)	277 (7.0)
North America	147 (8.1)	67 (4.6)	20 (4.3)	10 (4.3)	244 (6.1)
Middle East & North Africa	81 (4.5)	70 (4.8)	4 (0.9)	5 (2.1)	160 (4.0)
Sub-Saharan Africa	8 (0.4)	4 (0.27)	10 (2.2)	2 (0.9)	24 (0.6)
Income group					
High	1400 (77.3)	982 (67.3)	321 (69.5)	197 (83.8)	2906 (73.1)
Upper middle	305 (16.8)	222 (15.2)	115 (24.9)	30 (12.8)	705 (17.7)
Low-middle	106 (5.9)	255 (17.5)	26 (5.6)	8 (3.4)	362 (9.1)
BMI (kg/m^2)					
<18.5	25 (1.4)	61 (4.2)	19 (4.1)	8 (3.4)	113 (2.8)
18.5–24.9	496 (27.4)	683 (46.8)	228 (49.4)	86 (36.6)	1495 (37.6)
25–29.9	531 (29.3)	423 (29.0)	125 (27.1)	73 (31.1)	1155 (29.1)
30–34.9	363 (20.0)	184 (12.6)	57 (12.3)	37 (15.7)	642 (16.2)
35–39.9	195 (10.8)	63 (4.3)	20 (4.3)	18 (7.7)	296 (7.5)
≥40	184 (10.2)	37 (2.5)	9 (2.0)	9 (3.8)	239 (6.0)
Not available	17 (0.9)	8 (0.6)	4 (0.9)	4 (1.7)	33 (0.8)
WHO performance status					
0	1065 (58.8)	863 (59.2)	387 (83.8)	132 (56.2)	2448 (61.6)
1	520 (28.7)	446 (30.6)	58 (12.6)	71 (30.2)	1095 (27.6)
2	124 (6.9)	102 (7.0)	5 (1.1)	19 (8.1)	250 (6.3)
3	20 (1.1)	13 (0.9)	0 (0)	4 (1.7)	37 (0.9)
4	1 (0.1)	2 (0.1)	0 (0)	3 (1.3)	6 (0.2)
Not available	81 (4.5)	33 (2.3)	12 (2.6)	6 (2.6)	137 (3.5)
CCI					
0	205 (11.3)	427 (29.3)	274 (59.3)	27 (11.5)	936 (23.6)

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TABLE 1
Demographics and cancer related characteristics of all included patients—surgical and nonsurgical (n = 3973)[a]
(continued)

	Uterus (n=1811)	Ovary (n=1459)	Cervix (n=462)	Vulva/vagina (n=235)	Total (n=3973)
1	387 (21.4)	356 (24.4)	86 (18.6)	42 (17.9)	871 (21.9)
2	487 (26.9)	341 (23.4)	41 (8.9)	44 (18.7)	914 (23.0)
3	410 (22.6)	212 (14.5)	37 (8.0)	48 (20.4)	707 (17.8)
4	207 (11.4)	77 (5.3)	14 (3.0)	39 (16.6)	338 (8.5)
5	76 (4.2)	31 (2.1)	1 (0.2)	21 (8.9)	130 (3.3)
6	30 (1.7)	11 (0.8)	6 (1.3)	6 (2.6)	53 (1.3)
7	5 (0.3)	2 (0.1)	1 (0.2)	6 (2.6)	14 (0.4)
8	3 (0.2)	1 (0.1)	1 (0.2)	2 (0.9)	7 (0.2)
9	1 (0.1)	1 (0.1)	1 (0.2)	0 (0)	3 (0.1)
ASA grade					
1	381 (21.0)	417 (28.6)	216 (46.8)	34 (14.5)	1048 (26.4)
2	1013 (55.9)	786 (53.9)	205 (44.4)	137 (58.3)	2145 (54.0)
3	402 (22.2)	240 (16.5)	39 (8.4)	61 (26.0)	743 (18.7)
4	9 (0.5)	15 (1.0)	1 (0.2)	2 (0.9)	27 (0.7)
5	1 (0.1)	0 (0)	1 (0.2)	0 (0)	2 (0.1)
Not available	5 (0.3)	0 (0)	0 (0)	0 (0)	8 (0.2)
FIGO stage					
Not cancer	58 (3.2)	81 (5.6)	57 (12.3)	24 (10.2)	221 (5.6)
1	1276 (70.5)	452 (31.0)	300 (64.9)	142 (60.4)	2173 (54.7)
2	175 (9.7)	124 (8.5)	51 (11.0)	22 (9.4)	373 (9.4)
3	202 (11.2)	555 (38.0)	45 (9.7)	37 (15.7)	839 (21.1)
4	62 (3.4)	227 (15.6)	9 (2.0)	4 (1.7)	302 (7.6)
Not available	38 (2.1)	20 (1.4)	0 (0)	6 (2.6)	65 (1.6)
Histology					
SCC	22 (1.2)	31 (2.1)	323 (69.9)	198 (84.3)	578 (14.6)
Adenocarcinoma	1611 (89.0)	1116 (76.5)	118 (25.5)	9 (3.8)	2854 (71.8)
GCST	13 (0.7)	110 (7.5)	0 (0)	3 (1.3)	127 (3.2)
Other	139 (7.7)	34 (2.3)	7 (1.5)	18 (7.7)	198 (5.0)
Benign/preinvasive/borderline	21 (1.2)	133 (9.1)	14 (3.0)	5 (2.1)	173 (4.4)
Not available	5 (0.3)	35 (2.4)	0 (0)	2 (0.9)	43 (1.1)

Data are presented as total number (percentage). Details of operated vs non-operated group separately, are presented in Supplemental Table 2 and 4.

ASA grade, American Society of Anaesthesiologists Physical Status Classification system; *BMI*, body mass index; *CCI*, Charlson Comorbidity Index; *FIGO*, International Federation of Gynaecology and Obstetrics; *GCST*, germ cell, sex cord stromal or trophoblastic tumors; *NACT*, neoadjuvant chemotherapy; *SCC*, squamous cell carcinoma; *WHO*, World Health Organization.

[a] Six patients (0.1%) did not have a recorded cancer site.

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make a valid comparison of operated and nonoperated patients.

The treatment intent, surgical details, and postoperative outcomes are summarized in Table 3. The median time from MDT decision to surgery was 3 weeks (interquartile range, 1−5 weeks); 11.2% (424/3784) patients underwent surgery more than 8 weeks after the initial MDT decision.

Overall, 20.2% (279/1355) of ovarian cancer patients received neoadjuvant chemotherapy. Of those, 712/1355 (52.3%) had FIGO Stage III/IV disease. In this group, 253/712 (35.5%) had

TABLE 2
Comparison of operated and non-operated cohorts at hospitals that have included all patients discussed at tumor boards (group 1 hospitals; n = 2430)

	Non-operated (n=189)	Operated (n=2241)	Proportion not operated	*P* value
Age (y)				
17–19	0 (0)	6 (0.3)	0/6 (0)	.793
20–29	6 (3.2)	53 (2.4)	6/59 (10.2)	
30–39	11 (5.8)	163 (7.3)	11/174 (6.3)	
40–49	24 (12.7)	297 (13.3)	24/321 (7.5)	
50–59	38 (20.1)	555 (24.8)	38/593 (6.4)	
60–69	49 (25.9)	584 (26.1)	49/633 (7.7)	
70–79	34 (18.0)	449 (20.0)	34/483 (7.0)	
80–89	26 (13.8)	130 (5.8)	26/156 (16.7)	
>90	1 (0.5)	4 (0.2)	1/5 (20)	
Income group				
High	132 (69.8)	1885 (84.1)	132/2017 (6.5)	.003
Upper middle	21 (11.1)	236 (10.5)	21/257 (8.2)	
Low-middle	36 (19.1)	120 (5.4)	36/156 (23.1)	
BMI (kg/m^2)				
<18.5	4 (2.1)	53 (2.4)	4/57 (7.0)	.933
18.5–24.9	72 (38.1)	796 (35.5)	72/868 (8.3)	
25–29.9	43 (22.8)	636 (28.4)	43/679 (6.3)	
30–34.9	34 (18.0)	371 (16.6)	34/405 (8.4)	
35–39.9	12 (6.4)	198 (8.8)	12/210 (5.7)	
≥40	19 (10.1)	160 (7.1)	19/179 (10.6)	
Not available	5 (2.7)	27 (1.2)	5/32 (15.6)	
WHO performance status				
0	77 (40.7)	1408 (62.8)	77/1485 (5.2)	.054
1	79 (41.8)	601 (26.8)	79/680 (11.6)	
2	25 (13.2)	153 (6.8)	25/178 (14.0)	
3	4 (2.1)	24 (1.1)	4/28 (14.3)	
4	2 (1.1)	2 (0.1)	2/4 (50)	
Not available	2 (1.1)	53 (2.4)	2/4 (50)	
CCI				
0	40 (21.2)	477 (21.3)	40/517 (7.7)	.568
1	28 (14.8)	475 (21.2)	28/503 (5.6)	
2	43 (22.8)	532 (23.7)	43/575 (7.5)	
3	28 (14.8)	424 (18.9)	28/452 (6.2)	
4	27 (14.3)	198 (8.8)	27/225 (12.0)	
5	10 (5.3)	86 (3.8)	10/96 (10.4)	
6	12 (6.3)	32 (1.4)	12/44 (27.3)	
7	1 (0.5)	9 (0.4)	1/10 (10)	

Fotopoulou. Gynecologic cancer surgery during the COVID-19 pandemic. Am J Obstet Gynecol 2022. (continued)

neoadjuvant chemotherapy, and 165/712 (23.2%) experienced a significant delay (>8 weeks) for their operations. In those who had FIGO Stage III/IV disease and experienced significant delays, 138/165 (83.6%) had neoadjuvant chemotherapy, compared with 115/547 (21.0%) for those who did not experience a delay ($P<.0001$). In those who had FIGO stage I/II disease and experienced significant delays (7.3%; 40/548), 10/40 (25.0%) had neoadjuvant chemotherapy compared with 15/508 (3.0%) for those who did not experience a delay ($P<.0001$).

Most areas of surgical resection were confined to the pelvis and/or perineum (2624/3784; 69%); 15% (562/3784) involved the midabdomen and 8.4% (319/3784) involved the upper abdomen. The overall bowel resection rate was 3.5% (133/3784). A minimally-invasive approach was applied in 35.5% of all patients (1342/3784) and in 55% (963/1751) and 33% (150/449) of uterine and cervical cancers, respectively.

The surgical 30-day morbidity and mortality profile of the surgical cohort is presented in Table 3. The overall complication rate was 19.3% (731/3784). The postoperatively confirmed COVID-19 infection rate was 0.6% (22/3784) in the entire surgical cohort. Patients with ovarian and uterine cancer represented 95% (21/22) of the entire COVID-19 infected group. Thirty (0.8%) patients died within 30 days of their operations.

Examining separately the surgical morbidity profile of the patients who acquired postoperative COVID-19 infections (Supplemental Table 4), significant differences were noted compared with the uninfected cohort, with a notable increase in respiratory complications (27.3% vs 1.4%; $P<.0001$), wound infection (18.2% vs 4.4%; $P=.002$), postoperative ileus (13.6% vs 2.3%; $P<.0001$), urinary tract infection (13.6% vs 2.0%; $P<.0001$), and anastomotic leak (for those who had bowel surgery, 1/4; 25% vs 7/129; 5.4%; $P<.0001$). The length of stay was significantly longer in the COVID-19-infected group (median of 8.5 days vs 4 days; $P=.0001$). The 30-day mortality rate was

TABLE 2
Comparison of operated and non-operated cohorts at hospitals that have included all patients discussed at tumor boards (group 1 hospitals; n = 2430)
(continued)

	Non-operated (n=189)	Operated (n=2241)	Proportion not operated	*P* value
8	0 (0)	5 (0.2)	0/5 (0)	
9	0 (0)	3 (0.1)	0/3 (0)	
ASA grade				
1	36 (19.1)	536 (23.9)	36/572 (6.3)	.259
2	91 (48.2)	1235 (55.1)	91/1326 (6.9)	
3	55 (29.1)	450 (20.1)	55/505 (10.9)	
4	3 (1.6)	16 (0.7)	3/19 (15.8)	
5	0 (0)	1 (<0.1)	0/1 (0)	
Not available	4 (2.1)	3 (0.1)	4/7 (57)	
Cancer site				
Uterus	60 (31.8)	1036 (46.2)	60/1096 (5.5)	.101
Ovary	104 (55.0)	798 (35.6)	104/902 (11.5)	
Cervix	13 (6.9)	254 (11.3)	13/267 (4.9)	
Vagina/vulva	12 (6.4)	152 (6.8)	12/164 (7.3)	
Not available	0 (0)	1 (<0.1)	0/1 (0)	
FIGO stage[a]				
Not cancer	9 (4.8)	121 (5.4)	9/130 (6.9)	.044
1 or 2	93 (49.2)	1440 (64.3)	93/1533 (6.1)	
3 or 4	81 (42.9)	624 (27.8)	81/705 (11.5)	
Not available	6 (3.2)	56 (2.5)	6/62 (9.7)	
Lockdown stringency				
Full	153 (81.0)	1186 (52.9)	153/1339 (11.4)	.001
Moderate	29 (15.3)	457 (20.4)	29/486 (6.0)	
Light	7 (3.7)	598 (26.7)	7/605 (1.2)	
COVID-19 burden				
High burden	136 (72.0)	1973 (88.0)	136/2109 (6.5)	.008
Low burden	53 (28.0)	321 (13.2)	53/321 (16.5)	

Data presented as total number (percentage) or proportion (percentage).

ASA grade, American Society of Anaesthesiologists Physical Status Classification system; *BMI*, body mass index; *CCI*, Charlson Comorbidity Index; *FIGO*, International Federation of Gynaecology and Obstetrics; *WHO*, World Health Organization.

[a] Comparison of those with cancer and FIGO-stage only.

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18.2% (2/22) vs 0.7% (26/3762) in the COVID-19-infected and uninfected groups, respectively (*P*<.0001). Only 1 preoperative factor and 1 intraoperative factor were significantly associated with COVID-19 infection; they were WHO performance status (*P*=.003) and the rate of bowel resection (18.2% vs 3.4%; *P*<.0001). Multivariate modeling was not performed owing to the very low number of postoperative COVID-19 infections (n=22).

We also compared the patient characteristics and outcomes for those who had a prolonged hospital stay of ≥14 days. The cutoff is used for the continual National Health Service England audit that required mandatory data submission for every hospital in the United Kingdom. Those patients with poorer performance status and higher ASA score, higher disease stage, higher comorbidities index, having had an open surgery, respiratory complications, bowel surgery, and low COVID-19 burden had a higher risk of staying in the hospital longer than 14 days postoperatively (Supplemental Table 5).

When evaluating the impact of the COVID-19 pandemic on the type of treatment the patients received, we demonstrated that 20.7% (823/3973) of all patients (both operated and non-operated) had their standard of care adjusted (Table 4 and Supplementary Table 3).

Patients in LMICs (76/326; 23.3%; *P*<.0001) and areas under full lockdown (*P*<.0001) had poorer performance status (*P*<.0001), more comorbidities (*P*=.024), higher ASA grade (*P*=.010), ovarian cancer (213/1355, 15.7%; *P*<.0001) and FIGO stage 3 or 4 diseases (198/1060, 18.7%; *P*<.0001) were more likely to have their operations more than 8 weeks after the initial decision (Table 5).

In those who had an operation more than 8 weeks after the initial decision, the operations were more likely to be open surgery (*P*<.0001), involve mid-abdominal surgery (*P*<.0001), and require bowel resections (*P*=.011).

There was no significant difference in 30-day mortality (26/3360; 0.8% vs 4/424; 0.9%, *P*=0.771) in those who had delayed operations. However, a significance difference was observed for the composite of adverse outcomes owing to delay in operations, which included unresectable disease or disease progression, emergency surgery, and death (95/424; 22.4% vs 601/3360; 17.9%, *P*=.024), compared with those who had operations within 8 weeks of their MDT decisions.

In nonoperated patients (Supplementary Table 3) (189/2430; 7.9%), 1 in 20 (5/189; 2.7%) died within 3 months of MDT decision for surgery, and 1 in 5 (34/189; 18%) experienced disease progression and death.

TABLE 3
Treatment intent, surgical details and postoperative outcomes of patients who underwent gynecologic cancer surgery (n = 3784)

	Uterus (n=1751)	Ovary (n=1355)	Cervix (n=449)	Vulva/vagina (n=223)	Total (n=3784)	*P* value
Treatment intent[a]						
Curative	1669 (95.3)	1095 (80.8)	426 (94.8)	204 (91.5)	3400 (89.9)	.977
Life-prolonging	79 (4.5)	258 (19.0)	23 (5.1)	19 (8.5)	379 (10.0)	
Palliative	2 (0.1)	2 (0.2)	0 (0)	0 (0)	4 (0.1)	
Not available	1 (0.1)	0 (0)	0 (0)	0 (0)	1 (<0.1)	
Neoadjuvant therapy						
Chemotherapy	29 (1.7)	279 (20.6)	15 (3.3)	5 (2.2)	328 (8.7)	<.0001
Radiotherapy	19 (1.1)	1 (0.1)	2 (0.5)	3 (1.4)	25 (0.7)	.008
Hormonal therapy	14 (0.8)	2 (0.1)	0 (0)	0 (0)	16 (0.4)	.024
Targeted therapy	0 (0)	4 (0.3)	0 (0)	0 (0)	4 (0.1)	.127
Other	0 (0)	1 (0.1)	0 (0)	0 (0)	1 (<0.1)	.774
Time to operation	3 (1–5)	3 (1–5)	3 (1–5)	3 (2–5)	3 (1–5)	<.0001
≤8 wk	1605 (91.7)	1142 (84.3)	405 (90.2)	202 (90.6)	3360 (88.8)	
>8 wk	146 (8.3)	213 (15.7)	44 (9.8)	21 (9.4)	424 (11.2)	
Areas of surgical resection[b]						
Pelvis/Perineal	1443 (82.4)	616 (45.5)	374 (83.3)	189 (84.8)	2624 (69.3)	<.0001
Midabdominal	122 (7.0)	430 (31.7)	6 (1.3)	4 (1.8)	562 (14.9)	
Upper-abdominal	120 (6.9)	171 (12.6)	27 (6.0)	1 (0.5)	319 (8.4)	
Others	66 (3.8)	138 (10.2)	42 (9.4)	29 (13.0)	279 (7.4)	
Bowel surgery						
No	1734 (99.0)	1252 (92.4)	439 (97.8)	220 (98.7)	3651 (96.5)	<.0001
Yes	17 (1.0)	103 (7.6)	10 (2.2)	3 (1.4)	133 (3.5)	
Approach						
Open	751 (42.9)	1101 (81.3)	292 (65.0)	204 (91.5)	2353 (62.2)	<.0001
Minimally-invasive	963 (55.0)	211 (15.6)	150 (33.4)	17 (7.6)	1342 (35.5)	
Converted	37 (2.1)	42 (3.1)	5 (1.1)	0 (0)	84 (2.2)	
Not available	0 (0)	1 (0.1)	2 (0.5)	2 (0.9)	5 (0.1)	
Postoperative stay (d)	3 (1–5)	5 (3–8)	3 (1–5)	3 (2–6)	4 (2–6)	.0001
30-d surgical morbidity						
Any complications	274 (15.7)	303 (22.4)	88 (19.6)	65 (29.2)	731 (19.3)	<.0001
Respiratory complications	18 (1.0)	32 (2.4)	4 (0.9)	4 (1.8)	58 (1.5)	.030
COVID-19 infection	7 (0.4)	14 (1.0)	1 (0.2)	0 (0)	22 (0.6)	.087
Wound infection	67 (3.8)	54 (4.0)	20 (4.4)	28 (12.6)	169 (4.5)	
Hemorrhage	44 (2.5)	78 (5.8)	7 (1.6)	2 (0.9)	131 (3.5)	<.0001
Ileus	25 (1.4)	52 (3.8)	12 (2.7)	0 (0)	89 (2.4)	<.0001
Urinary tract infection	25 (1.4)	29 (2.1)	18 (4.0)	5 (2.2)	77 (2.0)	<.0001
Wound dehiscence	30 (1.7)	11 (0.8)	5 (1.1)	25 (11.2)	71 (1.9)	.016
Sepsis	14 (0.8)	16 (1.2)	4 (0.9)	3 (1.3)	37 (1.0)	<.0001
Thromboembolism	12 (0.7)	17 (1.3)	0 (0)	1 (0.4)	30 (0.8)	.817

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TABLE 3
Treatment intent, surgical details and postoperative outcomes of patients who underwent gynecologic cancer surgery (n = 3784) *(continued)*

	Uterus (n=1751)	Ovary (n=1355)	Cervix (n=449)	Vulva/vagina (n=223)	Total (n=3784)	*P* value
Kidney Injury	7 (0.4)	17 (1.3)	3 (0.7)	1 (0.4)	28 (0.7)	.095
Other organ injury	8 (0.5)	10 (0.7)	6 (1.3)	1 (0.4)	25 (0.7)	.092
Anastomosis leak	2 (0.1)	4 (0.3)	1 (0.2)	1 (0.4)	8 (0.2)	.337
Cardiac arrest	0 (0)	8 (0.6)	0 (0)	0 (0)	8 (0.2)	.764
Myocardial infarction	2 (0.1)	1 (0.1)	1 (0.2)	0 (0)	4 (0.1)	.006
Stroke	1 (0.1)	2 (0.1)	0 (0)	0 (0)	3 (0.1)	.915
Other complications	84 (4.8)	97 (7.2)	35 (7.8)	20 (9.0)	237 (6.3)	.836.007
30-d surgical mortality	8 (0.5)	20 (1.5)	0 (0)	2 (0.9)	30 (0.8)	.003

Six patients (0.1%) did not have a recorded cancer site. Data presented as total number (percentage) or median (interquartile range).

[a] Curative+life-prolonging vs palliative operation; [b] Midabdominal=any operation involving mid-abdominal procedures, but not upper-abdominal surgery; Upper-abdominal=any operations involving upper-abdominal procedures.

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Comment

Principal findings

This was a large prospective international study (with 1 in 4 participants from LMICs) to evaluate the impact of the COVID-19 crisis on the treatment delivery and outcomes of gynecologic cancer patients initially had plans for nonpalliative cancer surgery during the initial months of the pandemic. We demonstrated that 1 in 5 surgical gynecologic cancer patients had their standard of care adjusted as a result of the COVID-19 pandemic.

Although treatment alterations were not associated with a significant difference in 30-day postoperative mortality, significant delay (>8 weeks) in the time to surgery was associated with a composite of adverse outcomes (Table 5), including disease progression

TABLE 4
Summary of pandemic-related changes in care in operated patients by cancer type (n = 3778)[a]

	Uterus (n=1751)	Ovary (n=1355)	Cervix (n=449)	Vulva/vagina (n=223)	Total (n=3778)	*P* value
Any change in care	332 (19.0)	201 (14.8)	58 (12.9)	43 (19.3)	634 (17.0)	.001
Alternative hospitals	215 (12.3)	117 (8.6)	42 (9.4)	28 (12.6)	402 (10.6)	.006
Delay to definitive surgery	198 (11.3)	115 (8.5)	34 (7.6)	34 (15.3)	381 (10.1)	.001
Change of choice of operations	77 (4.4)	15 (1.1)	7 (1.6)	6 (2.7)	105 (2.8)	<.0001
Expedited surgery	39 (2.2)	31 (2.3)	6 (1.3)	4 (1.8)	80 (2.1)	.631
Non-routine use of neoadjuvant treatments	18 (1.0)	24 (1.8)	0 (0)	0 (0)	42 (1.1)	.005
Neoadjuvant treatments not given	5 (0.3)	4 (0.3)	2 (0.5)	0 (0)	11 (0.3)	.796
Longer neoadjuvant treatments	1 (0.1)	36 (2.7)	0 (0)	0 (0)	37 (1.0)	<.0001
Shorter neoadjuvant treatments	2 (0.1)	15 (1.1)	0 (0)	0 (0)	17 (0.5)	<.0001
Non-routine use of adjuvant treatments	4 (0.2)	3 (0.2)	1 (0.2)	0 (0)	8 (0.2)	.918
Adjuvant treatments not given	14 (0.8)	4 (0.3)	4 (0.9)	0 (0)	22 (0.6)	.145
Not recruited to a clinical trial	3 (0.2)	1 (0.1)	1 (0.2)	0 (0)	5 (0.1)	.771
Recruited to a clinical trial (not routine)	2 (0.1)	0 (0)	0 (0)	0 (0)	2 (0.1)	.509

Data presented as total number (percentage). Multiple changes were reported for each patient when appropriate.

[a] Six patients (0.1%) did not have a recorded cancer site and were excluded from this table.

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TABLE 5
Comparisons of patients and outcomes who have received any operations by time to surgery (≤8 weeks vs >8 weeks; n = 3784)

	≤8 wk (n=3360)	>8 wk (n=424)	Proportion >8 wk	*P* value
Age (y)				
17–19	12 (0.4)	1 (0.2)	1/13 (7.7)	.165
20–29	84 (2.5)	10 (2.4)	10/94 (10.6)	
30–39	259 (7.7)	29 (6.8)	29/288 (10.1)	
40–49	507 (15.1)	77 (18.2)	77/584 (13.2)	
50–59	853 (25.4)	113 (26.7)	113/966 (11.7)	
60–69	882 (26.3)	96 (22.6)	96/978 (9.8)	
70–79	603 (18.0)	68 (16.0)	68/671 (10.1)	
80–89	156 (4.6)	28 (6.6)	28/184 (15.2)	
>90	4 (0.1)	2 (0.5)	2/6 (33.3)	
Income group				
High	2501 (74.4)	273 (64.4)	273/2774 (9.8)	<.0001
Upper middle	609 (18.1)	75 (17.7)	75/684 (11.0)	
Low-middle	250 (7.4)	76 (17.9)	76/326 (23.3)	
BMI (kg/m^2)				
<18.5	91 (2.7)	18 (4.3)	18/109 (16.5)	.364
18.5–24.9	1260 (37.5)	163 (38.4)	163/1423 (11.5)	
25–29.9	995 (29.6)	117 (27.6)	117/1112 (10.5)	
30–34.9	549 (16.3)	59 (13.9)	59/608 (9.7)	
35–39.9	250 (7.4)	34 (8.0)	34/284 (12.0)	
≥40	190 (5.7)	30 (7.1)	30/220 (13.6)	
Not available	25 (0.7)	3 (0.7)	3/28 (10.7)	
WHO performance status				
0	2152 (64.0)	219 (51.7)	219/2371 (9.2)	<.0001
1	858 (25.5)	158 (37.3)	158/1016 (15.6)	
2	189 (5.6)	36 (8.5)	36/225 (16.0)	
3	29 (0.9)	4 (0.9)	4/33 (12.1)	
4	4 (0.1)	0 (0)	0/4 (0)	
Not available	128 (3.8)	7 (1.7)	7/135 (5.2)	
CCI				
0	791 (23.5)	105 (24.8)	105/896 (11.7)	.024
1	740 (22.0)	103 (24.3)	103/843 (12.2)	
2	789 (23.5)	82 (19.3)	82/871 (9.4)	
3	617 (18.4)	62 (14.6)	62/679 (9.1)	
4	266 (7.9)	45 (10.6)	45/311 (14.5)	
5	100 (3.0)	20 (4.7)	20/120 (16.7)	
6	37 (1.1)	4 (0.9)	4/41 (9.8)	
7	13 (0.4)	0 (0)	0/13 (0)	
8	5 (0.2)	2 (0.5)	2/7 (28.6)	

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and death compared with those who did not experience a delay. In those in whom operation was cancelled, 1 in 5 had disease progression, and 1 in 20 died within 3 months of their MDT decisions.

Results in the context of what is known

Our results suggest that the surgical morbidity profile appeared to be equivalent to the historic surgical morbidity data outside of the COVID-19 pandemic[18–20] in contrast to previous single-center data, suggesting higher morbidity rates.[11] It is plausible that the modifications of surgical approaches have influenced the overall morbidity profile during the pandemic. For example, in patients undergoing colorectal cancer surgery,[14] there was a significant increase in the overall rate of stoma formation (34.2% vs 27.2% in the prepandemic era), especially end stoma formation (70% vs 43.6% prepandemic).

Despite this study being conducted during the first wave of the COVID-19 pandemic, a low perioperative COVID-19 infection rate (0.6%) was observed. Our data appeared more favorable than the previously reported experience,[13,14,21] with a lower incidence of postoperative COVID-19 infection (0.6% vs 3.8%) and lower 30-day mortality in the non-COVID19-infected patients' cohort (0.7% vs 1.8%). Consistent with previous reports,[13,14,21] patients infected with COVID-19 had a significantly longer postoperative stay and higher surgical morbidity and mortality (63.6% and 18.2%, respectively) than uninfected patients. The cause of the more favorable outcomes in patients with gynecologic cancer than previously reported experiences is likely to be multifactorial and could be related to the overall less radical surgical procedures. Only 3.5% of our operated patients underwent bowel resections, which is a surrogate marker of surgical radicality. Nevertheless, similar to previous reports,[14] our data also confirmed that bowel resection was associated with higher risks of perioperative COVID-19 infection, other surgical morbidity, and

longer hospitalization. These data consistently demonstrated the significant difference in surgical mortality between COVID-19-infected and uninfected patients, regardless of the type and site of surgery.

In addition to the well-established risk factor of prolonged hospital stay, we showed that low COVID-19 burden areas were associated with significantly higher rates of increased hospitalization (>14 days). It is possible that the healthcare systems that were least affected by the pandemic continued to operate for complex patients with a high disease burden, who in turn required a longer hospital stay.

Although published recommendations highlighted expected delays in gynecologic cancer delivery, the published evidence demonstrated some variations of the impact of COVID-19. For example, Bruce et al[22] suggested that the number of referrals to gynecologic oncology decreased during the early stages of the pandemic, but the time to evaluation and treatment initiation were unaffected. In contrast, a number of surveys and retrospective cohort studies have described delays in consultations and treatments.[23–26] This study specifically evaluated the impact of the significant delay in the time to surgery on oncologic outcomes in patients with gynecologic cancers. One in 10 patients experienced significant delay (>8 weeks) to surgery (Table 5), particularly patients with ovarian cancer (213/1355; 15.7%), multiple comorbidities, stage III/IV disease (198/1060; 18.7%), and those in LMICs (76/326; 23.3%). A significant delay in time to surgery was associated with neoadjuvant chemotherapy use in patients with ovarian cancer (83.6% vs 21% for FIGO Stage III/IV disease; 25% vs 3.0% for FIGO stage I/II disease). The results highlighted this delay disproportionately affect those who required more complex surgery, at higher anesthetic risks and in areas where resources were scarce (LMICs and areas in full lockdown with subsequently low COVID-19 burden). Consistent with a previous systematic review,[10] treatment delay was associated with poorer outcomes.

TABLE 5
Comparisons of patients and outcomes who have received any operations by time to surgery (≤8 weeks vs >8 weeks; n = 3784) *(continued)*

	≤8 wk (n=3360)	>8 wk (n=424)	Proportion >8 wk	*P* value
9	2 (0.1)	1 (0.2)	1/3 (33.3)	
ASA grade				
1	917 (27.3)	95 (22.4)	95/1012 (9.4)	.010
2	1834 (54.6)	220 (51.9)	220/2054 (10.7)	
3	582 (17.3)	106 (25.0)	106/688 (15.4)	
4	21 (0.6)	3 (0.7)	3/23 (12.5)	
5	4 (0.1)	0 (0)	0/4 (0)	
Not available	2 (0.1)	0 (0)	0/2 (0)	
Cancer site				
Uterus	1605 (47.8)	146 (34.4)	146/1751 (8.3)	<.0001
Ovary	1142 (34.0)	213 (50.2)	213/1355 (15.7)	
Cervix	405 (12.1)	44 (10.4)	44/449 (9.8)	
Vagina/vulva	202 (6.0)	21 (5.0)	21/223 (9.4)	
Not available	6 (0.2)	0 (0)	0/6 (0)	
FIGO stage				
Not cancer	179 (5.3)	33 (7.8)	33/212 (15.6)	<.0001
1 or 2	2262 (67.3)	191 (45.1)	191/2453 (7.8)	
3 or 4	862 (25.7)	198 (46.7)	198/1060 (18.7)	
Not available	57 (1.7)	2 (0.5)	2/59 (3.4)	
Lockdown stringency				
Full	1577 (46.9)	340 (80.2)	340/1917 (17.7)	<.0001
Moderate	853 (25.4)	51 (12.0)	51/904 (5.6)	
Light	839 (25.0)	22 (5.2)	22/861 (2.6)	
COVID-19 burden				
High burden	2376 (70.7)	283 (66.8)	283/2659 (10.6)	.240
Low burden	917 (27.3)	131 (30.9)	131/1048 (12.5)	
Not available	67 (2.0)	10 (2.4)	10/77 (13.0)	
Surgery performed				
Pelvis/perineal	2366 (70.4)	258 (60.9)	258/2624 (9.8)	<.0001
Midabdominal	451 (13.4)	111 (26.2)	111/562 (19.8)	
Upper-abdominal	291 (8.7)	28 (6.6)	28/319 (8.8)	
Others	252 (7.5)	27 (6.4)	27/279 (9.7)	
Bowel surgery				
No	3251 (96.8)	400 (94.3)	400/3651 (11.0)	.011
Yes	109 (3.2)	24 (5.7)	24/133 (18.1)	
Approach				
Open	2042 (60.8)	311 (73.4)	311/2353 (13.2)	<.0001
Minimally-invasive	1235 (36.8)	107 (25.2)	107/1342 (8.0)	

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TABLE 5
Comparisons of patients and outcomes who have received any operations by time to surgery (≤8 weeks vs >8 weeks; n = 3784) *(continued)*

	≤8 wk (n=3360)	>8 wk (n=424)	Proportion >8 wk	*P* value
Converted	78 (2.3)	6 (1.4)	6/84 (7.1)	
Not available	5 (0.2)	0 (0)	0/5 (0)	
Postoperative complication				
Any complications	640 (19.1)	91 (21.5)	91/731 (12.5)	.235
Respiratory complications	51 (1.5)	7 (1.7)	7/58 (12.1)	.834
Mortality	26 (0.8)	4 (0.9)	4/30 (13.3)	.711
Composite[a]	601 (17.9)	95 (22.4)	95/696 (13.7)	.024

Data presented as total number (percentage) or proportion (percentage). For postoperative outcomes, data were collected at 30 days after the surgeries.

ASA grade, American Society of Anaesthesiologists Physical Status Classification system; *BMI*, body mass index; *CCI*, Charlson Comorbidity Index; *FIGO*, International Federation of Gynaecology and Obstetrics; *WHO*, World Health Organization.

[a] A composite outcome of unresectable disease or disease progression, emergency surgery and death.

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Strengths and limitations

This work evaluated the outcomes of the largest cohort of surgical gynecologic cancer patients during the COVID-19 pandemic. Our data covered all regions of the world to minimize geographic bias and generate conclusions that could be applied to different healthcare systems. It delivered a global view on cancer surgery delivery and outcomes—an area where comprehensive prospective data are scarce. Similar to other large-scale international datasets, this study includes heterogeneity between the cohorts; bias toward high-income countries; and significant variations in the surgical practice, pathways, and infrastructures; which made direct translation to practice for individual patients challenging.

There are very limited existing multicentered international studies with similar coverage of LMICs reporting detailed outcomes and complication rates of gynecologic cancer surgery.[18–20] However, they had different classifications and recording methods compared with this current study. Therefore, direct comparison was inappropriate, which limited our ability to identify any change in the morbidity and mortality rates because of the COVID-19 pandemic.

The study and follow-up periods for CovidSurg-Cancer were deliberately short to encourage wider participations and a rapid turnover of data to inform practice. Although the comparison of a retrospective cohort could aid direct comparison of management adjustments and outcomes and it would have been performed in a single-center setting,[11] the resources required to do so globally at the first peak of the pandemic could not be justified. We also acknowledge that post-MDT patient selections have contributed to the associations between surgical delay or cancellation and poorer outcomes, but the results highlight the need to target resources for those with complex care needs to ensure that they receive their planned urgent life-prolonging operations.

Clinical implications

Gynecologic cancer surgery during the early stages of the COVID-19 pandemic and before the availability of vaccination and effective treatments appeared to be safe, with a low risk of COVID-19 infection.[14] With significant contribution from LMICs (26.9%; 1067/3973), these data also provide a global snapshot of the morbidity and mortality rates experienced by patients undergoing gynecologic cancer surgery. This study identified that a significant proportion of patients had their surgical plans delayed or cancelled, which was associated with poorer outcomes. The results represent an early and clear signal that robust mechanisms and pathways are urgently needed to ensure adequate cancer care even in times of crisis without detrimental oncologic compromise. With this large data set estimating the number of treatment plan alternations globally, the results could be used to coordinate plans and allocate resources as required to rescue and salvage the detrimental effects. Yet, few health systems have established consensus agreements to date.[1,8] These results will also add to the evidence for future pandemics and the planning of relevant studies during a worldwide crisis in the future.

Research implications

The data were collected during the initial phase of the pandemic when the impingement of the virus was completely new, when none of the patients were vaccinated, and when protective measures were immature. Continued evaluation of the impact of the COVID-19 pandemic on cancer care delivery in the medium- and long-term is required. Population-based studies will be required to evaluate which patient subgroups (eg, cancer types or stage) were the most adversely affected. Comparative studies are also required to identify effective ways to mitigate the detrimental impact of the pandemic on cancer care.

Conclusions

The new rising incidence of COVID-19 worldwide owing to emerging variants combined with incomplete vaccination coverage has continued to disrupt healthcare delivery, and our results remain highly relevant. Despite the very low risk of perioperative COVID-19 infection, those infected had substantially poorer outcomes. The high rates of pandemic-related treatment plan modifications were associated with early negative impact on oncological outcomes. Robust strategies for the safe provision of surgical cancer care when the pandemic is transitioning into an endemic state are urgently needed. ■

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Author and article information

From the Department of Surgery and Cancer, Gynecologic Oncology, Imperial College London, London, United Kingdom (Dr Fotopoulou); Institute of Cancer and Genomic Sciences, University of Birmingham, Birmingham, United Kingdom (Dr Khan); Particle Physics Group, School of Physics and Astronomy, University of Birmingham, Birmingham, United Kingdom (Dr Bracinik); National Institute for Health and Care Research Global Health Research Unit on Global Surgery, University of Birmingham, Birmingham, United Kingdom (Dr Glasbey); Memorial Sloan Kettering Cancer Center, New York, NY (Dr Abu-Rustum); University Clinic of Navarra, Madrid, Spain (Dr Chiva); Division Gynecologic Oncology, Fondazione Policlinico Universitario A. Gemelli, Università Cattolica del Sacro Cuore, Rome, Italy (Dr Fagotti); Department of Gynecologic Oncology, Saitama Medical University International Medical Center and on behalf of Gynecologic Oncology Trial and Investigation Consortium and Asia-Pacific Gynecologic Oncology Trials Group, Saitama, Japan (Dr Fujiwara); Department of Obstetrics, Gynecology and Women's Health and Masonic Cancer Center, University of Minnesota, Minneapolis, MN (Dr Ghebre); Division of Gynecologic Oncology, Department of Obstetrics and Gynecology, Hacettepe University Faculty of Medicine, Ankara, Turkey (Dr Gutelkin); Department of Obstetrics and Gynaecology, Komfo Anokye Teaching Hospital, Kumasi, Ghana (Dr Konney); Gynecologic Oncology Department, National University Cancer Institute, Singapore, Singapore (Dr Ng); Gynecologic Oncology Unit, National Cancer Institute, Bogotá and Astorga Oncology Clinic, Medellín, Colombia (Dr Pareja); Department of Surgical Oncology, All India Institute of Medical Sciences Rishikesh, Rishikesh, India (Dr Seenivasagam); Department of Gynecology with Center of Surgical Oncology, Charité Campus Virchow Klinikum, Berlin, Germany (Dr Sehouli); Tata Memorial Hospital, Mumbai, India (Dr Surappa); NIHR Global Health Research Unit on Global Surgery, University of Birmingham, Birmingham, United Kingdom (Dr Bhangu); Institute of Cancer and Genomic Sciences, University of Birmingham, Birmingham, United Kingdom (Dr Leung); and Institute of Cancer and Genomic Sciences, University of Birmingham, Birmingham, United Kingdom (Dr Sundar).

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Additional members of the COVIDSurg Gynecological Cancer Collaborators have been listed in the Appendix.

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Corresponding author: Sudha Sundar, MD, PhD. S.S.Sundar@bham.ac.uk

SUPPLEMENTAL FIGURE
Case Report Form for COVIDSurg-Cancer (gyneco-oncology)

Case Report Form CovidSurg-Cancer-Gynae

NB: Additional data points may be required for specific cancer types

NIHR Global Health Research Unit on Global Surgery — CovidSurg

Patient **REDCap ID**:_____

Age: 0-4w | 4-52w | 1-9y | 10-16y | 17-19y | 20-29y | 30-39y | 40-49y | 50-59y | 60-69y | 70-79y | 80-89y | 90y+ **Sex**: Female | Male **ASA Grade**: 1 | 2 | 3 | 4 | 5

Weight (<52 weeks only):_____ kg

WHO/ECOG Performance status: 0 | 1 | 2 | 3 | 4 | 5 | Unknown

Comorbidities:

- □ Current smoker
- □ Asthma
- □ Current cancer disease
- □ CKD (Moderate/Severe)
- □ COPD
- □ Congenital abn (cardiac)
- □ Congenital abn (non cardiac)
- □ Congestive heart failure
- □ Dementia
- □ Diabetes Mellitus
- □ Hypertension
- □ Myocardial Infarction
- □ Peripheral Vascular Dis
- □ Stroke/TIA
- □ Other: _____

Cancer-specific details:

Cancer type
Uterine | Ovarian | Cervical | Vulva | Vagina

Histological type
Squamous cell | Adenocarcinoma | Germcell, sex cord stromal or trophoblastic | Other:_____

Date of cancer **diagnosis**: ___/__/____

Date of **decision** for surgery: ___/___/____

FIGO stage at time of decision for surgery
Stage 0 | Stage 1 | Stage II | Stage III | Stage IV

Was the initial MDT (tumour board) decision for primary surgical treatment?
Yes – decision for surgical Rx (optimal treatment option) | Yes – decision for surgical Rx (compromised option due to COVID-19) | No – decision for non-surgical Rx (optimal treatment option) | No – decision for non-surgical Rx (compromised option due to COVID-19)

Did the patient have an operation related to this cancer during the 3-month study window? No / Yes

If a cancer operation WAS performed:

Date of **surgery**: ___/__/____

Op performed in
Dedicated COVID-free hospital | Dedicated COVID Rx hospital | Mixed hospital type with ED | Mixed hospital type without ED | Other:_____

COVID-19 CRITCON level
□ Level 0 □ Level 1 □ Level 2 □ Level 3 □ Level 4

Was **COVID-19** suspected at time of surgery? Yes | No

Was **COVID-19 screening** performed preoperatively?

Laboratory test | CT thorax | Other:_____

Urgency of surgery:
Immediate | Urgent | Expedited | Elective

If a cancer operation WAS performed:

If **emergency cancer surgery** was required, why?
□ Gastro-intestinal obstruction □ Bleeding □ Sepsis
□ Tumour progression □ Organ perforation
□ Other:_____

Anaesthesia: Local | Regional | General

Operation performed?_____

Approach: Open | Minimally invasive | Converted to open

Surgical **intent**: Curative | Palliative

Did this represent a change to your typical operative approach in the pre-COVID-19 era?
□ No change to operative approach
□ Yes, chose to avoid minimally invasive surgery related to COVID-19
□ Yes, chose to avoid open surgery related to COVID-19

Resection margin status: R0 | R1 | R2 | Unknown

Did any change to treatment occur due to the COVID-19 pandemic (operated patients)**?**
No change to care, no neoadjuvant Rx | No change – neoadjuvant equivalent to pre-COVID | Delay to definitive Rx | Expedited definitive surgery | Change in choice of operation | Op performed in alt. hospital | IR procedure before surgery, not typically indicated | Neoadj treatment, not typically indicated | No Neoadj, typically indicated | Neoadj treatment longer than typical | Neoadj treatment shorter than typical | Adj treatment, not typically indicated | No adj, typically indicated | Other:_____

Neoadjuvant therapy
Chemotherapy | Radiotherapy | Targeted therapy | Immunotherapy | Hormonal/Non-hormonal treatment | Other:_____

If re-imaged before surgery, was there reponse to neoadjuvant treatment
Not re-imaged | Re-imaged, partial response | Re-imaged, complete response | Re-imaged, progression

COVID-19 post-operatively (30 days): Yes – lab test | Yes – CT thorax | Yes– clinical only | No
If yes: Inpatient | Required Admission | Community

Mortality: Died on table | d0-7 | d8-30 | Alive still in hosp 30d | transferred | discharged to rehab | discharged home

Re-operation: Yes | No

Post-op intensive care: No | planned from theatre | unplanned from theatre | unplanned from ward
(If no/unplanned from ward): **Would post-operative ICU bed have been planned pre-COVID-19 era?** Yes, not available ~ COVID| Yes, not available (other)| No

Total **length of hospital stay**: ____days

Did surgeons contract COVID-19 (30-days): Yes | No

If a cancer operation WAS performed:

Complications:

- □ Acute kidney injury
- □ ARDS
- □ Anastomotic leak
- □ Blood transfusion
- □ Cardiac arrest
- □ Coma >24h
- □ Deep Vein Thrombosis
- □ Graft/prothesis/flap fail
- □ Myocardial infraction
- □ Pneumonia
- □ Respiratory failure
- □ Sepsis
- □ Septic shock
- □ Stroke/TIA
- □ SSI superficial/deep
- □ SSI organ space
- □ UTI
- □ Wound dehiscence

If NO operation was performed (by 3 months from study entry)

Is there **still** a plan for surgery? Yes | No

Why was no operation performed in the 3 months?
If still plan for surgery:
□ Patient choice to avoid surgery during pandemic
□ MDT decision to delay surgery due to risk to patient
□ Ongoing neoadjuvant treatment
□ No bed / intensive care space / theatre space
□ Change of recommendations in society guidelines related to COVID-19
□ Other:_____
If no ongoing plan for surgery:
□ Patient choice to avoid surgery during pandemic
□ MDT decision to delay surgery due to risk to patient
□ Disease progression, surgery no longer indicated
□ Change in clinical status unrelated to cancer e.g. MI
□ Died awaiting surgery
□ Change of recommendations in society guidelines
□ Other: _____

Has the cancer been **re-staged**? No | Yes
If so, date__/__/__

FIGO stage at time of reimaging/re-discussion by MDT or tumour board
Stage 0 | Stage 1 | Stage II | Stage III | Stage IV

Was there a response to neoadjuvant treatment?
Partial response | Complete response | Progression

Did any change to treatment occur due to the COVID-19 pandemic (non-operated patients)**?**
No change to care – delayed/cancelled other reason | Operation cancelled because of COVID-19 | Operation delayed because of COVID-19 | Change in Rx strategy | IR procedure before/instead of surgery, not typically indicated | Neodj treatment, not typically indicated | No Neoadj, typically indicated | Neoadj treatment longer than typical | Neoadj treatment shorter than typical | Less access to staging procedures | Less access to staging investigations | Other_____

Fotopoulou. Gynecologic cancer surgery during the COVID-19 pandemic. Am J Obstet Gynecol 2022.

SUPPLEMENTAL TABLE 1

Demographics of patients who underwent any operations (n = 3778)[a]

	Uterus (n=1751)	Ovary (n=1355)	Cervix (n=449)	Vulva/vagina (n=223)	Total (n=3778)
Age (y)					
17–19	1 (0.1)	12 (0.9)	0 (0)	0 (0)	13 (0.3)
20–29	7 (0.4)	60 (4.4)	23 (5.1)	4 (1.8)	94 (2.5)
30–39	53 (3.0)	106 (7.8)	121 (27.0)	7 (3.1)	287 (7.6)
40–49	172 (9.8)	246 (18.2)	142 (31.6)	22 (9.9)	582 (15.4)
50–59	460 (26.3)	362 (26.7)	96 (21.4)	48 (21.5)	966 (25.6)
60–69	539 (30.8)	353 (26.1)	37 (8.2)	47 (21.1)	976 (25.8)
70–79	409 (30.8)	179 (13.2)	26 (5.8)	56 (25.1)	670 (17.7)
80–89	106 (6.1)	37 (2.7)	4 (0.9)	37 (16.6)	184 (4.9)
>90	4 (0.2)	0 (0)	0 (0)	2 (0.9)	6 (0.2)
Region					
Europe & Central Asia	1078 (61.6)	756 (55.8)	268 (59.7)	177 (79.37)	2279 (60.3)
Latin America & Caribbean	196 (11.1)	174 (12.8)	81 (18.0)	17 (7.6)	467 (12.4)
East Asia & Pacific	178 (10.2)	141 (10.4)	50 (11.1)	4 (1.8)	373 (9.9)
South Asia	73 (4.2)	150 (11.1)	18 (4.0)	8 (3.6)	249 (6.6)
North America	142 (8.1)	65 (4.8)	20 (4.5)	10 (4.5)	237 (6.3)
Middle East & North Africa	79 (4.5)	65 (4.8)	4 (0.9)	5 (2.2)	153 (4.1)
Sub-Saharan Africa	6 (0.3)	4 (0.3)	8 (1.8)	2 (0.9)	20 (0.5)
Income group					
High	1351 (77.2)	914 (67.5)	317 (70.6)	186 (83.4)	2768 (73.3)
Upper middle	298 (17.0)	249 (18.4)	108 (24.1)	29 (13.0)	684 (18.1)
Low-middle	102 (5.8)	192 (14.2)	24 (5.4)	8 (3.6)	326 (8.6)
BMI (kg/m^2)					
<18.5	24 (1.4)	58 (4.3)	19 (4.2)	8 (3.6)	109 (2.9)
18.5–24.9	482 (27.5)	637 (47.0)	222 (49.4)	80 (35.9)	1421 (37.6)
25–29.9	520 (29.7)	393 (29.0)	125 (27.8)	71 (31.8)	1109 (29.4)
30–34.9	350 (20.0)	170 (12.6)	52 (11.6)	35 (15.7)	607 (16.1)
35–39.9	188 (10.7)	59 (4.4)	20 (4.5)	17 (7.6)	284 (7.5)
≥40	174 (9.9)	31 (2.3)	7 (1.6)	9 (4.0)	220 (5.8)
Not available	14 (0.8)	7 (0.5)	4 (0.9)	3 (1.4)	28 (0.7)
WHO performance status					
0	1045 (59.7)	815 (60.2)	380 (84.6)	130 (58.3)	2370 (62.7)
1	491 (28.0)	409 (30.2)	53 (11.8)	63 (28.3)	1016 (26.9)
2	115 (6.6)	87 (6.4)	4 (0.9)	19 (8.5)	225 (6.0)
3	18 (1.0)	11 (0.8)	0 (0)	4 (1.8)	33 (0.9)
4	1 (0.1)	1 (0.1)	0 (0)	2 (0.9)	4 (0.1)
Not available	81 (4.6)	32 (2.4)	12 (2.7)	5 (2.2)	130 (3.4)
CCI					
0	200 (11.4)	396 (29.2)	270 (60.1)	27 (12.1)	893 (23.6)
1	378 (21.6)	340 (25.1)	85 (18.9)	40 (17.9)	843 (22.3)

Fotopoulou. Gynecologic cancer surgery during the COVID-19 pandemic. Am J Obstet Gynecol 2022. *(continued)*

SUPPLEMENTAL TABLE 1

Demographics of patients who underwent any operations (n = 3778)[a] *(continued)*

	Uterus (n=1751)	Ovary (n=1355)	Cervix (n=449)	Vulva/vagina (n=223)	Total (n=3778)
2	477 (27.2)	317 (23.4)	35 (7.8)	41 (18.4)	870 (23.0)
3	398 (22.7)	199 (14.7)	36 (8.0)	46 (20.6)	679 (18.0)
4	196 (11.2)	64 (4.7)	13 (2.9)	37 (16.6)	310 (8.2)
5	71 (4.1)	28 (2.1)	1 (0.2)	19 (8.5)	119 (3.2)
6	23 (1.3)	7 (0.5)	6 (1.3)	5 (2.2)	41 (1.1)
7	4 (0.2)	2 (0.2)	1 (0.2)	6 (2.7)	13 (0.3)
8	3 (0.2)	1 (0.1)	1 (0.2)	2 (0.9)	7 (0.2)
9	1 (0.1)	1 (0.1)	1 (0.2)	0 (0)	3 (0.1)
ASA grade					
1	375 (21.4)	392 (28.9)	212 (47.2)	33 (14.8)	1012 (26.8)
2	991 (56.6)	729 (53.8)	199 (44.3)	131 (58.7)	2050 (54.3)
3	374 (21.4)	221 (16.3)	36 (8.0)	56 (25.1)	687 (18.2)
4	8 (0.5)	13 (1.0)	1 (0.2)	2 (0.9)	24 (0.6)
5	1 (0.1)	0 (0)	1 (0.2)	0 (0)	2 (0.1)
Not available	2 (0.1)	0 (0)	0 (0)	1 (0.5)	3 (0.1)
FIGO Stage					
Not cancer	57 (3.3)	76 (5.6)	57 (12.7)	21 (9.4)	211 (5.6)
1/2	1406 (80.3)	548 (40.4)	339 (75.5)	156 (70.0)	2449 (64.8)
3/4	255 (14.6)	712 (52.6)	53 (11.8)	40 (17.9)	1060 (28.1)
Not available	33 (1.9)	19 (1.4)	0 (0)	6 (2.7)	58 (1.5)
Histology					
SCC	22 (1.3)	31 (2.3)	310 (69.0)	188 (84.3)	551 (14.6)
Adenocarcinoma	1554 (88.8)	1030 (76.0)	118 (26.3)	9 (4.0)	2711 (71.8)
GCST	13 (0.7)	106 (7.8)	0 (0)	3 (1.4)	122 (3.2)
Other	137 (7.8)	34 (2.5)	7 (1.6)	17 (7.6)	195 (5.2)
Benign/preinvasive/borderline	21 (1.2)	129 (9.6)	14 (3.1)	4 (1.8)	168 (4.5)
Not available	4 (0.2)	25 (1.9)	0 (0)	2 (0.9)	31 (0.8)

Data are presented as total number (percentage). Details of operated vs non-operated group separately, are presented in Supplemental Tables 2 and 4.

ASA grade, American Society of Anaesthesiologists Physical Status Classification system; *BMI*, body mass index; *CCI*, Charlson Comorbidity Index; *FIGO*, International Federation of Gynaecology and Obstetrics; *GCST*, germ cell, sex cord stromal or trophoblastic tumors; *NACT*, neoadjuvant chemotherapy; *SCC*, squamous cell carcinoma; *WHO*, World Health Organization.

[a] Six patients (0.1%) did not have a recorded cancer site and were excluded from this table.

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SUPPLEMENTAL TABLE 2

Demographics of patients did not undergo any operations (n = 189)

	Uterus (n=60)	Ovary (n=104)	Cervix (n=13)	Vulva/vagina (n=12)	Total (n=189)
Age (y)					
17–19	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
20–29	0 (0)	5 (4.8)	1 (7.7)	0 (0)	6 (3.2)
30–39	3 (5.0)	7 (6.7)	1 (7.7)	0 (0)	11 (5.8)
40–49	3 (5.0)	19 (18.3)	2 (15.4)	0 (0)	24 (12.7)
50–59	13 (21.7)	18 (17.3)	3 (23.1)	4 (33.3)	38 (20.1)
60–69	15 (25.0)	27 (26.0)	5 (38.5)	2 (16.7)	49 (25.9)
70–79	12 (20.0)	19 (18.3)	1 (7.7)	2 (16.7)	34 (18.0)
80–89	13 (21.7)	9 (8.7)	0 (0)	4 (33.3)	26 (13.8)
>90	1 (1.7)	0 (0)	0 (0)	0 (0)	1 (0.5)
Region					
Europe & Central Asia	44 (73.3)	64 (61.5)	4 (30.8)	11 (91.7)	123 (65.1)
Latin America & Caribbean	6 (10.0)	6 (5.8)	4 (30.8)	1 (8.3)	17 (9.0)
East Asia & Pacific	0 (0)	0 (0)	3 (23.1)	0 (0)	3 (1.6)
South Asia	1 (1.7)	27 (26.0)	0 (0)	0 (0)	28 (14.8)
North America	5 (8.3)	2 (1.9)	0 (0)	0 (0)	7 (3.7)
Middle East & North Africa	2 (3.3)	5 (4.8)	0 (0)	0 (0)	7 (3.7)
Sub-Saharan Africa	2 (3.3)	0 (0)	2 (15.4)	0 (0)	4 (2.1)
Income group					
High	49 (81.7)	68 (65.4)	4 (30.8)	11 (91.7)	132 (69.4)
Upper middle	7 (11.7)	6 (5.8)	7 (53.9)	1 (8.3)	21 (11.1)
Low-middle	4 (6.7)	30 (28.9)	2 (15.4)	0 (0)	36 (19.1)
BMI (kg/m^2)					
<18.5	1 (1.7)	3 (2.9)	0 (0)	0 (0)	4 (2.1)
18.5–24.9	14 (23.3)	46 (44.2)	6 (46.2)	6 (50)	72 (38.1)
25–29.9	11 (18.3)	30 (28.9)	0 (0)	2 (16.7)	43 (22.8)
30–34.9	13 (21.7)	14 (13.5)	5 (38.5)	2 (16.7)	34 (18.0)
35–39.9	7 (11.7)	4 (3.9)	0 (0)	1 (8.3)	12 (6.4)
≥40	11 (18.3)	6 (5.8)	2 (15.4)	0 (0)	19 (10.1)
Not available	3 (5.0)	1 (1.0)	0 (0)	1 (8.3)	5 (2.7)
WHO Performance Status					
0	20 (33.3)	48 (46.2)	7 (53.9)	2 (16.7)	77 (40.7)
1	29 (48.3)	37 (35.6)	5 (38.5)	8 (66.7)	79 (41.8)
2	9 (15.0)	15 (14.4)	1 (7.7)	0 (0)	25 (13.2)
3	2 (3.3)	2 (1.9)	0 (0)	0 (0)	4 (2.1)
4	0 (0)	1 (1.0)	0 (0)	1 (8.3)	2 (1.1)
Not available	0 (0)	1 (1.0)	0 (0)	1 (8.3)	2 (1.1)
CCI					
0	5 (8.3)	31 (29.8)	4 (30.8)	0 (0)	40 (21.2)
1	9 (15.0)	16 (15.4)	1 (7.7)	2 (16.7)	28 (14.8)

Fotopoulou. Gynecologic cancer surgery during the COVID-19 pandemic. Am J Obstet Gynecol 2022. *(continued)*

SUPPLEMENTAL TABLE 2

Demographics of patients did not undergo any operations (n = 189) *(continued)*

	Uterus (n=60)	Ovary (n=104)	Cervix (n=13)	Vulva/vagina (n=12)	Total (n=189)
2	10 (16.7)	24 (23.1)	6 (46.2)	3 (25.0)	43 (22.8)
3	12 (20.0)	13 (12.5)	1 (7.7)	2 (16.7)	28 (14.8)
4	11 (18.3)	13 (12.5)	1 (7.7)	2 (16.7)	27 (14.3)
5	5 (8.3)	3 (2.9)	0 (0)	2 (16.7)	10 (5.3)
6	7 (11.7)	4 (3.9)	0 (0)	1 (8.3)	12 (6.4)
7	1 (1.7)	0 (0)	0 (0)	0 (0)	1 (0.5)
ASA grade					
1	6 (10.0)	25 (24.0)	4 (30.8)	1 (8.3)	36 (19.1)
2	22 (36.7)	57 (54.8)	6 (46.2)	6 (50.0)	91 (48.2)
3	28 (46.7)	19 (18.3)	3 (23.1)	5 (41.7)	55 (29.1)
4	1 (1.7)	2 (1.9)	0 (0)	0 (0)	3 (1.6)
5	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Not available	3 (5.0)	1 (1.0)	0 (0)	0 (0)	4 (2.1)
FIGO stage					
Not cancer	1 (1.7)	5 (4.8)	0 (0)	3 (25.0)	9 (4.8)
1/2	45 (75.0)	28 (26.9)	12 (92.3)	8 (66.7)	93 (49.2)
3/4	9 (15.0)	70 (67.3)	1 (7.7)	1 (8.3)	81 (42.9)
Not available	5 (8.3)	1 (1.0)	0 (0)	0 (0)	6 (3.2)
Histology					
SCC	0 (0)	0 (0)	13 (100.0)	10 (83.3)	23 (12.2)
Adenocarcinoma	57 (95.0)	86 (82.7)	0 (0)	0 (0)	143 (75.7)
GCST	0 (0)	4 (3.9)	0 (0)	0 (0)	4 (2.1)
Other	2 (3.3)	0 (0)	0 (0)	1 (8.3)	3 (1.6)
Benign/preinvasive/borderline	0 (0)	4 (3.9)	0 (0)	1 (8.3)	5 (2.7)
Not available	1 (1.7)	10 (9.6)	0 (0)	0 (0)	11 (5.8)

Data presented as total number (percentage) unless stated otherwise.

ASA grade, American Society of Anaesthesiologists Physical Status Classification system; *BMI*, body mass index; *CCI*, Charlson Comorbidity Index; *FIGO*, International Federation of Gynaecology and Obstetrics; *GCST*, germ cell, sex cord stromal or trophoblastic tumors; *NACT*, neoadjuvant chemotherapy; *SCC*, squamous cell carcinoma; *WHO*, World Health Organization.

Fotopoulou. Gynecologic cancer surgery during the COVID-19 pandemic. Am J Obstet Gynecol 2022.

SUPPLEMENTARY TABLE 3

Summary of pandemic-related changes in care and outcomes at the last follow-up in non-operated patients by cancer type (n = 189)

	Uterus (n=60)	Ovary (n=104)	Cervix (n=13)	Vulva/vagina (n=12)	Total (n=189)	*P* value
Did not have surgery owing to the pandemic	50 (83.3)	87 (83.7)	10 (76.9)	11 (91.7)	158 (83.6)	.802
Operation cancelled owing to the pandemic	9 (15.0)	11 (10.6)	2 (15.4)	1 (8.3)	23 (12.2)	.804
Postponed owing to the pandemic	28 (46.7)	62 (59.6)	8 (61.5)	6 (50.0)	104 (55.0)	.403
Changed to nonsurgical treatment	9 (15.0)	9 (8.7)	3 (23.1)	2 (16.7)	23 (12.2)	.344
Managed by interventional radiologists	1 (1.7)	1 (1.0)	0 (0)	0 (0)	2 (1.1)	.921
Received neoadjuvant treatment	5 (8.3)	18 (17.3)	2 (15.4)	1 (8.3)	26 (13.8)	.404
Neoadjuvant treatments not given	3 (5.0)	3 (2.9)	0 (0)	0 (0)	6 (3.2)	.683
Longer neoadjuvant treatments	1 (1.7)	15 (14.4)	0 (0)	0 (0)	16 (8.5)	.014
Shorter neoadjuvant treatments	1 (1.7)	2 (1.9)	0 (0)	0 (0)	3 (1.6)	.923
Limited access to staging procedure	0 (0)	5 (4.8)	0 (0)	0 (0)	5 (2.7)	.241
Limited access to staging investigations	0 (0)	2 (1.9)	0 (0)	0 (0)	2 (1.1)	.648
Mortality	2 (3.3)	3 (2.9)	0 (0)	0 (0)	5 (2.7)	.846
Composite[a]	6 (10.0)	21 (20.2)	5 (38.5)	2 (16.7)	34 (18.0)	.084

Data presented as total number (percentage). Multiple changes were reported for each patient when appropriate.

[a] A composite outcome of unresectable disease or disease progression, emergency surgery and death.

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SUPPLEMENTAL TABLE 4

Complication rates by COVID-19 status of patients who have received any operations (n = 3784)

	Uninfected (n=3762)	COVID-19 (n=22)	*P* value
Cancer site			
Uterus	1774 (46.4)	7 (31.8)	.087
Ovary	1341 (35.7)	14 (63.6)	
Cervix	448 (11.9)	1 (4.6)	
Vulva/vagina	223 (5.9)	0 (0)	
Age (y)			
17–19	13 (0.4)	0 (0)	.266
20–29	92 (2.5)	2 (9.1)	
30–39	288 (7.7)	0 (0)	
40–49	581 (15.4)	3 (13.6)	
50–59	962 (25.6)	4 (18.2)	
60–69	974 (25.9)	4 (18.2)	
70–79	664 (17.7)	7 (31.8)	
80–89	182 (4.8)	2 (9.1)	
>90	6 (0.2)	0 (0)	
BMI (kg/m^2)			
<18.5	107 (2.8)	2 (9.1)	.257
18.5–24.9	1413 (37.6)	10 (45.5)	
25–29.9	1105 (29.4)	7 (31.8)	
30–34.9	608 (16.2)	0 (0)	
35–39.9	283 (7.5)	1 (4.6)	
≥40	218 (5.8)	2 (9.1)	
Not available	28 (0.7)	0 (0)	
WHO Performance Status			
0	2364 (62.8)	7 (31.8)	.003
1	1006 (26.7)	10 (45.5)	
2	220 (5.9)	5 (22.7)	
3	33 (0.9)	0 (0)	
4	4 (0.1)	0 (0)	
Not available	135 (3.6)	0 (0)	
CCI			
0	891 (23.7)	5 (22.7)	.097
1	841 (22.4)	2 (9.1)	
2	869 (23.1)	2 (9.1)	
3	672 (17.9)	7 (31.8)	
4	308 (8.2)	3 (13.6)	
5	117 (3.1)	3 (13.6)	
6	41 (1.1)	0 (0)	
7	13 (0.4)	0 (0)	

Fotopoulou. Gynecologic cancer surgery during the COVID-19 pandemic. Am J Obstet Gynecol 2022. (continued)

SUPPLEMENTAL TABLE 4

Complication rates by COVID-19 status of patients who have received any operations (n = 3784) *(continued)*

	Uninfected (n=3762)	COVID-19 (n=22)	*P* value
8	7 (0.2)	0 (0)	
9	3 (0.1)	0 (0)	
ASA grade			
1	1006 (26.7)	6 (27.3)	.177
2	2046 (54.4)	8 (36.4)	
3	681 (18.1)	7 (31.8)	
4	23 (0.6)	1 (4.6)	
5	2 (0.1)	0 (0)	
Not available	4 (0.2)	0 (0)	
FIGO stage			
Not cancer	2442 (64.9)	11 (50.0)	.315
1/2	1050 (27.9)	10 (45.5)	
3/4	59 (1.6)	0 (0)	
Not available	211 (5.6)	1 (4.6)	
Surgery performed			
Pelvis/perineal	2609 (69.4)	15 (68.2)	.884
Midabdominal	558 (14.8)	4 (18.2)	
Upper-abdominal	318 (8.5)	1 (4.6)	
Others	277 (7.4)	2 (9.1)	
Bowel surgery			
No	3633 (96.6)	18 (81.8)	<.0001
Yes	129 (3.4)	4 (18.2)	
Approach			
Open	2335 (62.1)	18 (81.8)	.178
Minimally-invasive	1339 (35.6)	3 (13.6)	
Converted	83 (2.2)	1 (4.6)	
Not available	5 (0.1)	0 (0)	
Postoperative stay (d)	4 (2–6)	8.5 (5–17)	.0001
Postoperative complication			
Any complications	717 (19.1)	14 (63.6)	<.0001
Respiratory complications	52 (1.4)	6 (27.3)	<.0001
Wound infection	164 (4.4)	4 (18.2)	.002
Hemorrhage[a]	129 (3.4)	2 (9.1)	.147
Ileus	86 (2.3)	3 (13.6)	<.0001
Urinary tract infection	74 (2.0)	3 (13.6)	<.0001
Wound dehiscence	69 (1.8)	2 (9.1)	.012
Sepsis	34 (0.9)	3 (13.6)	<.0001
Thromboembolism	30 (0.8)	0 (0)	.674
Kidney injury	27 (0.72)	1 (4.6)	.037

Fotopoulou. Gynecologic cancer surgery during the COVID-19 pandemic. Am J Obstet Gynecol 2022. *(continued)*

SUPPLEMENTAL TABLE 4

Complication rates by COVID-19 status of patients who have received any operations (n = 3784) *(continued)*

	Uninfected (n=3762)	COVID-19 (n=22)	*P* value
Other organ injury	24 (0.6)	1 (4.6)	.024
Anastomosis leak	7 (0.2)	1 (4.6)	<.0001
Cardiac arrest	8 (0.2)	0 (0)	.829
Myocardial infarction	4 (0.1)	0 (0)	.878
Stroke	3 (0.1)	0 (0)	.895
Other complications	233 (6.2)	4 (18.2)	.021
Mortality	26 (0.7)	4 (18.2)	<.0001

Data are presented as total number (percentage) or mean (interquartile range). For postoperative outcomes, data were collected at 30 days after the surgeries.

ASA grade, American Society of Anaesthesiologists Physical Status Classification system; *BMI*, body mass index; *CCI*, Charlson Comorbidity Index; *FIGO*, International Federation of Gynaecology and Obstetrics; *WHO*, World Health Organization.

[a] Haemorrhage requiring blood transfusion.

Fotopoulou. Gynecologic cancer surgery during the COVID-19 pandemic. Am J Obstet Gynecol 2022.

SUPPLEMENTAL TABLE 5

Comparisons of patients and outcomes who have received any operations by length of stay (<14 days vs ≥14 days; n = 3772)[a]

	<14 d (n=3595)	≥14 d (n=177)	Proportion ≥14 d	*P* value
Age (y)				
17–19	13 (0.4)	0 (0)	0/13 (0)	.034
20–29	92 (2.6)	2 (1.1)	2/94 (2.1)	
30–39	281 (7.8)	7 (4.0)	7/288 (2.4)	
40–49	563 (15.7)	21 (11.9)	21/584 (3.6)	
50–59	929 (25.8)	37 (20.9)	37/966 (3.8)	
60–69	919 (25.7)	56 (31.6)	56/975 (5.7)	
70–79	622 (17.3)	43 (24.3)	43/665 (6.5)	
80–89	170 (4.7)	11 (6.2)	11/181 (6.1)	
>90	6 (0.2)	0 (0)	0/6 (0)	
Income group				
High	2634 (73.3)	129 (72.9)	129/2763 (4.7)	.888
Upper middle	652 (18.1)	31 (17.5)	31/683 (4.5)	
Low-middle	309 (8.6)	17 (9.6)	17/326 (5.2)	
BMI (kg/m^2)				
<18.5	100 (2.8)	9 (5.1)	9/109 (8.3)	.164
18.5–24.9	1349 (37.5)	73 (41.2)	73/1422 (5.1)	
25–29.9	1058 (29.4)	52 (29.4)	52/1110 (4.7)	
30–34.9	579 (16.1)	27 (15.3)	27/606 (4.5)	
35–39.9	276 (7.7)	6 (3.4)	6/282 (2.1)	
≥40	211 (5.9)	8 (4.5)	8/219 (3.7)	
Not available	22 (0.6)	2 (1.1)	2/24 (8.3)	
WHO performance status				
0	2293 (63.8)	75 (42.4)	75/2368 (3.2)	<.0001
1	947 (26.3)	61 (34.5)	61/1008 (6.1)	
2	193 (5.4)	31 (17.5)	31/224 (13.8)	
3	28 (0.8)	5 (2.8)	5/33 (15.2)	
4	3 (0.1)	1 (0.6)	1/4 (25)	
Not available	131 (3.6)	4 (2.3)	4/135 (3.0)	
CCI				
0	869 (24.2)	27 (15.3)	27/896 (3.0)	.001
1	815 (22.7)	28 (15.8)	28/843 (3.3)	
2	819 (22.8)	49 (27.7)	49/868 (5.7)	
3	638 (17.8)	37 (20.9)	37/675 (5.5)	
4	288 (8.0)	21 (11.9)	21/309 (6.8)	
5	109 (3.0)	9 (5.1)	9/118 (7.6)	
6	36 (1.0)	4 (2.3)	4/40 (10)	
7	13 (0.4)	0 (0)	0/13 (0)	
8	6 (0.2)	1 (0.6)	1/6 (14.3)	

Fotopoulou. Gynecologic cancer surgery during the COVID-19 pandemic. Am J Obstet Gynecol 2022. *(continued)*

SUPPLEMENTAL TABLE 5

Comparisons of patients and outcomes who have received any operations by length of stay (<14 days vs ≥14 days; n = 3772)[a] *(continued)*

	<14 d (n=3595)	≥14 d (n=177)	Proportion ≥14 d	*P* value
9	2 (0.1)	1 (0.6)	1/2 (33.3)	
ASA grade				
1	980 (27.3)	31 (17.5)	31/1011 (3.1)	<.0001
2	1957 (54.4)	89 (50.3)	89/2046 (4.4)	
3	632 (17.6)	53 (29.9)	53/685 (7.7)	
4	21 (0.6)	3 (1.7)	3/24 (12.5)	
5	2 (0.1)	0 (0)	0/2 (0)	
Not available	3 (0.1)	1 (0.6)	1/4 (25)	
Cancer site				
Uterus	1709 (47.5)	34 (19.2)	34/1743 (2.0)	<.0001
Ovary	1249 (34.7)	104 (58.8)	104/1353 (7.7)	
Cervix	428 (11.9)	21 (11.9)	21/449 (4.7)	
Vagina/vulva	203 (5.7)	18 (10.2)	18/221 (8.1)	
Not available	6 (0.2)	0 (0)	0/6 (0)	
FIGO stage				
Not cancer	205 (5.7)	6 (3.4)	6/211 (2.8)	<.0001
1 or 2	2384 (66.3)	59 (33.3)	59/2443 (2.4)	
3 or 4	947 (26.3)	112 (63.3)	112/1059 (10.6)	
Not available	59 (1.6)	0 (0)	0/59 (0)	
Lockdown stringency				
Full	1819 (50.6)	91 (51.4)	91/1910 (4.8)	.006
Moderate	846 (23.5)	57 (32.2)	57/903 (6.3)	
Light	829 (23.1)	28 (15.8)	28/857 (3.3)	
COVID-19 burden				
High burden	2557 (71.1)	90 (50.9)	90/2647 (3.4)	<.0001
Low burden	961 (26.7)	87 (49.2)	87/1048 (8.3)	
Not available	77 (2.1)	0 (0)	0/77 (0)	
Surgery performed				
Pelvis/perineal	2521 (70.1)	93 (52.5)	93/2614 (3.6)	<.0001
Midabdominal	523 (14.6)	39 (22.0)	39/562 (6.9)	
Upper-abdominal	304 (8.5)	15 (8.5)	15/319 (4.7)	
Others	247 (6.9)	30 (17.0)	30/277 (10.8)	
Bowel surgery				
No	3494 (97.2)	145 (81.9)	145/3639 (4.0)	<.0001
Yes	101 (2.8)	32 (18.1)	32/133 (24.1)	
Approach				
Open	2190 (60.9)	159 (89.8)	159/2349 (6.8)	<.0001
Minimally-invasive	1324 (36.8)	11 (6.2)	11/1335 (0.8)	
Converted	76 (2.1)	7 (4.0)	7/83 (8.4)	

Fotopoulou. Gynecologic cancer surgery during the COVID-19 pandemic. Am J Obstet Gynecol 2022. *(continued)*

SUPPLEMENTAL TABLE 5

Comparisons of patients and outcomes who have received any operations by length of stay (<14 days vs ≥14 days; n = 3772)[a] *(continued)*

	<14 d (n=3595)	≥14 d (n=177)	Proportion ≥14 d	*P* value
Not available	5 (0.1)	0 (0)	0/5 (0)	
Postoperative complication				
Any complications	608 (16.9)	120 (67.8)	120/728 (16.5)	<.0001
Respiratory complications	35 (1.0)	23 (13.0)	23/58 (39.7)	<.0001
Mortality	20 (0.6)	10 (5.7)	10/30 (33.3)	<.0001

Data presented as total number (percentage) or proportion (percentage).

ASA grade, American Society of Anaesthesiologists Physical Status Classification system; *BMI*, body mass index; *CCI*, Charlson Comorbidity Index; *FIGO*, International Federation of Gynaecology and Obstetrics; *WHO*, World Health Organization.

[a] Twelve patients (0.32%) did not have recorded length of stay. For postoperative outcomes, data were collected at 30 days after the operations.

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