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# Gynecologic oncology treatment modifications or delays in response to the COVID-19 pandemic in a publicly funded versus privately funded North American tertiary cancer center

Sabrina Piedimonte<sup>a</sup>, Sue Li<sup>b</sup>, Stephane Laframboise<sup>a,c</sup>, Sarah E. Ferguson<sup>a,c</sup>, Marcus Q. Bernardini<sup>a,c</sup>, Genevieve Bouchard-Fortier<sup>a,c</sup>, Liat Hogen<sup>a,c</sup>, Paulina Cybulska<sup>a,c</sup>, Michael J. Worley Jr<sup>b</sup>, Taymaa May<sup>a,c,\*</sup>

<sup>a</sup> Division of Gynecologic Oncology, Department of Surgical Oncology, Princess Margaret Cancer Center, University of Toronto, Toronto, ON, Canada

<sup>b</sup> Division of Gynecologic Oncology, Brigham and Women's Hospital, Dana Farber Cancer Institute, Boston, MA, USA

<sup>c</sup> Department of Obstetrics and Gynecology, University of Toronto, Toronto, ON, Canada

## HIGHLIGHTS

- COVID-19 treatment modifications were more prevalent in a Canadian versus American cancer center
- Cases with higher surgical-oncologic priority levels were 80% less like to undergo treatment modifications
- Black race and uterine disease were independent factors associated with treatment modification
- The impact of the pandemic related oncologic treatment modifications on survival is yet to be determined

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## ABSTRACT

**Objective.** To compare gynecologic oncology surgical treatment modifications and delays during the first wave of the COVID-19 pandemic between a publicly funded Canadian versus a privately funded American cancer center.

**Methods.** This is a retrospective cohort study of all planned gynecologic oncology surgeries at University Health Network (UHN) in Toronto, Canada and Brigham and Women's Hospital (BWH) in Boston, USA, between March 22, 2020 and July 30, 2020. Surgical treatment delays and modifications at both centers were compared to standard recommendations. Multivariable logistic regression was performed to adjust for confounders.

**Results.** A total of 450 surgical gynecologic oncology patients were included; 215 at UHN and 235 at BWH. There was a significant difference in median time from decision-to-treat to treatment (23 vs 15 days,  $p < 0.01$ ) between UHN and BWH and a significant difference in treatment delays (32.56% vs 18.29%;  $p < 0.01$ ) and modifications (8.37% vs 0.85%;  $p < 0.01$ ), respectively.

On multivariable analysis adjusting for age, race, treatment site and surgical priority status, treatment at UHN was an independent predictor of treatment modification (OR = 9.43, 95% CI 1.81–49.05,  $p < 0.01$ ). Treatment delays were higher at UHN (OR = 1.96, 95% CI 1.14–3.36  $p = 0.03$ ) and for uterine disease (OR = 2.43, 95% CI 1.11–5.33,  $p = 0.03$ ).

**Conclusion.** During the first wave of COVID-19 pandemic, gynecologic oncology patients treated at a publicly funded Canadian center were 9.43 times more likely to have a surgical treatment modification and 1.96 times more likely to have a surgical delay compared to an equal volume privately funded center in the United States.

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## 1. Introduction

During the unprecedented times of the COVID-19 pandemic, resource utilization has focused on the care of patients with COVID-

related disease requiring intensive care unit (ICU) beds, ventilators, anesthesiologists, and respiratory therapists, resulting in the cancellation of elective surgeries and reduction of operating room capacity in many jurisdictions [1]. Oncologic surgery was deemed essential and was often among the last services to be cancelled [2]. Modelling studies predict that as many as 13,000 people could be affected by a delay in oncologic surgery in the first 3 months of the pandemic, and delays in cancer surgeries beyond 6 weeks can affect long-term oncologic outcomes for these

\* Corresponding author at: Division of Gynecologic Oncology, Princess Margaret Cancer Centre, 610 University Avenue, OPG Wing, 6-811, Toronto, ON M5G 2M9, Canada.  
E-mail address: [Taymaa.May@uhn.ca](mailto:Taymaa.May@uhn.ca) (T. May).

patients [3]. In addition, oncology patients may be at higher risk of developing moderate or severe COVID-19 infection if exposed in a hospital setting, due to increased age, comorbidities (cardiovascular disease, pulmonary disease, diabetes), Eastern Cooperative Oncology Group (ECOG) >2, immunocompromise due to chemotherapy, thus potentially adding further delays to surgery and access to chemotherapy [1,4].

In Canada, provincial and national guidance to lower operating room capacities, and limit intensive care (ICU) admissions have precluded gynecologic oncologists from providing oncologic surgery within the usually recommended treatment timelines and as per evidence-based practice [1,5]. This has led to important modifications in practice and prioritization as to which patients need urgent surgery as compared to alternative therapies within the available resources [1]. Surgeries have been prioritized based on Canadian and regional gynecologic oncology guidelines and has led to a number of surgeries being cancelled or delayed [1,5,6]. In the province of Ontario, between March 15, 2020–October 25, 2020, there was a 19% overall decrease in surgical oncology volumes compared to the same time period the previous year (March 17, 2019–Oct 17, 2019). Surgeries for gynecologic malignancies decreased by 8% in the province of Ontario as compared to the previous year. In the US, based on a nationwide registry analysis of surgical procedures performed in academic and private hospitals across 21 states, there was a 57% median per week reduction in case volume between March 16 and May 31, 2020 compared to the same weeks in 2019. In addition, there was great variability noted across institutions with *per-institution* median weekly reductions ranging from 33% to 72% [7].

The primary objective of this study is to determine differences in treatment delays and modifications in surgical gynecologic oncology cases during the first wave of the COVID-19 pandemic between a large-volume publicly funded Canadian cancer center as compared to a privately funded American cancer center.

## 2. Methods

This is a retrospective cohort study comparing surgical delays and treatment modifications in all patients with gynecologic malignancy treated at University Health Network (UHN) in Toronto, Ontario and Brigham and Women's Hospital (BWH) in Boston, Massachusetts. This study received institutional research ethics board approval from both institutions.

### 2.1. Patient selection: inclusion and exclusion criteria

All patients aged 18 years and older with a gynecologic malignancy or suspicion of gynecologic malignancy (ovarian, endometrial, uterine, cervical, vulvar, vaginal) and planned for surgical intervention between March 2, 2020 and July 30, 2020 were included in the present study. Patients under 18, non-surgical intent or management with primary chemotherapy or radiotherapy, patient referrals for benign disease or for a non-surgical second opinion were excluded.

### 2.2. Treatment decisions

On March 25, 2020, all previously scheduled elective surgeries at UHN were cancelled from the operative system booking and the operating room capacity was decreased by 90% to 10% capacity. Procedures for malignancy were scheduled based on a newly developed clinical priority system. Prioritization of surgical oncology cases were done based on institutional, provincial and national guidelines for each disease site [1]. The Gynecologic Oncology Society of Canada (GOC) recommended surgery within 14–28 days of decision-to-treat date for: high risk endometrial adenocarcinoma (grade 3 endometrioid serous, clear cell, or carcinosarcoma), uterine sarcoma, stage IB1 or IB2 cervical cancer, early stage ovarian cancer, late stage chemo-resistant ovarian cancer (low-grade serous, clear cell, endometrioid or mucinous carcinoma), interval cytoreductive surgery for advanced ovarian cancer following a

maximum of 5 cycles of neoadjuvant chemotherapy (NACT), vulvar carcinomas and Gestational Trophoblastic Neoplasia [1]. Worrisome pelvic masses with increased tumour markers and peritoneal carcinomatosis not amenable to biopsy should proceed with surgery within 28 days. A pelvic mass with normal tumour markers, grade 1 endometrial cancer and stage 1a1–1a2 cervical cancers should be treated between 28 and 56 days. Advanced high-grade serous or high-grade endometrioid ovarian cancers were treated with neoadjuvant chemotherapy as opposed to primary cytoreductive surgery. The standard Cancer Care Ontario (CCO)-Ontario Health (OH) wait times from decision-to-treat to surgical procedures are as follows: for an assigned priority 2 case is 14 days, priority 3 is 28 days and priority 4 is 84 days [5] and were used as the UHN priority categories. The Division of Gynecologic Oncology at UHN met weekly to assign new pandemic priorities for all surgical cases based on the above recommendations, diagnosis and patient characteristics to ensure that patients were treated within the modified pandemic timeframe (Supplement 1).

As of April 30, 2020 at BWH, surgeons were asked to identify all cases that could be delayed for 30 days. As of May 4, 2020, all elective surgeries were cancelled. Procedures for malignancy and concern for malignancy were allowed to be scheduled based on clinical priority. BWH/DFCI leadership developed criteria for clinical prioritization. Criteria were developed based on local resources and a review of guidelines set forth by the Society of Gynecologic Oncology (SGO) [6]. Priority 1 included cases that should be completed within 14 days. Priority 2 included cases that should be completed within 42 days. Priority 3 included cases that should be completed between specific dates (e.g. patients undergoing neoadjuvant chemotherapy). Priority 4 included cases that were not time sensitive. The Division of Gynecologic Oncology met weekly to assign priority for all surgical cases based on diagnosis and patient characteristics.

### 2.3. Data collection

Data was collected in a retrospective fashion using each institution's individual electronic medical records. Patients were identified from surgical and Multidisciplinary Cancer Conference (MCC) lists. The following demographic parameters were collected: age, ethnicity, disease site, date of referral to gynecologic oncology, and date of first consultation by a gynecologic oncologist. Delays from referral to consultation were calculated by subtracting the time from referral to initial consult. The decision-to-treat date was defined as the time a surgical decision was made and documented, either at ambulatory clinic visit or at an MCC consensus visit. The date of the treatment received during the pandemic was recorded and subtracted from the decision-to-treat date. The time to treatment was subtracted from the recommended wait times based on CCO priority levels for the UHN cohort (p1, p2, p3, p4) and based on the Brigham and Women's Hospital wait Times for the BWH cohort.

Treatment delays were calculated by subtracting the time from decision-to-treat to the respective institutional recommended wait time based on the priority status as defined above; crude numbers and ranges were reported only for patients that had a positive delay (ie patients who had treatment beyond the recommended time frame). When reporting the percentage of treatment delays, we only considered a significant delay as anything beyond 14 days from the recommended treatment time. This was done to avoid overestimating the number of delays in patients were treated 1 or 2 days outside of the recommended time frame, which may have been due to chance. We used 14 days as this was felt to be clinically significant and also how Bogani et al. reported their significant treatment delays due to the pandemic [8].

We also noted if there were any treatment modifications, the type modification including NACT in lieu of Primary cytoreductive surgery (PCS) for advanced ovarian cancer, hormonal treatment instead of surgery for low-grade endometrial cancer, additional cycles

of chemotherapy for patients receiving neoadjuvant chemotherapy prior to interval cytoreductive surgery, different chemotherapy regimen or different systemic agent from the institutional standard of care protocol), the reason, delays, date and result of screening COVID test, date and result of diagnostic COVID test and if there were treatment delays from COVID positive status. The primary outcome was the number of patients who had delays or modifications secondary to the COVID-19 pandemic, the median time to treatment and whether there were significant differences between the two cohorts. The secondary outcome was to perform an adjusted analysis of risk factors influencing surgical modifications and delays of treatments.

#### 2.4. Data analysis

Data was analyzed using Stata 16.0. Descriptive statistics of patient demographics are reported in Table 1. Medians were reported for continuous variables and were compared using Wilcoxon Rank sum test and categorical variables were compared using chi square for significance. Univariable logistic regression was performed to determine odds ratios for treatment modifications and delays based on the following risk factors: age, cohort, race, tumour site, and surgical priority status. Adjusted odds ratios were calculated using multivariable logistic regression. For treatment modifications and delays, we selected the model which had the best AIC (Akaike Information Criterion).

### 3. Results

This study evaluated the treatment delays and modifications of 450 surgical gynecologic oncology patients treated during the study period

**Table 1**  
Demographic parameters of surgical gynecologic oncology patients treated between March 2, 2020 and July 30, 2020.

	UHN N = 215 (%)	BWH N = 235 (%)	P-Value Significance
Median Age (range)	58 (25–90)	61 (23–94)	0.11
Ethnicity			0.09
Caucasian	130 (60.47)	214 (91.06)	
African American	8 (3.72)	2 (0.85)	
Hispanic	26 (12.09)	14 (5.96)	
Asian	11 (5.12)	2 (0.85)	
Unknown	40 (18.60)	3(1.28)	
<b>Disease Site</b>			<b>0.04</b>
Ovary/FT/Peritoneum	116 (53.90)	106 (45.11)	
Uterus	73 (33.90)	82 (34.89)	
Vulva	10 (4.90)	28 (11.91)	
Cervix	15 (6.98)	16 (6.81)	
Vagina	0 (0)	2 (0.85)	
GTN	0 (0)	1 (0.43)	
<b>Type of surgery</b>			<b>&lt;0.01</b>
TAH/BSO+/- debulking	91 (42.32)	64 (27.23)	
MIS hysterectomy /BSO/SLND	66 (30.69)	58 (24.68)	
Radical hysterectomy			
Vulvectomy/WLE	5 (2.33)	2 (0.85)	
BSO/USO	5 (2.33)	23 (9.79)	
Other	16 (7.44)	38 (16.17)	
	31 (14.44)	50 (21.27)	
<b>Priority Category<sup>a</sup></b>			<b>&lt;0.01</b>
<b>1</b> (UHN urgent/BWH 14 d)	0	220 (93.62)	
<b>2</b> (UHN 14 d/BWH 42 d)	98 (45.58)	12 (5.12)	
<b>3</b> (UHN 28 d/BWH between 2 treatments)	104 (48.37)	1 (0.43)	
<b>4</b> (UHN 84 d/BWH no time)	13 (6.05)	2 (0.85)	

Bold numbers indicate statistically significant values. Abbreviations: UHN: United Health Network, BWH: Brigham and Women's Hospital, FT: fallopian tube, GTN: gestational trophoblastic neoplasia, TAH: Total Abdominal Hysterectomy, TLH: Total laparoscopic hysterectomy, BSO: bilateral salpingo-oophorectomy, MIS: minimally invasive surgery, WLE: wide local excision, USO: unilateral salpingo-oophorectomy. d:days.

<sup>a</sup> BWH P1 is equivalent in priority days to UHN P2.

of March 2, 2020 and July 30, 2020, corresponding to the 1st wave of the COVID-19 pandemic at two high volume academic centers. There were 215 patients included from UHN and 235 patients from BWH with similar inclusion criteria.

Patient demographics are displayed in Table 1. The median age of patients was 58 years old (range 25–90) in the UHN cohort and 61 (range 23–94) in the BWH cohort, ( $p = 0.11$ ). There was no significant difference in ethnicity. Primary site of disease was as follows: ovary 53.95% vs 45.1%, uterus 33.95% vs 34.9%, vulva 4.65% vs 11.9%, cervix 6.97% vs 6.8% in the UHN vs BWH cohorts, respectively. There was a higher proportion of cytoreductive surgeries performed at UHN and a higher proportion of vulvectomies and bilateral salpingo-oophorectomies (BSOs) at BWH.

There was no significant difference between the 2 cohorts in terms of median time to initial consultation (Table 2): 11 days (range 1–144) and UHN and 10 (range 1–51) at BWH;  $p = 0.47$ . The time from decision-to-treat to treatment was longer in the UHN cohort with a median of 23 days in the UHN cohort (range 1–146 days) vs 15 days in the BWH cohort (range 1–205);  $p < 0.01$ . There was a higher proportion of treatment delays (32.56% vs 18.29%;  $p < 0.01$ ) and treatment modifications (8.37% vs 0.85%,  $p < 0.01$ ) at UHN as compared to BWH. In terms of surgical priority status, at UHN, most cases (48%) were priority 3 (within 28 days) while at BWH most cases (93.62%) were priority 1 (within 14 days). The proportion of cases with priority within 14 days was higher at BWH, 93.62% vs 46% at UHN (Table 1).

On univariable analysis, patients who were treated at UHN (OR 10.64, 95% CI 2.44–46.44,  $p < 0.01$ ), were of black race (OR 6.83, 1.32–35.21,  $p = 0.02$ ), or had uterine disease (OR = 3.00, 1.19–7.5,  $p = 0.01$ ) were more likely to have treatment modifications (Table 3). Patients with a surgical priority status of <14 days were less likely to have a treatment modification (OR 0.20, 95% CI 0.08–0.52,  $p < 0.01$ ). Patients who were treated at UHN (OR 2.17, 95% CI 1.4–3.4) and patients who had uterine disease (OR 2.12 95% CI 0.48–1.16,  $p = 0.76$ ) were more likely to have treatment delays (Table 3). Ovarian disease was protective against treatment delays at both sites (OR 0.63, 95% CI: 0.4–0.98,  $p = 0.04$ ) (Table 3). When adjusting for age, race, primary disease site, treatment center and priority status in multivariable analysis, treatment at UHN (OR = 1.96, 1.14–3.36,  $p = 0.02$ ) and primary uterine disease (OR = 2.43, 1.11–5.33, 0.03) were factors that contributed to significant treatment delays, while treatment at UHN was an independent prognostic factor for treatment modifications (OR = 9.43, 95% CI 1.81–49.05,  $p < 0.01$ ) (Tables 4 and 5).

In addition, the proportion of treatment delays decreased over time at both institutions based on decision to treat date and most of the delayed patients received their treatment at a peak time in May (Fig. 1).

Due to delays at UHN, 1 patient declined surgery after the delay, 2 patients were operated on at another center and 3 patients had additional cycles of NACT prior to surgery. Five patients with advanced ovarian cancer who were candidates for PCS had treatment modification and received NACT due to the pandemic; one of these patients developed a pulmonary embolus during NACT which contributed to further delays. The majority of surgical delays at UHN were in priority 4 surgeries (<84 days) including 8 grade 1 endometrial cancers and 8 ileostomy reversals. Most of the treatment modifications were in patients receiving hormonal therapy for low grade endometrial cancer in the UHN and BWH cohorts while awaiting surgery (Table 2). Three patients in priority 3 category (<28 days) with advanced ovarian cancer who were treated with NACT were treated with additional chemotherapy cycles (up to five) and also experienced delays in scheduling of their interval cytoreductive surgeries. In addition, two patients self-delayed their initial work-up due to fears of COVID-19.

Two patients in the UHN cohort had treatment modifications due to COVID positive status. One patient with uterine leiomyosarcoma with initial plan for surgery due to vaginal bleeding and uterine rupture tested positive for COVID-19 in the gynecologic oncology ambulatory clinic at her initial consultations. She was admitted to hospital with

**Table 2**  
Treatment effects during the COVID pandemic between March 2, 2020 and July 30, 2020.

	UHN n = 215 (%)	BWH n = 235 (%)	P-Value Significance
Median time from referral to first consultation, days (range)	11 (1–144)	10 (1–51)	0.47
Median time from decision to treat to treatment, days (range)	23 (1–146)	15 (1–205)	<b>&lt;0.01</b>
Treatment Delays (%)	70 (32.56)	43 (18.29)	<b>&lt;0.01</b>
Median delays in days compared to recommended wait time	13 (0–120)	10 (0–115)	0.25
Treatment modifications (%)	18 (8.37)	2 (0.85)	<b>&lt;0.01</b>
-NACT rather than PCS	5 (21.0)	0 (0)	-
-Hormonal treatment awaiting surgery	8 (3.72)	1 (0.43)	
-Additional cycles of neoadjuvant chemotherapy			
-Declined surgery after delay	3 (0.93)	1 (0)	
-Radiation instead of surgery			
	1 (0.47)	0	
	1 (0.47)	0	
COVID-19 +	2 (0.93)	0 (0)	0.20
% COVID-19 screened	185 (86.04)	163 (69.36)	<b>&lt;0.01</b>

Bolded numbers indicate statistically significant values.

UHN: University Health Network; BWH: Brigham and Women's Hospital; NACT: neoadjuvant chemotherapy, PCS: primary cytoreductive surgery.

COVID-induced pneumonia. During the admission, she had poor functional status and received Total Parenteral Nutrition (TPN) for 2 months. Given the poor functional status she was no longer a candidate for primary surgery and received primary radiation treatment instead. The second patient was diagnosed with advanced high grade serous ovarian cancer in March 2020 and scheduled to receive neoadjuvant chemotherapy but had a one-month delay in starting chemotherapy due to admission for COVID-19 induced pneumonia. Following the delay, she received 5 cycles of NACT but she was no longer a candidate for interval cytoreductive surgery due to refractory disease and was lost to follow up in August 2020.

#### 4. Discussion

During the response phase of the COVID-19 pandemic, oncologic surgical prioritization was based on available resources, patient tumour characteristics and expected impact of delays [9]. Our study found that gynecologic oncology patients in a public Canadian institution were 9.43 times more likely to have a treatment modification and 1.96 times more likely to have a treatment delay as compared to an equal volume American privately funded center after adjusting for confounders. Some of the reasons include differences in hospital resource allocation; while both centers cared for COVID-19 patients, UHN was a designated COVID-19 referral center treating severely ill patients requiring specialized support such as Extracorporeal membrane oxygenation (ECMO). Surgical priorities at UHN were reviewed weekly by a multidisciplinary team that included department heads of surgical

**Table 3**

Univariable analysis evaluating modifications and delays based on clinical parameters and potential confounders.

	Treatment modifications		P value	Treatment delays		P value
	OR	95% CI		OR	95% CI	
Age > 70	1.49	0.56–3.98	0.43	0.91	0.54–1.52	0.71
Cohort (UHN)	10.64	2.44–46.44	<b>&lt;0.01</b>	2.17	1.40–3.40	<b>&lt;0.01</b>
Race						
White	1.29	0.27–5.83	0.74	0.94	0.49–1.77	0.84
Black	6.83	1.32–35.21	<b>0.02</b>	1.46	0.37–5.76	0.59
Tumour site						
Ovary	0.54	0.21–1.37	0.19	0.63	0.40–0.98	<b>0.04</b>
Uterus	3.00	1.19–7.50	<b>0.02</b>	2.12	1.37–3.28	<b>&lt;0.01</b>
Priority < 14 days	0.20	0.08–0.52	<b>&lt;0.01</b>	0.75	0.48–1.16	0.76

Bolded numbers indicate statistically significant values. OR: Odds ratio, 95% CI: 95% confidence interval.

oncology, cardiac surgery, transplantation and other disciplines to determine weekly operative time allocations. These priorities were unaffected by factors including surgeons infected with COVID, the density of cancers per gynecologic oncologist or the number of gynecologic oncologists per capita of patients and operating room end times, but rather institutional limitations including stepdown beds, ICU beds, nursing and anesthesia personnel. On the other hand, although BWH had institutional restrictions on operative time allocations, allotted operating room time within the department of Obstetrics and Gynecology was prioritized to the Division of Gynecologic Oncology. Prioritization remained constant throughout the study period, however, the proportion of patients with significant treatment delays decreased over time based on decision to treat date and patients with delays received their treatment at a peak time in May at both institutions. Interestingly, the trends at both institutions followed the same curve, indicating that both a public and private center were similarly affected by the first

**Table 4**

Adjusted OR for treatment modification using multivariable logistic regression.

	Adjusted OR	95% CI	p-value
Age > 70	1.85	0.59–5.79	0.29
White	2.71	0.57–12.84	0.21
Ovary	1.88	0.22–16.26	0.57
Uterus	4.18	0.48–35.73	0.19
Cohort (UHN)	9.43	1.81–49.05	<b>&lt;0.01</b>
Priority < 14	0.59	0.189–1.84	0.36

Bolded numbers indicate statistically significant values.

Adjusted odds ratios for treatment modification accounting for age > 70, race, disease site, cohort and priority status. Black race omitted from the model as perfectly predicts outcome of modification as highlighted by a high OR in the univariable. Model selected based on the best AIC, AIC 127.13.

**Table 5**

Adjusted OR for treatment delay using multivariable logistic regression.

	Adjusted OR	95% CI	p-value
Age > 70	0.70	0.38–1.29	0.26
White	1.17	0.63–2.67	0.49
Black	1.23	0.28–6.06	0.74
Ovary	1.17	0.54–2.54	0.69
Uterus	2.43	1.11–5.33	<b>0.03</b>
Cohort (UHN)	1.96	1.14–3.36	<b>0.02</b>
Priority < 14 days	1.19	0.78–1.72	0.41

Bolded numbers indicate statistically significant values.

Adjusted odds ratios for treatment modification accounting for age > 70, race, disease site, cohort and priority status. Model selected based on the best AIC, AIC 380.53.

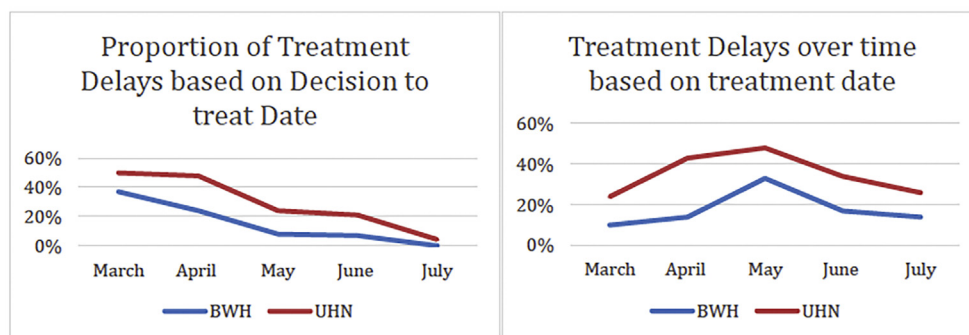


Fig. 1. Trends in Treatment Delays based on decision to treat date (Fig. 1a) and treatment date (Fig. 1b) between March 2, 2020 and July 30, 2020 at both institutions.

pandemic wave, albeit double the chance of having a surgical delay in a Canadian institution.

In both cohorts, delays most commonly affected patients with grade 1 endometrial cancers who were temporarily managed using progestins. Eighteen patients underwent treatment modifications at UHN, compared to 2 at BWH, corresponding to 9.43× higher chance of having a COVID-19 related modification at UHN. Two patients in the UHN cohort were diagnosed with COVID-19 at presentation and developed COVID-19 induced pneumonia. This ultimately affected the treatment algorithm of both patients as one patient received palliative radiation therapy as opposed to surgery for uterine carcinosarcoma and the other patient had a treatment delay of neoadjuvant chemotherapy for advanced ovarian cancer and never received cytoreductive surgery. Bogani et al. reported the adverse effects of COVID-19 on gynecologic oncology surgical patients [8]. Among 355 women treated for gynecologic malignancies between February and March 2020 in Milan Italy, 5.3% developed COVID-19 and one patient died of COVID-19. Five patients were diagnosed with COVID-19 at time of surgery and two died in the postoperative period while 2 others had prolonged admission. Of the 19 COVID-19 positive patients, 42% of patients had delayed treatment, 15.8% avoided medical treatment, 10% delayed surgical treatment and 10.5% had a change in surgical plan. This paper highlights the perioperative morbidity in gynecologic cancer patients affected by COVID-19 and the impact this can have on cancer treatment.

The findings of our study highlight the impact of the global COVID-19 pandemic on access to timely oncologic care. In both cohorts combined, racial disparity was identified in black race and was associated with treatment modification in gynecologic oncology patients. Women with uterine disease were 2.43 times more likely to undergo treatment modifications and 2.12 times more likely to experience treatment delays compared to other disease sites. Importantly, disease presentation with high surgical prioritization (surgery within 14 days of decision-to-treat date) were not subject to treatment modifications or delays at either site, emphasizing that surgeries for aggressive disease or critical presentation received high triaging priority, while cancers deemed more indolent were subject to more treatment delays and modifications. Hence, surgeries that were booked as a high priority in both cohorts were 80% less likely to undergo a treatment modification compared to other priority statuses. Though there were more patients in the highest priority category at BWH, extensive analysis as to how prioritization is done is outside the scope of this study.

When comparing our study to the literature, both cohorts still had less treatment delays and modifications as compared to other centers. In three New York city hospitals, 39% of gynecologic oncology patients experienced a COVID-19 related modification in cancer care among which 67% of surgical plans were modified, which was higher than the impact noted in both our study cohorts [10]. In addition, based on a survey of 187 gynecologic oncologists, 97% expressed that their practice has changed due to COVID-19 [11]. Treatments were considered priority

in 45% of high-risk uterine cases, 41% of ovarian cancer cases and 41% of advanced cervical cancer cases. Early-stage low grade endometrial cancer was deferred in 49% of respondents' practices with temporary progestin treatment in 31% of cases. Among the survey participants, cervical cancer, surgical treatments were only delayed for COVID-19 positive status.

The limitations of the present study are the retrospective nature of the study design and inherent biases associated with it. Furthermore, there were institutional differences and selection biases of patients undergoing surgery based on multidisciplinary oncologic meetings and differences in decision criteria between both sites. We adjusted for these confounders using multivariable logistic regression. The strengths of our study include the large volumes of tertiary gynecologic oncology cancer patients treated at each institution. The two centers have comparable levels of surgical and oncologic care and differ in their healthcare infrastructure and funding models. This allowed for a direct comparison and highlighted the differences observed between the institutional impact on the gynecologic cancer surgical care delivered during the pandemic.

In summary, our study highlights that there were more treatment delays and modifications of gynecologic cancer treatment in a Canadian publicly funded versus an American privately funded cancer center during the first wave of the COVID-19 pandemic. These differences were within the range reported in the literature and most of the impact was on patients with uterine disease. Importantly, the sequelae of these treatment delays and modifications on disease associated morbidity, risk of recurrence and disease specific mortality is yet to be elucidated and warrants long-term follow-up and future studies. Our group will prospectively follow the patients identified in both study cohorts to study the long-term oncologic impact of the systematic oncologic treatment restrictions during the pandemic. In addition, future projects may include further analysis of how surgical prioritization is done at each institution, which was not the scope of the present study.

#### Author contributions

SP: Data curation, Data interpretation, Formal Analysis, Manuscript Writing and editing.

SL: Data curation, Data interpretation, Manuscript review and editing.

MQB: Data interpretation, Manuscript review and editing.

SL: Data interpretation, Manuscript review and editing.

SEF: Data interpretation, Manuscript review and editing.

GBF: Data interpretation, Manuscript review and editing.

LH: Data interpretation, Manuscript review and editing.

PC: Data interpretation, Manuscript review and editing.

MJW: Conceptualization and Supervision, Data interpretation, Manuscript editing.

TM: Conceptualization and Supervision, Data interpretation, Manuscript writing and editing.

## Declaration of Competing Interest

The authors have no conflicts of interest to declare.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ygyno.2021.04.030>.

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