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Impact of the COVID-19-pandemic on patients with gynecological malignancies undergoing surgery: A Dutch population-based study using data from the 'Dutch Gynecological Oncology Audit'

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HIGHLIGHTS

- Surgical volume for cervical cancer dropped substantially during the COVID-19-pandemic.
- Surgical volumes for ovarian, vulvar, and endometrial cancer remained stable.
- Time to first treatment was significantly shorter during the pandemic year for all gynecological malignancies.
- For advanced-stage ovarian cancer patients, neoadjuvant chemotherapy administration rates increased in 2020.
- Complicated course and 30-day-mortality rates were not affected by the pandemic for all gynecological malignancies.

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ABSTRACT

Objective. The COVID-19-pandemic caused drastic healthcare changes worldwide. To date, the impact of these changes on gynecological cancer healthcare is relatively unknown. This study aimed to assess the impact of the COVID-19-pandemic on surgical gynecological-oncology healthcare.

Methods. This population-based cohort study included all surgical procedures with curative intent for gynecological malignancies, registered in the Dutch Gynecological Oncology Audit, in 2018–2020. Four periods were identified based on COVID-19 hospital admission rates: 'Pre-COVID-19', 'First wave', 'Interim period', and 'Second wave'. Surgical volume, perioperative care processes, and postoperative outcomes from 2020 were compared with 2018–2019.

Results. A total of 11,488 surgical procedures were analyzed. For cervical cancer, surgical volume decreased by 17.2% in 2020 compared to 2018–2019 (mean 2018–2019: $n = 542.5$, 2020: $n = 449$). At nadir (interim period), only 51% of the expected cervical cancer procedures were performed. For ovarian, vulvar, and endometrial cancer, volumes remained stable. Patients with advanced-stage ovarian cancer more frequently received neoadjuvant chemotherapy in 2020 compared to 2018–2019 (67.7% ($n = 432$) vs. 61.8% ($n = 783$), $p = 0.011$). Median time to first treatment was significantly shorter in all four malignancies in 2020. For vulvar and endometrial cancer, the length of hospital stay was significantly shorter in 2020. No significant differences in complicated course and 30-day-mortality were observed.

Conclusions. The COVID-19-pandemic impacted surgical gynecological-oncology healthcare: in 2020, surgical volume for cervical cancer dropped considerably, waiting time was significantly shorter for all malignancies, while neoadjuvant chemotherapy administration for advanced-stage ovarian cancer increased. The safety of perioperative healthcare was not negatively impacted by the pandemic, as complications and 30-day-mortality remained stable.

1. Introduction

Since the start of the COVID-19-pandemic, healthcare focus has drastically changed towards treating severely ill COVID-19 patients, which resulted in the postponement of oncological surgeries worldwide due to lack of capacity [1]. Additionally, population screening programs (including the cervical cancer screening program) were discontinued, and the accessibility of the general physician (GP) practices was limited for symptomatic patients in the Netherlands. Next to delayed surgery, this may also have led to delayed cancer diagnosis.

The impact of the pandemic on gynecological cancer patients appears to be substantial, as three affiliated New York City hospitals reported that 39% of their gynecological cancer patients experienced a COVID-19-related treatment modification, such as delay, change, or cancellation, during the first two months of the pandemic. Moreover, two-thirds of the patients scheduled for surgery experienced modification in their surgical plan [2]. It is unclear whether modifications in treatments or surgical plans due to the COVID-19-pandemic have led to suboptimal cancer treatments.

Preoperative risk evaluations may also have impacted surgical care for patients with gynecological malignancies during the pandemic. Recent studies found that patients who develop COVID-19 perioperatively have an increased risk of pulmonary complications and postoperative mortality (in particularly oncological patients, >70-year-old) [3]. A significant proportion of patients with gynecological malignancies are elderly. Therefore, treatment strategies for gynecological malignancies may have shifted towards non-surgical alternatives. Whether shifts in treatment strategy, such as increased neoadjuvant chemotherapy (NAC) administration for advanced-stage ovarian cancer, actually occurred during the pandemic is unknown.

Besides patient risks, pandemic-induced risk evaluations for healthcare workers could have affected the surgical care for patients with gynecological malignancies. The assumed association of aerosol-generating procedures (i.e., laparoscopic surgery) and increased SARS-CoV-2 infection risks for hospital personnel [4] may potentially have led to a shift in surgical strategy (open vs. minimally invasive techniques). However, whether the proportion of minimally invasive surgeries (MIS) has decreased due to the assumed association is yet unclear.

Another important factor that the COVID-19-pandemic could have influenced is the surgical volume of patients with gynecological malignancies. A recent single-center study from the United Kingdom showed that maintaining surgical volume was feasible during the year of the pandemic. However, this might have been at the expense of the safety of perioperative healthcare, as significantly more postoperative complications occurred and significantly higher 30-day-mortality rates were observed [5]. It is unclear whether these outcomes are indicative of populational cohorts.

Although few studies have been published on the impact of the COVID-19-pandemic on gynecological cancer healthcare [2,5–8], they are based on small sizes, and there is a lack of population-based data with adequate power. Therefore, this study aimed to evaluate the impact of the pandemic on surgical care for gynecological cancer patients, concerning the surgical volume, perioperative care processes, and outcomes, in the Netherlands.

2. Methods

2.1. Study design

This nationwide cohort study used data from the 'Dutch Gynecological Oncology Audit' (DGOA). The DGOA is a population-based and prospectively maintained quality registry, facilitated by the Dutch Institute for Clinical Auditing, that contains reliable, detailed clinical data of all patients with any form of therapy for ovarian, vulvar, endometrial, and cervical cancer in the Netherlands (population 17.3 million) [9,10]. Since January 2014, the DGOA has been a mandatory registry for all Dutch hospitals treating gynecological malignancies. Ethical approval or informed consent was not required according to Dutch legislation.

2.2. Patient selection

All patients with ovarian, vulvar, endometrial, and cervical cancer who underwent curative surgery registered in the DGOA between week 1 in 2018 and week 52 in 2020 were included. Patients with borderline ovarian tumors were excluded from the analyses.

2.3. Patient and tumor characteristics

Variables for analysis were: age (<70 and ≥70 years for ovarian, vulvar, and endometrial cancer, <50 and ≥50 years for cervical cancer), body mass index (BMI) (<20, ≥20 and ≤25, >25 and ≤30, >30), Charlson Comorbidity Index (0, 1, 2+) [11], FIGO (The International Federation of Gynecology and Obstetrics) stage (I, II, III, IV) and tumor histology.

2.4. Surgical volume

For the surgical volume analysis, four periods were identified in 2020 based on COVID-19 hospital admission rates in the Netherlands: 'Pre-COVID-19' (January 1st, 2020 – March 15th, 2020), 'First wave' (March 16th, 2020 – May 24th, 2020), 'Interim period' (May 25th, 2020 – September 20th, 2020) and 'Second wave' (September 21st, 2020 – December 27th, 2020) [12,13]. During the first and second wave, the total number of COVID-19-related hospital admissions in the Netherlands was 500 or higher, and/or the total number of COVID-19-related Intensive Care Unit (ICU) admissions was 200 or higher. During the pre-COVID-19 and interim period, COVID-19-related hospital admissions were below 500, and/or COVID-19-related ICU admissions were below 200. The combined results of 2018–2019 were indicated 'expected', the results of 2020 were indicated 'observed'. The 'Moving Average' of three weeks was calculated (the week before, the week itself, and the week after). Furthermore, the observed surgical volume was divided by the expected, resulting in weekly observed/expected (O/E) ratios. An O/E ratio greater than 1 indicated that more surgeries were registered in 2020 than was expected based on 2018–2019. An O/E ratio of less than 1 indicated a lower-than-expected frequency of surgery.

2.5. Perioperative care processes

Time to first treatment (TTFT) was calculated and analyzed per tumor group. TTFT was defined as the date of the first visit at the outpatient clinic to the date of the start of neoadjuvant treatment or surgery. Additionally, patients were categorized into two groups: those treated within 42 days or not. The 42-days-limit was used since, according to the Dutch Federation of Oncological Societies (SONCOS), patients treated for gynecological malignancies should start treatment within six weeks after their first visit [14]. Records with a negative TTFT or TTFT >150 days were assessed as registration errors and were excluded for analysis.

A sub-analysis was performed on patients with advanced-stage ovarian cancer to assess whether treatment strategy shifts to neoadjuvant chemotherapy (NAC) administration had occurred. Patients with FIGO IIB-IV ovarian cancer that underwent primary or interval cytoreductive surgery (CRS) were included.

Additionally, a sub-analysis was performed to determine whether the assumed association of aerosol-generating procedures and increased SARS-CoV-2 infection risks for hospital personnel impacted the surgical strategy (open vs. MIS). MIS were defined as (robot-assisted) laparoscopy or transvaginal surgery. The surgical strategy was evaluated for patients with early-stage endometrial cancer (FIGO IA endometrioid endometrium carcinoma) only because Dutch guidelines indicate that treating these patients with MIS is superior to open surgery [15].

Furthermore, shifts in the type of surgery were calculated for all ovarian, vulvar, endometrial, and cervical cancer procedures.

2.6. Postoperative outcomes

The following early postoperative outcomes were calculated: length of hospital stay (LOHS), postoperative complications (no complication, complication with/without reintervention), complicated course, and 30-day-mortality. Records with a negative LOHS were assessed as registration errors and excluded from the analysis. The complicated course was defined as complications rated ≥ grade 3 on the Clavien-Dindo scale [16], and/or any complication combined with a prolonged LOHS (>14 days), and/or death within 30 days after the procedure, and/or death during hospital admission following surgery. The Clavien-Dindo grade was calculated based on the following complication-related items registered in detail in the DGOA registry: the type of complication (infections, operative injuries, wound defects, perioperative bleeding, thromboembolic events, systemic and/or technical complications), the severity of the complication (with/without reintervention), the type of reintervention (endoscopic, radiological, and/or surgical reintervention), and the length of ICU stay.

2.7. Statistical analysis

Data analysis of patient and tumor demographics, TTFT, treatment strategy, surgical strategy, type of surgery, and early postoperative outcomes were performed comparing the entire year 2020 (week 1 to 52) with 2018–2019 (week 1 to 52) combined. Data were analyzed using RStudio version 1.4.1106 (RStudio, PBC, Boston, MA, 2021). Based on group sizes, categorical data were compared using chi-squared or Fisher's exact tests, and non-parametric comparisons of non-normally distributed continuous variables were performed using the Kruskal-Wallis test. A two-sided p-value of <0.05 was considered statistically significant. Missing data below 5.0% were excluded for analysis.

3. Results

3.1. Patient and tumor demographics

A total of 11,488 surgeries with the intent of curative treatment were registered in the DGOA registry for ovarian, vulvar, endometrial, and cervical cancer (7639 in 2018–2019 and 3849 in 2020). Patient and tumor characteristics are shown in Table 1. No significant differences between 2018–2019 and 2020 were observed for age and comorbidity. Tumor histology differed significantly over the years for ovarian cancer surgeries ($p = 0.034$). The BMI of patients undergoing endometrial cancer surgeries was significantly different in 2020 ($p = 0.009$). For cervical cancer, the patient distribution across the different FIGO stages differed significantly over the years, with more FIGO III patients in 2020 ($p < 0.001$).

3.2. Surgical volume

Trends in surgical volume for all four malignancies combined are displayed in Fig. 1. At first, an increase in procedures was observed. Subsequently, a drop in procedures was observed during the first wave and interim period. The drop was primarily caused by a drop in procedures for cervical cancer: at its nadir, in the interim period, only 51% of the expected surgical procedures for cervical cancer were performed. Surgical volume recovered to pre-pandemic levels during the second wave.

Overall surgical volume for cervical cancer dropped considerably by 17.2% in 2020 ($n = 449$), compared to the mean of 2018–2019 ($n = 542.5$). Surgical volume for other gynecological malignancies remained stable. For ovarian cancer, a difference of 6.2% was observed (2020: $n = 1160$, compared to the mean of 2018–2019 $n = 1092.5$). For surgical procedures for vulvar cancer, a difference of 1.7% was observed (in 2020: $n = 458$, compared to the mean of 2018–2019: $n = 450.5$). For endometrial cancer, a difference of 2.8% was observed (2020: $n = 1782$, compared to the mean of 2018–2019: $n = 1734$).

3.3. Perioperative care processes

For all four malignancies, TTFT was significantly shorter in 2020 compared to 2018–2019 (all p-values <0.001) (Table 2). Moreover, for ovarian, endometrial, and cervical cancer, significantly more patients were treated within six weeks (p-values 0.012, <0.001, and 0.001, respectively).

Demographics and the sub-analyses for treatment strategy and surgical strategy are displayed in Table 3. Relatively more patients treated with CRS for advanced-stage ovarian cancer had FIGO stage IV disease in 2020 (31.3%, $n = 200$) compared to 2018–2019 (26.2%, $n = 323$). Patients with FIGO IIB-IV ovarian cancer more frequently received NAC and interval CRS (67.7%; $n = 432$) compared to 2018–2019 (61.8%; $n = 783$) ($p = 0.011$). In 2020, significantly more MIS for patients with FIGO IA endometrioid endometrium carcinoma were performed (92.9%, $n = 706$) compared to 2018–2019 (86.5%, $n = 1279$) ($p < 0.001$).

No significant differences were observed for the type of surgery for ovarian and cervical cancer, the type of surgery for vulvar and endometrial cancer differed significantly over the years ($p < 0.001$) (Table 2).

3.4. Postoperative outcomes

Early postoperative outcomes are depicted in Table 2. Median LOHS was significantly shorter in 2020 for vulvar cancer and endometrial cancer (p-values <0.001). For ovarian and cervical cancer, no significant differences were observed for LOHS. For ovarian cancer surgeries, significantly fewer postoperative complications occurred in 2020 ($p = 0.018$), while no significant differences were observed for the complicated course and 30-day-mortality. No significant differences in postoperative complications, complicated course, and 30-day-mortality were observed for vulvar, endometrial, and cervical cancer.

4. Discussion

Worldwide, there have been concerns about the impact of the COVID-19-pandemic on surgical care for gynecological cancer patients.

Table 1
Patient and tumor demographics of surgical procedures for ovarian, vulvar, endometrial, and cervical cancer in 2018–2020, registered in the DGOA.

Ovarian cancer	2018–2019 (*N* = 2185)	2020 (*N* = 1160)	
	N (%)	N (%)	P-value[A]
Age			0.073
<70 years	1451 (66.9)	755 (65.1)	Chi-squared
≥70 years	724 (33.1)	405 (34.9)	
Body Mass Index			0.205
<20	194 (8.9)	79 (6.8)	Chi-squared
≥20 and ≤ 25	906 (41.5)	483 (41.6)	
>25 and ≤ 30	658 (30.1)	350 (30.2)	
>30	417 (19.1)	236 (20.3)	
Missing	10 (0.5)	12 (1.0)	
Charlson Comorbidity Index			0.172
0	1561 (71.4)	799 (68.9)	Chi-squared
1	258 (11.8)	137 (11.8)	
2+	366 (16.8)	224 (19.3)	
FIGO (2014) pathology			0.290
Stage I	625 (28.6)	336 (29.0)	Chi-squared
Stage II	214 (9.8)	118 (10.2)	
Stage III	931 (42.6)	448 (38.6)	
Stage IV	397 (18.2)	228 (19.7)	
Missing	18 (0.8)	30 (2.6)	
Histology			**0.034**
Epithelial	1984 (90.8)	1066 (91.9)	Chi-squared
Non-epithelial	135 (6.2)	76 (6.6)	
Mixed	66 (3.0)	18 (1.6)	

Vulvar cancer	2018–2019 (*N* = 901)	2020 (*N* = 458)	
	N (%)	N (%)	P-value[A]
Age			0.439
<70 years	460 (51.1)	244 (53.3)	Chi-squared
≥70 years	441 (48.9)	214 (46.7)	
Body Mass Index			0.107
<20	60 (6.7)	25 (5.5)	Chi-squared
≥20 and ≤25	299 (33.2)	124 (27.1)	
>25 and ≤30	277 (30.7)	141 (30.8)	
>30	263 (29.2)	154 (33.6)	
Missing	2 (0.2)	14 (3.1)	
Charlson Comorbidity Index			0.305
0	490 (54.4)	231 (50.4)	Chi-squared
1	198 (22.0)	103 (22.5)	
2+	213 (23.6)	124 (27.1)	
FIGO (2009) pathology			0.865
Stage I	512 (56.8)	261 (57.0)	Fisher's exact
Stage II	16 (1.8)	7 (1.5)	
Stage III	237 (26.3)	112 (24.5)	
Stage IV	8 (0.9)	4 (0.9)	
Missing	128 (14.3)	74 (16.2)	
Histology			0.687
Squamous cell carcinoma	801 (88.9)	402 (87.8)	Fisher's exact
Adenocarcinoma	13 (1.4)	8 (1.7)	
Melanoma	29 (3.2)	16 (3.5)	
Sarcoma	0 (0.0)	1 (0.2)	
Unknown/other	55 (6.1)	31 (6.8)	
Missing	3 (0.3)	0 (0)	

Endometrial cancer	2018–2019 (*N* = 3468)	2020 (*N* = 1782)	
	N (%)	N (%)	P-value[A]
Age			0.789
<70 years	1864 (53.8)	965 (54.2)	Chi-squared
≥70 years	1603 (46.2)	817 (45.8)	
Missing	1 (0.02)	0 (0.0)	
Body Mass Index			**0.009**
<20	125 (3.6)	35 (2.0)	Chi-squared
≥20 and ≤ 25	724 (20.9)	391 (21.9)	
>25 and ≤ 30	1053 (30.4)	557 (31.3)	
>30	1531 (44.1)	774 (43.4)	
Missing	35 (1.0)	25 (1.4)	
Charlson Comorbidity Index			0.850
0	2032 (58)	1037 (58.6)	Chi-squared
1	683 (19.7)	346 (19.4)	
2+	753 (21.7)	399 (22.4)	
FIGO (2009) pathology			0.276
Stage I	2669 (77.0)	1388 (77.9)	Chi-squared
Stage II	209 (6.0)	95 (5.3)	
Stage III	335 (9.6)	169 (9.5)	
Stage IV	129 (3.7)	84 (4.7)	
Missing	126 (3.6)	46 (2.6)	
Histology			0.503
Carcinoma	3150 (90.8)	1633 (91.6)	Fisher's exact
Sarcoma	109 (3.1)	44 (2.5)	
Mixed	163 (4.7)	90 (5.1)	
Unknown/other	5 (0.1)	3 (0.2)	
Missing	41 (1.2)	12 (0.7)	

Cervical cancer	2018–2019 (*N* = 1085)	2020 (*N* = 449)	
	N (%)	N (%)	P-value[A]
Age			0.405
<50 years	810 (74.7)	326 (72.6)	Chi-squared
≥50 years	275 (25.3)	123 (27.4)	
Body Mass Index			0.676
<20	117 (10.8)	48 (10.7)	Chi-squared
≥20 and ≤25	480 (44.2)	180 (40.1)	
>25 and ≤30	314 (28.9)	124 (27.6)	
>30	166 (15.3)	76 (16.9)	
Missing	8 (0.7)	21 (4.7)	
Charlson Comorbidity Index			0.300
0	910 (83.9)	389 (86.7)	Chi-squared
1	104 (9.6)	39 (8.7)	
2+	71 (6.5)	21 (4.7)	
FIGO (2018) pathology			**<0.001**
Stage I	957 (88.2)	382 (85.1)	Fisher's exact
Stage II	56 (5.2)	18 (4.0)	
Stage III	10 (0.9)	25 (5.6)	
Stage IV	4 (0.4)	1 (0.2)	
Missing	58 (5.3)	23 (5.1)	
Histology			0.346
Squamous cell carcinoma	725 (66.8)	306 (68.2)	Chi-squared
Adenocarcinoma	267 (24.6)	108 (24.1)	
Adenosquamous carcinoma	40 (3.7)	10 (2.2)	
Unknown/other	50 (4.6)	15 (3.3)	
Missing	3 (0.3)	10 (2.2)	

[A] *P-value of year of surgery, in Chi-squared test or Fisher's exact test.*

The extent of the impact is unknown since no multi-center impact studies have been published yet. This study aimed to assess the impact of the pandemic on surgical care for gynecological cancer patients by comparing 2020 to 2018–2019 at a multi-center level. The current study showed that during the pandemic year, surgical volume for cervical cancer dropped considerably, TTFT for all four tumor types was significantly shorter, and the treatment strategy for advanced-stage ovarian cancer showed an increase in NAC before surgery. Besides, surgical strategy for early-stage endometrial cancer shifted to increased MIS. The safety of perioperative care for all gynecological malignancies was maintained as no significant differences were found in the complicated course rates and 30-day-mortality, whereas the LOHS was shorter or remained the same.

The surgical volume for gynecological malignancies increased during the pre-pandemic period. This increase could be explained by gynecologists working ahead and operating on oncological patients more

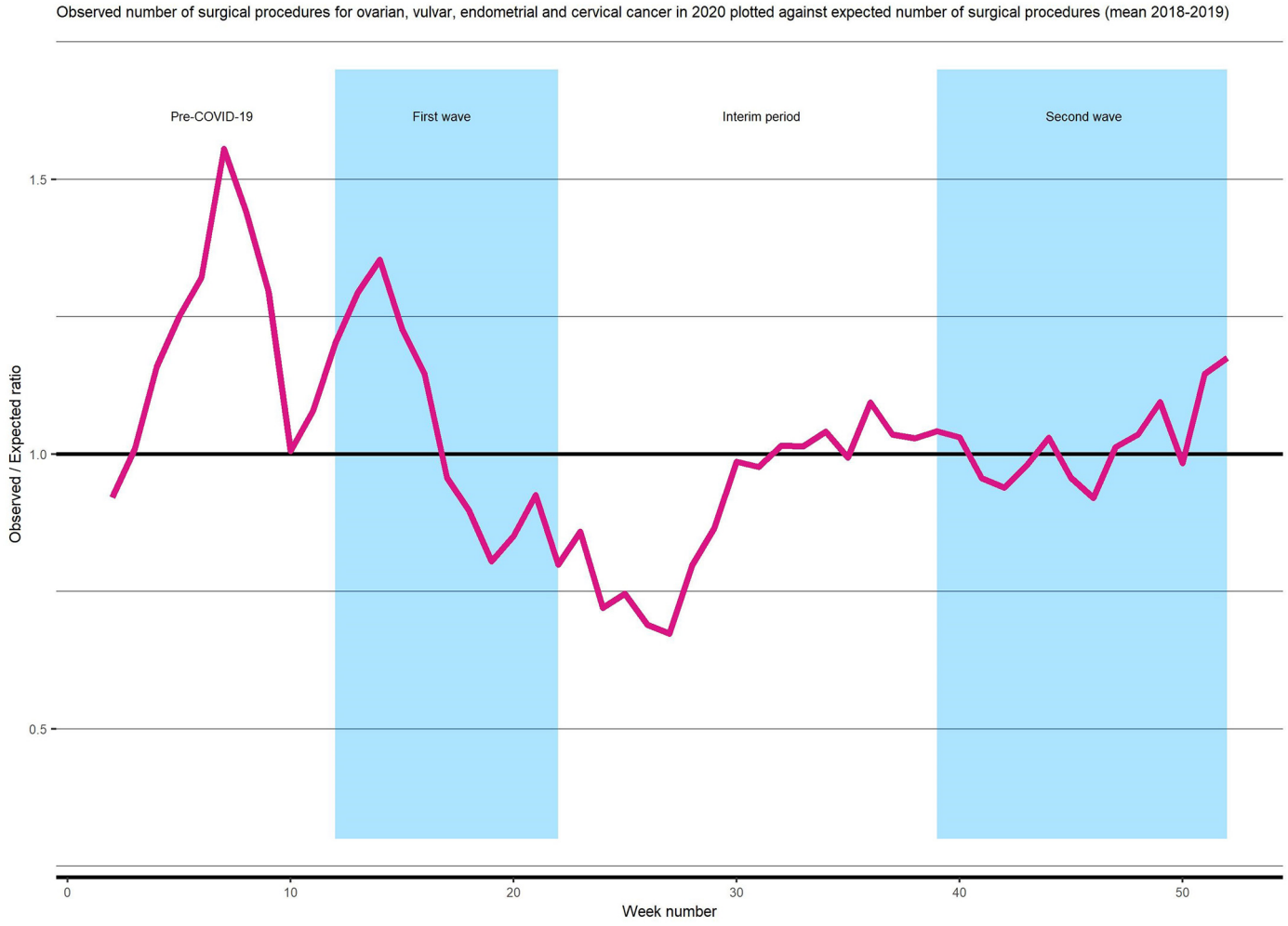

Fig. 1. Surgical procedures for gynecological malignancies per week in the Netherlands.
Observed number of surgical procedures for ovarian, vulvar, endometrial and cervical cancer in 2020 plotted against expected number of surgical procedures (mean 2018–2019).

quickly. Before the arrival of the SARS-CoV-2 virus in the Netherlands, media showed images of (European) hospitals where routine (and oncological) healthcare was disrupted heavily, which might have triggered gynecologists. After that, a decrease in procedures was observed during the first wave and the beginning of the interim period. The limited accessibility of the GP practices for symptomatic patients may have contributed to this decline in surgical volume. In addition, a patient's delay may potentially have occurred as the Dutch government discouraged people from going to the GP during the first wave and mid-interim period. Afterward, surgical volume recovered for all gynecological malignancies to pre-pandemic levels, except cervix carcinoma.

The national screening program for cervical cancer was discontinued in the Netherlands from March 16th, 2020 (start of the first wave) to July 1st, 2020 (mid interim period). Combined with the reduced accessibility of the GP practices, this could explain the decrease in surgical procedures for cervical cancer during this period. An alternative explanation for the decreased surgical volume for cervical cancer is the treatment strategy shift to non-surgical treatments, such as chemoradiation. Whether this treatment strategy shift has occurred remains unclear, as only surgical procedures were analyzed in this study and reliable data on chemoradiation is not available in the DGOA registry. The fact that the surgical volume for cervical cancer decreased by 17.2% is concerning. A FIGO stage migration towards advanced-stage cervical tumors appears to be inevitable with, as a result, increased morbidity and mortality for (young) women. Dutch politicians/legislators should learn from this pandemic that population screening programs should not be discontinued, nor should symptomatic women be discouraged to consult their GP.

Patient and tumor characteristics were similar in the different cohorts. The most noticeable difference was the increase in FIGO stage III cervix carcinoma patients in 2020. The presumable explanation for this is the incorporation of the revised FIGO classification (2018) for cervical cancer in the DGOA registry from 2020. This revised FIGO staging system also includes surgicopathological findings as part of the stage assignment, resulting in patients being upstaged to stage III in case of unexpectedly found lymph node metastases after surgery [17–19].

The COVID-19-pandemic seemed to have affected the TTFT positively as the TTFT was significantly shorter for all four gynecological malignancies in 2020. This reduced waiting time could be explained by the discontinuation and postponement of healthcare for benign disorders, including benign gynecological healthcare. Consequently, an increased capacity was available for cancer surgery patients at the outpatient clinic, the radiology department, the surgical wards, and the theatre, leading to a shorter TTFT. The reduced waiting time for gynecological-oncological patients has been at the expense of elective, non-oncological surgical care, for which currently a considerable waiting period exists in the Netherlands [13].

In 2020, significantly more patients with advanced-stage ovarian cancer received NAC. Multiple reasons could explain this significant increase. Firstly, in 2020, the amount of FIGO stage IV patients increased

Table 2
Perioperative care processes and outcomes of surgical procedures for ovarian, vulvar, endometrial, and cervical cancer in 2018–2020, registered in the DGOA.

Ovarian cancer	2018–2019 (*N* = 2185)	2020 (*N* = 1160)	
	N (%)	N (%)	P-value[A]
Time to first treatment			**<0.001**
Median, in days [Q1, Q3]	27.0 [16.0,45.0]	23.0 [13.0, 38.0]	Kruskal-Wallis
Missing	193 (8.8)	55 (4.7)	
Treatment within 42 days			**0.012**
Yes	1460 (66.8)	855 (73.7)	Chi-squared
No	532 (24.3)	250 (21.6)	
Missing	193 (8.8)	55 (4.7)	
Type of surgery			0.617
Staging procedure	377 (17.3)	185 (15.9)	Chi-squared
Cytoreductive surgery	1329 (60.8)	720 (62.1)	
Other	478 (21.9)	255 (22.0)	
Missing	1 (0.0)	0 (0.0)	
Length of hospital stay			0.178
Median [Q1, Q3]	5.00 [3.00,7.00]	5.00 [3.00,7.00]	Kruskal-Wallis
Missing	82 (3.8)	117 (10.1)	
Postoperative complications			**0.018**
No complication	1422 (65.1)	800 (69.0)	Chi-squared
Complication			
Without re-intervention	673 (30.8)	304 (26.2)	
With re-intervention	90 (4.1)	56 (4.8)	
Complicated course [B]			0.464
No	1996 (91.4)	1069 (92.2)	Chi-squared
Yes	189 (8.6)	91 (7.8)	
30-day-mortality			0.904
Alive	2173 (99.5)	1453 (99.5)	Chi-squared
Dead	12 (0.5)	6 (0.5)	

Vulvar cancer	2018–2019 (*N* = 901)	2020 (*N* = 458)	
	N (%)	N (%)	P-value[A]
Time to first treatment			**<0.001**
Median, in days [Q1, Q3]	32.0 [22.0,50.0]	27.0 [16.0,47.0]	Kruskal-Wallis
Missing	84 (9.3)	21 (4.6)	
Treatment within 42 days			0.125
Yes	545 (60.5)	310 (67.7)	Chi-squared
No	272 (30.2)	127 (27.7)	
Missing	84 (9.3)	21 (4.6)	
Type of surgery			**<0.001**
Wide local excision/ re-excision	519 (57.6)	317 (69.2)	Chi-squared
Local excision	160 (17.8)	88 (19.2)	
Radical vulvectomy	44 (4.9)	8 (1.7)	
Other	167 (18.5)	45 (9.8)	
Missing	11 (1.2)	0 (0.0)	
Length of hospital stay			**<0.001**
Median [Q1, Q3]	2.00 [1.00,4.00]	1.00 [0,3.00]	Kruskal-Wallis
Missing	30 (3.3)	22 (4.8)	
Postoperative complications			0.499
No complication	614 (68.1)	309 (67.5)	Chi-squared
Complication			
Without re-intervention	256 (28.4)	138 (30.1)	
With re-intervention	31 (3.4)	11 (2.4)	
Complicated course [B]			0.107
No	859 (95.3)	445 (97.2)	Chi-squared
Yes	42 (4.7)	13 (2.8)	
30-day-mortality			1.000
Alive	900 (99.9)	457 (99.8)	Fisher's exact
Dead	1 (0.1)	1 (0.2)	

Endometrial cancer	2018–2019 (*N* = 3468)	2020 (*N* = 1782)	
	N (%)	N (%)	P-value[A]
Time to first treatment			**<0.001**
Median, in days [Q1, Q3]	34.0 [22.0,50.0]	30.0 [20.0,45.0]	Kruskal-Wallis
Missing	230 (6.6)	91 (5.1)	
Treatment within 42 days			**<0.001**
Yes	2140 (61.7)	1218 (68.4)	Chi-squared
No	1098 (31.7)	473 (26.5)	
Missing	230 (6.6)	91 (5.1)	
Type of surgery			**<0.001**
Hysterectomy (+/− BSO[C])	2654 (76.5)	1302 (73.1)	Chi-squared
Staging procedure	498 (14.4)	295 (16.6)	
Cytoreductive surgery	183 (5.2)	103 (5.8)	
Radical hysterectomy + LND[D] (+/− BSO[C])	43 (1.2)	11 (0.6)	
Other	81 (2.3)	71 (4.0)	
Missing	9 (0.3)	0 (0.0)	
Length of hospital stay			**<0.001**
Median [Q1, Q3]	2.00 [1.00,3.00]	1.00 [1.00,3.00]	Kruskal-Wallis
Missing	138 (4.0)	110 (6.2)	
Postoperative complications			0.059
No complication	3061 (88.3)	1607 (90.2)	Chi-squared
Complication			
Without re-intervention	329 (9.5)	134 (7.5)	
With re-intervention	78 (2.2)	41 (2.3)	
Complicated course[B]			0.270
No	3349 (96.6)	1731 (97.1)	Chi-squared
Yes	119 (3.4)	51 (2.9)	
30-day-mortality			1.000

Cervical cancer	2018–2019 (*N* = 1085)	2020 (*N* = 449)	
	N (%)	N (%)	P-value[A]
Time to first treatment			**<0.001**
Median, in days [Q1, Q3]	36.0 [26.0, 51.0]	31.0 [21.0,48.0]	Kruskal-Wallis
Missing	115 (10.6)	33 (7.3)	
Treatment within 42 days			**0.001**
Yes	595 (54.8)	291 (64.8)	Chi-squared
No	375 (34.6)	125 (27.8)	
Missing	115 (10.6)	33 (7.3)	
Type of surgery			0.131
(Radical) Hysterectomy (+/− BSO[C])	629 (57.9)	255 (56.8)	Fisher's exact
Conization/amputation/trachelectomy	247 (22.8)	102 (22.7)	
LLETZ[E]	133 (12.3)	71 (15.8)	
Lymph node debulking	62 (5.7)	15 (3.3)	
Exenteration/laparotomy	4 (0.4)	2 (0.4)	
Missing	10 (0.9)	4 (0.9)	
Length of hospital stay			0.064
Median [Q1, Q3]	2.00 [1.00,4.00]	2.00 [0,4.00]	Kruskal-Wallis
Missing	37 (3.4)	13 (2.9)	
Postoperative complications			0.201
No complication	850 (78.3)	367 (81.7)	Chi-squared
Complication			
Without re-intervention	203 (18.7)	67 (14.9)	
With re-intervention	32 (2.9)	15 (3.3)	
Complicated course[B]			0.953
No	1047 (96.5)	433 (96.4)	Chi-squared
Yes	38 (3.5)	16 (3.6)	
30-day-mortality			0.293

Table 2 (*continued*)

Endometrial cancer	2018–2019 (*N* = 3468)	2020 (*N* = 1782)		Cervical cancer	2018–2019 (*N* = 1085)	2020 (*N* = 449)	
	N (%)	N (%)	P-value[A]		N (%)	N (%)	P-value[A]
Alive	3458 (99.7)	1777 (99.7)	Fisher's exact	Alive	1085 (100.0)	448 (99.8)	Fisher's exact
Dead	10 (0.3)	5 (0.3)		Dead	0 (0.0)	1 (0.2)	

[A] *P-value of year of surgery, in Chi-squared test/ Fisher's exact test for categorical data and Kruskal-Wallis test for continuous data.*
[B] *Complicated course: when one of the following events (or a combination of) is present:*
-Complication of any kind, combined with a prolonged length of hospital stay (>14 days)
*-Clavien-Dindo classification of surgical complications ≥ grade 3**
-Death within 30 days after the surgical procedure
**: Clavien-Dindo classification of surgical complications:*
-Grade 3: Complication requiring surgical, endoscopic, or radiological intervention.
-Grade 4: Life-threatening complication requiring intermediate care/ intensive care unit management.
-Grade 5: Complication leading to the death of the patient.
[C] *Bilateral Salpingo-Oöphorectomy.*
[D] *Pelvic and/or para-aortic Lymph Node Dissection.*
[E] *Large Loop Excision of the Transformation Zone of the cervix.*

(these patients usually receive NAC more frequently than FIGO stage IIB-III patients). It is unclear whether the increase in FIGO stage IV patients in 2020 was caused by a pandemic-induced patient's (and doctor's) delay. Secondly, preoperative risk evaluations could have led to more NAC administration because operating these patients in times of low SARS-CoV-2 infection rates could lead to fewer complications and mortality [3]. Lastly, multidisciplinary teams could have decided to administer NAC more frequently to postpone high-complex surgeries, thereby creating ICU and theatre capacity.

The surgical strategy for early-stage endometrial cancer shifted towards increased MIS at the expense of open surgery, while patient and tumor characteristics were similar in both cohorts (2018–2019 vs. 2020). Apparently, the supposed association of aerosol-generating procedures and increased SARS-CoV-2 infection risks for hospital personnel did not affect the number of MIS. This result is reassuring, as multiple studies have affirmed that no data support this assumed association [20,21]. The reduced admittance time for patients undergoing MIS could have influenced the surgical strategy. There are no indications that the number of gynecological oncologists performing MIS changed over the study period.

The type of surgery differed significantly for vulvar cancer, as relatively less radical vulvectomies were registered and relatively more wide local excisions. This significant difference was probably caused by the inconclusive terminology used in the DGOA registry: registrations of radical vulvectomies and wide local excisions could indicate similar procedures for vulva carcinoma. Therefore, whether the amount of high-complex vulvar cancer procedures decreased in 2020 is unknown.

Table 3
Demographics and treatment/surgical strategy for advanced-stage ovarian cancer (FIGO IIB-IV) and early-stage endometrioid endometrial cancer (FIGO IA).

Advanced-stage ovarian cancer	2018–2019 (*N* = 1268)	2020 (*N* = 638)		Early-stage endometrioid endometrial cancer	2018–2019 (*N* = 1479)	2020 (*N* = 760)	
	N (%)	N (%)	P-value[A]		N (%)	N (%)	P-value[A]
Age			0.886	Age			0.723
<70 years	735 (58.0)	372 (58.3)		<70 years	921 (62.3)	479 (63.0)	
≥70 years	533 (42.0)	266 (41.7)		≥70 years	558 (37.7)	281 (37.0)	
Body Mass Index			0.773	Body Mass Index			0.633
<20	108 (8.5)	50 (7.8)		<20	36 (2.4)	16 (2.1)	
≥20 and ≤ 25	536 (42.3)	260 (40.8)		≥20 and ≤25	273 (18.5)	154 (20.3)	
>25 and ≤ 30	388 (30.6)	196 (30.7)		>25 and ≤30	427 (28.9)	205 (27.0)	
>30	229 (18.1)	126 (19.7)		>30	732 (49.5)	373 (49.1)	
Missing	7 (0.6)	6 (0.9)		Missing	11 (0.1)	12 (1.6)	
Charlson Comorbidity Index			0.364	Charlson Comorbidity Index			0.462
0	830 (65.5)	404 (63.3)		0	866 (58.6)	462 (60.8)	
1	208 (16.4)	101 (15.8)		1	291 (19.7)	149 (19.6)	
2+	230 (18.1)	133 (20.8)		2+	322 (21.8)	149(19.6)	
FIGO (2014) pathology			**0.044**	Surgical strategy			**<0.001**
Stage IIB	118 (9.3)	62 (9.7)		Minimally invasive technique	1279 (86.5)	706 (92.9)	
Stage III	818 (64.5)	376 (58.9)		Open surgery	185 (12.5)	43 (5.7)	
Stage IV	323 (26.2)	200 (31.3)		Missing	15 (1.0)	11 (1.4)	
Histology			**0.040**				
Epithelial	1196 (94.3)	618 (96.9)		[A] *P-value of year of surgery, in Chi-squared test.*			
Non-epithelial	19 (1.5)	7 (1.1)		[B] *Neoadjuvant chemotherapy.*			
Mixed	53 (4.2)	13 (2.0)					
Treatment strategy			**0.011**				
Interval cytoreductive surgery (NAC[B])	783 (61.8)	432 (67.7)					
Primary cytoreductive surgery	485 (38.2)	206 (32.3)					

Focusing on early postoperative outcomes, the LOHS for vulvar and endometrial cancer procedures was significantly shorter in 2020 compared to 2018–2019. It is assumable that patients were discharged more quickly after surgical procedures to create capacity. Further review of the initial length of hospital stay and readmissions could give an insight into whether healthcare costs could be reduced when these patients are discharged more quickly.

The safety of perioperative care was maintained for all four malignancies, as no significant differences in the year of surgery occurred for the complicated course and 30-day-mortality, in contrast to the findings of Leung et al. [5]. This study showed that maintaining the surgical volume was feasible during the pandemic. However, significantly more postoperative complications occurred, and higher mortality rates were observed [5]. These results are not supported by the results of the current populational study. This is reassuring since the organisation of care for patients with a gynecological malignancy in the Netherlands enabled caregivers to deliver standard care under these difficult circumstances.

There are certain limitations of the current study. Firstly, no data on the SARS-CoV-2-infection status of the patients were analyzed. However, this study aimed to assess the overall impact of the pandemic on surgical patients with gynecological malignancies, not solely the impact on patients infected with the SARS-CoV-2-virus. Secondly, readmissions for complications were not registered in the DGOA. However, the complications themselves were registered in detail. As patients are usually readmitted for complications, this study hereby provides insight into the early postoperative outcomes in the different years. Strengths of this study are the number of analyzed procedures; the fact that in this study, the mean of 2018–2019 was compared to 2020, thereby minimalizing annual differences; and its multi-center, population-based character.

The current Dutch study results might differ from other countries because of international differences in COVID-19-related hospital admission rates and ICU bed capacity. There were fewer COVID-19-related hospital admissions in the Netherlands compared to Belgium, France, Italy, Spain, and the United Kingdom, while the COVID-19 wave patterns were similar. However, the Dutch COVID-19 admission rates were higher than those in Canada and Israel [22]. Focusing on the ICU bed capacity, fewer ICU beds were available in the Netherlands compared to other countries (the Netherlands: 6.71 ICU beds per 100,000 inhabitants, Germany: 47.74 ICU beds per 100,000 inhabitants) [23]. Acknowledging these international differences and reporting on the impact of the pandemic in the different countries should enable us to learn from COVID-19 and prepare for future pandemics.

5. Conclusions

The COVID-19-pandemic impacted the surgical care for patients with gynecological malignancies in the Netherlands: the surgical volume for cervical cancer dropped considerably, possibly due to the reduced accessibility of GP practices, the interruption of the cervical cancer screening program, and the treatment shift to non-surgical alternatives. Treatment strategy shifted to increased NAC administration rates in patients with advanced-stage ovarian cancer, and waiting time was significantly shorter for patients with ovarian, vulvar, endometrial, and cervical cancer. The safety of perioperative healthcare was not negatively impacted by the pandemic, as the complicated course rates and the 30-day-mortality remained stable. Important lessons learned from this impact study are that population screening programs should not be discontinued, nor should patients be discouraged from going to the GP. Whether the COVID-19-pandemic impacted the survival of gynecological cancer patients should be evaluated shortly.

Author contribution

MA was the principal author, performed analyses and interpretation of data. WD, BS, RK, and MW all performed interpretation of data and performed revision of the manuscript. The participants of the Dutch Gynecological Oncology Collaborators Group collected data for the DGOA registry and read and approved the manuscript.

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Declaration of Competing Interest

The authors declare that there are no conflicts of interest.

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