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Twenty-year surgical trends in a gynecologic oncology fellowship training program: Implications for practice

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HIGHLIGHTS

- Fellowship surgical training reflects the significant changes that have occurred in the practice of gynecologic oncology.
- The number of radical hysterectomies and bowel resections/anastomoses significantly declined after 2004.
- Hysterectomy and lymphadenectomy rates have been stable; minimally invasive surgeries have increased starting in 2008.
- Further data from other institutions are needed to determine whether our findings are national or local trends.
- Findings indicate that fellowship training and practice in gynecologic oncologic surgery deserves reevaluation.

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ABSTRACT

Objective: To assess whether there were any significant changes in surgical training volume over the past 20 years that might have ramifications toward preparedness for practice.

Methods: We used deidentified annual summaries of fellow case numbers for the academic years 1999 through 2018. Unpaired *t*-tests with Welch's correction were performed on all surgical categories for 10-year and 5-year periods.

Results: The total number of hysterectomies performed each year did not change significantly. The percent of hysterectomies performed by minimally invasive surgery increased significantly starting in 2008. There was a significant decline in the number of radical hysterectomies conducted starting after 2004, which then remained stable. There was also a significant decline in the number of bowel resections/anastomoses performed by fellows on the gynecologic oncology services that occurred and stabilized during the same time frame. There were other significant trends associated with the introduction of minimally invasive techniques.

Conclusion: The results of this study suggest the need to reevaluate fellowship training and/or the scope of surgical practice in gynecologic oncology.

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1. Introduction

Gynecologic oncology is unique among the oncologic disciplines in its relatively comprehensive approach. The American Board of Obstetrics and Gynecology's definition of a gynecologic oncologist has remained essentially unchanged since the subspecialty was first recognized by the Board 40 years ago [1]. However, since this time, especially over the past 20 years, the discipline has undergone ongoing transformations and challenges, including the development and adoption of minimally invasive surgeries, the incorporation of radical upper abdominal surgery, the widespread use of neoadjuvant chemotherapy for advanced ovarian cancer, a decline in the incidence of cervical cancer, and expansion of medical therapies. As gynecologic oncology is a subspecialty whose identity and necessary skill set have been closely linked to radical pelvic surgery, potential changes in surgical training has implications for practice. A recent study has shown a correlation between surgical outcomes and volume [2], so preparing incoming gynecologic fellows for these changes is relevant.

Changes in residency have been found to affect the preparedness of incoming gynecologic oncology fellows, which has been highlighted in recent publications and discussed in a 2018 National Summit convened by the president of ACOG [3–6]. The ability of

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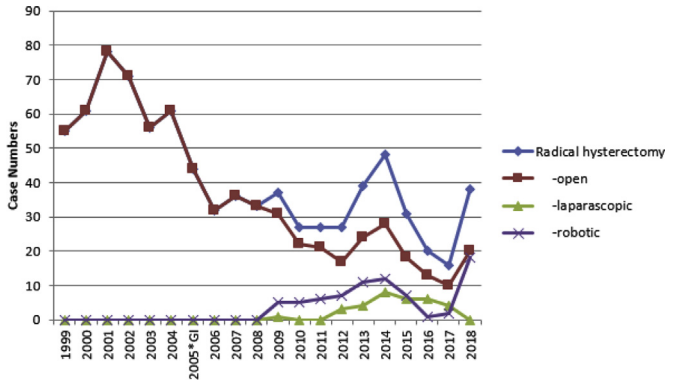

Fig. 1. Radical hysterectomy.
The number of radical hysterectomy cases performed by our fellows over a 20-year period is shown. Each number represents the total fellow cases per year collectively. The number of radical hysterectomies performed significantly decreased and then remained stable.

fellowship training programs to prepare individuals for practice and adapt to these changes is not well known. To address this, we evaluated trends in the number of surgical training procedures undertaken by our fellows over the past 20 years. The purpose of this study was to assess whether there were any significant changes in surgical training volume during this time that might have ramifications for the preparedness for practice.

2. Methods

The University of South Florida Morsani College of Medicine has faculty from both the University of South Florida and H. Lee Moffitt Cancer Center and Research Institute. Therefore, gynecologic oncology fellows undertook their fellowships at a large, primarily academic general hospital (Tampa General Hospital), an NCI-designated Comprehensive Cancer Center (Moffitt), and a community hospital (Advent Health Tampa).

This study used deidentified annual summaries of fellow case numbers for academic years 1999 through 2018 (June 30). Although our fellowship was formalized in 1979, case logs were not available until 1999. The methods of our study did not meet the criteria of human research; therefore, IRB review was not required. Numbers were collated in Microsoft Excel to perform statistical analyses.

During the 20 years included in the study, our fellowship has had 3 fellows per year (1 laboratory fellow and 2 clinical fellows). For purposes of this study, the total fellow cases per year were collectively used to compile the data set and formulate the tables and figures. We have not maintained a database of the total number of new and recurrent gynecologic cancers treated annually.

Unpaired *t*-tests with Welch's correction were performed on all surgical categories for 10-year (1999–2008 vs 2009–2018) and 5-year periods (1999–2003 vs 2004–2008, 1999–2003 vs 2009–2013, 1999–2003 vs 2014–2018, 2004–2008 vs 2009–2013, 2004–2008 vs 2014–2018, and 2009–2013 vs 2014–2018). Excel line graphs were generated to show the trends of each category by year.

3. Results

A core of 4 faculty members were part of the program for the majority of the 20-year study period; seven others participated at different times. There was an average of 6 (range, 3–7) full-time attending gynecologic oncologists in the training program each year. The raw data of the total number of fellow cases by case type each year are shown in Table 1. As shown in Table 1, for 14 years, our fellows participated in an off-service 4-week rotation in gastrointestinal oncologic surgery during the second year of their training. This rotation was terminated by the surgical oncology service at the end of the 2017/18 academic year. Selected case types are represented graphically in Figs. 1 to 3 and Supplementary Figs. 1 to 4. Table 2 shows a comparison between the numbers of surgeries performed during the first (1999–2008) and second (2009–2018) 10-year periods. Five-year incremental comparisons are shown in Table 3.

Although there were fluctuations, the total number of hysterectomies performed each year did not change significantly (Supplementary Fig. 1). Consistent with the national trend, the percent of hysterectomies performed by minimally invasive surgery increased significantly starting in 2008. From 2004, there was a significant decline in the number of radical hysterectomies performed by fellows, which then remained stable (Fig. 1). There was also a significant decline in the number of bowel resections/anastomoses performed by the fellows on the gynecologic oncology services, which occurred and stabilized during the same time frame (Fig. 2). There were other significant trends associated with the introduction of minimally invasive techniques, such as an increase in the number of minimally invasive pelvic and paraaortic lymphadenectomies performed and an associated decrease in the number of open lymphadenectomies (Fig. 3 and Supplementary Fig. 4).

4. Discussion

As evidenced by the agenda of the Society of Gynecologic Oncology's fiftieth anniversary annual meeting and recent issues of *Gynecologic Oncology*, there are increasing transformations and developments in gynecologic cancer care [7]. Our results reflect these changes in part. For a subspecialty whose identity and necessary skill set have been closely linked to radical pelvic surgery, these changes have profound implications for training.

The reduction in the number of radical hysterectomies performed by our fellows is potentially in line with the national trend,

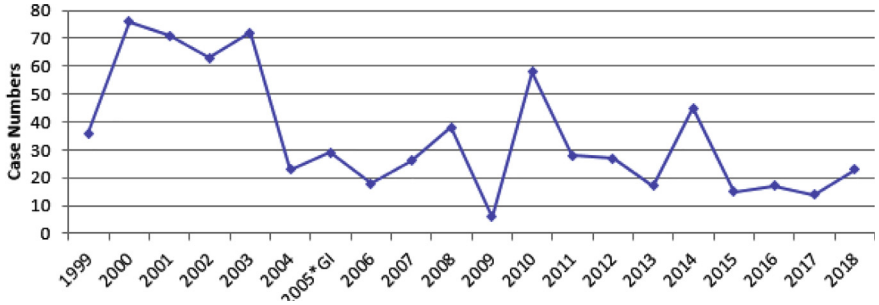

Fig. 2. Bowel resection/anastomosis GYO.
The number of bowel resections/anastomoses performed over a 20-year period. Each number represents the total fellow cases per year collectively.
There was a significant decline in the number of bowel resections/anastomoses performed by the gynecologic oncology service, which then stabilized from 2015.

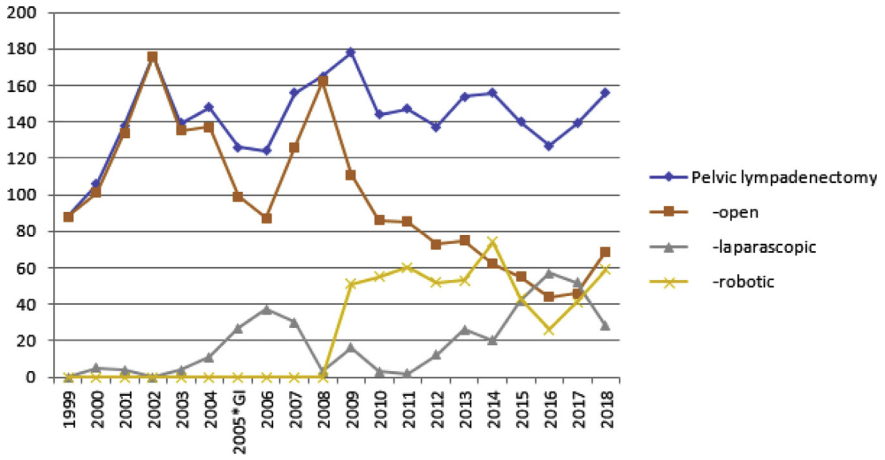

Fig. 3. Pelvic lymphadenectomy. The number of pelvic lymphadenectomies performed over a 20-year period are shown, indicating primarily a transition toward the robotic approach. Each number represents the total fellow cases per year collectively.

as there are increasingly fewer incidences of cervical cancer and refined case selections. The number of ovarian cancer debulking cases performed remained stable during the study period (Supplementary Fig. 2). As a group, we were early adopters of neoadjuvant chemotherapy with interval cytoreductive surgery (IDS) for the treatment of a large percent of women presenting with advanced ovarian cancer. Primary debulking (PDS) was not differentiated from interval debulking surgery in the fellow case logs, and we have not maintained a database that would allow for the quantification of this transition. As reported in the literature, IDS is frequently less extensive or radical than PDS [8,9]. With increasingly effective systemic therapies, this trend is likely to continue. In the present study, radical hysterectomies for ovarian cancer and low rectal resection did not change, and other surrogates for radicality (diaphragmatic resection, splenectomy) were too infrequent to include. However, consistent with reports in the literature, we observed a decline in the number of bowel resections, which, we believe, was the result of a partial transition to IDS [9]. We

Table 1
Twenty-year trends in fellowship case numbers (1999 – 2018).

	'99	'00	'01	'02	'03	'04	'05[a]	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18
Hysterectomy, no.	101	133	160	284	265	259	266	197	233	271	309	235	237	249	276	236	216	259	283	334
Abdominal, no.	101	133	160	281	258	221	234	161	178	183	184	149	134	132	149	108	96	118	107	176
MIS, %	0	0	0	1	3	15	12	18	23	32	40	37	43	65	46	58	55	51	63	47
Radical hysterectomy, no.	55	61	78	71	56	61	44	32	36	33	37	27	27	27	39	48	31	20	16	38
Open, no.	55	61	78	71	56	61	44	32	36	33	31	22	21	17	24	28	18	13	10	20
MIS, %	0	0	0	0	0	0	0	0	0	0	16	19	22	37	38	42	42	35	38	47
Ovarian cancer debulking, no.	63	99	97	86	71	95	91	56	80	71	45	59	70	43	65	59	61	59	74	149
Radical hysterectomy for ovary, no.	N/A	N/A	N/A	24	18	9	44	19	17	20	7	6	14	17	10	14	9	10	6	0
Bowel resection/anastomosis GYO, no.	36	76	71	63	72	23	29	18	26	38	6	58	28	27	17	45	15	17	14	23
Bowel resection/anastomosis GI, no.	0	0	0	0	0	0	10	5	7	14	5	21	21	18	17	12	17	16	16	9
Low rectal resection ± anastomosis GYO, no.	0	0	0	21	18	15	26	11	8	12	15	14	19	7	18	15	4	13	11	13
Low rectal GI, no.	0	0	0	0	0	0	9	3	9	10	5	8	7	8	21	5	6	11	11	6
Colostomy GYO, no.	8	15	31	33	21	17	9	5	17	11	8	23	16	19	22	13	5	19	8	20
Colostomy GI, no.	0	0	0	0	0	0	8	2	4	9	9	8	7	10	20	7	5	15	11	4
Pelvic exenteration, no.	13	23	26	6	8	6	11	7	15	18	24	14	10	14	16	15	7	13	8	18
Anterior, no.	2	4	2	1	4	2	6	2	5	7	10	2	1	2	2	5	3	2	4	5
Posterior, no.	9	15	14	1	1	3	2	0	2	3	4	1	1	2	6	2	0	5	1	6
Total, no.	2	4	10	4	3	1	3	5	8	8	10	11	8	10	8	8	4	6	3	7
Radical modified vulvectomy, no.	15	25	19	33	26	21	10	21	15	20	17	16	29	27	24	12	15	8	11	24
Urinary diversion, no.	4	10	18	11	7	3	9	7	13	15	20	14	13	14	13	10	7	8	7	12
Pelvic lymphadenectomy, no.	88	105	138	176	139	148	126	124	156	165	178	144	147	137	154	156	140	127	139	156
open, no.	88	101	134	176	135	137	99	87	126	162	111	86	85	73	75	62	55	44	46	69
MIS, %	0	5	3	0	3	7	21	30	19	2	38	40	42	47	51	60	61	65	67	56
Paraaortic lymphadenectomy, no.	48	35	78	99	93	117	90	81	86	98	109	64	84	80	78	89	77	59	55	69
Open, no.	48	35	78	99	93	114	83	68	74	97	78	50	54	54	50	34	37	32	24	44
MIS, %	0	0	0	0	0	3	8	16	14	1	28	22	36	33	36	62	52	46	56	36
Inguinal lymphadenectomy, no.	15	17	18	37	24	15	13	14	15	17	20	21	23	23	22	9	15	16	13	14

The raw data of the total number of fellow cases by case type each is shown, which was obtained via deidentified annual summaries of fellow case numbers. Of note, over the 20-year period, the number of some radical surgeries decreased, and the number of non-invasive surgeries increased.
Abbreviations: GYO, gynecologic oncology service; MIS, minimally invasive surgery; N/A, not applicable
[a] 2005 is the starting point of the off-service 4-week gastrointestinal rotation (2005-2018).

Table 2
Ten-year comparisons.

Row	Category	Mean for '99-'08, no.	Mean for '09-'18, no.	Up/down	t test P value [1]
1	Hysterectomy	216.9	263.4	Up	.06977
2	Abdominal	191	135.3	Down	.01579
3	Laparoscopic	22	49.7	Up	.03738
4	Robotic	3.7	80.6	Up	1.7×10^{-9}
5	Radical hysterectomy	52.7	31	Down	.00229
6	Open	52.7	20.4	Down	.00007
7	Laparoscopic	0	3.2	Up	.00681
8	Robotic	0	7.4	Up	.00125
9	Ovarian cancer debulking	80.9	68.4	Down	.25880
10	Radical hysterectomy for ovary	15.1	9.3	Down	.23286
11	Bowel resection/anastomosis GYO	45.2	25	Down	.03438
12	Bowel resection/anastomosis GI	3.6	15.2	Up	.00008
13	Low rectal resection ± anastomosis GYO	11.1	12.9	Up	.58953
14	Low rectal GI	3.1	8.8	Up	.01282
15	Colostomy GYO	16.7	15.3	Down	.70273
16	Colostomy GI	2.3	9.6	Up	.00129
17	Pelvic exenteration	13.3	13.9	Up	.83033
18	Anterior	3.5	3.6	Up	.92513
19	Posterior	5	2.8	Down	.27019
20	Total	4.8	7.5	Up	.04302
21	Radical modified vulvectomy	20.5	18.3	Down	.48402
22	Continent urinary diversion	4.1	2.3	Down	.06146
23	Other urinary diversion	4.9	8.9	Up	.03394
24	Pelvic lymphadenectomy	136.6	147.8	Up	.26157
25	Open	124.5	70.6	Down	.00028
26	Laparoscopic	12.1	25.8	Up	.08585
27	Robotic	0	51.4	Up	4.9×10^{-7}
28	Paraaortic lymphadenectomy	82.5	76.4	Down	.51699
29	Open	78.9	45.7	Down	.00215
30	Laparoscopic	3.6	12.5	Up	.01463
31	Robotic	0	18.2	Up	.00025

[1] *P* values in red/green indicate that the mean case numbers for the second 10-year period are significantly higher/lower, respectively, than the first 10 years.
A comparison between the numbers of surgeries performed during the first (1999-2008) and second (2009-2018) 10-year periods is shown. For hysterectomies there were no significant differences in the mean number of cases observed. The mean case numbers for abdominal hysterectomies were significantly reduced during the 10 year period from 2009 to 2018, while mean case numbers for laparoscopic and robotic hysterectomy significantly increased. The number of radical hysterectomies decreased significantly, as did the number of bowel resections/anastomoses within gynecologic oncology. The change in the lymphadenectomy approach to minimally invasive surgery is also noted. Abbreviations: GI, gastrointestinal surgery service; GYO, gynecologic oncology service.

anticipate that this reduction in the number of bowel resections is also a national trend.

Intestinal surgery is complex, involving a multitude of nuances and high-stake procedures. These issues are magnified in many gynecologic cancer patients because of factors such as carcinomatosis, poor nutrition, and prior radiation therapy. Just how many of each type of procedure needs to be performed and managed to have competency remains a related and pertinent topic that is beyond the scope of this paper. If the trends noted in the present study continue and are generalizable, it is unclear how well-prepared gynecologic oncology fellowship graduates will be to perform such cases.

The number of pelvic exenterations done by our fellows did not change significantly during the study period (Supplementary Fig. 3). A large percent of patients undergoing exenterations at our institutions are referred from other gynecologic oncologists in our state (Florida). Exenterations are also done for nongynecologic malignancies in concert with other pelvic oncologic disciplines (colorectal, urology). Our program is potentially unique in this respect, and the numbers of these and associated surgical procedures (including urinary diversion and myocutaneous flaps) we perform may be above average relative to other fellowships [6]. Although fellows gain exposure to these surgeries, one must question whether they are prepared to perform them after graduation outside of a high-volume center. Furthermore, given the increased numbers and complexity, exenterations and associated reconstructions should potentially be performed in referral centers with experienced surgeons and/or a multidisciplinary team.

The number of pelvic and paraaortic lymphadenectomies performed by our fellows remained stable throughout the study period. As with some of the other procedures, there has been a dilutional effect secondary to the incorporation of minimally invasive techniques. This has created educational challenges, including volume issues such as open-surgery skill sets. Recently, we have begun performing sentinel pelvic lymph node dissections for endometrial cancer patients. These procedures are currently listed as pelvic lymphadenectomy in the fellow case logs. We have begun to notice an adverse effect on the surgical training of pelvic lymphadenectomy and a decrease in the number of paraaortic lymphadenectomies attributed to the sentinel procedure, which has been reported by others [5]. Furthermore, information continues to accumulate, which may lead to an increasingly selective

Table 3
Five-year comparisons.

Row	Category	Mean, no.				t test P value [1]					
		'99-'03	'04-'08	'09-'13	'14-'18	'99-'03 vs. '04-'08	'99-'03 vs. '09-'13	'99-'03 vs. '14-'18	'04-'08 vs. '09-'13	'04-'08 vs. '14-'18	'09-'13 vs. '14-'18
1	Hysterectomy	188.6	245.2	261.2	265.6	.2043	.1201	.1125	.4380	.4347	.8641
2	Abdominal	186.6	195.4	149.6	121	.8252	.3616	.1423	.0281	.0055	.1364
3	Laparoscopic	2	42	25	74.4	.0003	.0342	.0015	.0893	.0238	.0040
4	Robotic	0	7.4	88.6	72.6	.3739	.0001	.0009	4.0×10^{-5}	.0004	.1392
5	Radical hysterectomy	64.2	41.2	31.4	30.6	.0116	.0005	.0022	.1557	.2190	.9055
6	Open	64.2	41.2	23	17.8	.0116	.0002	.0001	.0238	.0083	.2184
7	Laparoscopic	0	0	1.6	4.8	N/A	.1202	.0240	.1202	.0240	.0855
8	Robotic	0	0	6.8	8	N/A	.0036	.0655	.0036	.0655	.7362
9	Ovarian cancer debulking	83.2	78.6	56.4	80.4	.6576	.0181	.8869	.0385	.9271	.2469
10	Radical hysterectomy for ovary	8.4	21.8	10.8	7.8	.1274	.6869	.9203	.1381	.0753	.3658
11	Bowel resection/anastomosis GYO	63.6	26.8	27.2	22.8	.0042	.0126	.0025	9673	.5688	.6853
12	Bowel resection/anastomosis GI	0	7.2	16.4	14	.0377	.0052	.0008	.0425	.0464	.4978
13	Low rectal resection ± anastomosis GYO	7.8	14.4	14.6	11.2	.2871	.2465	.5382	.9590	.4109	.2668
14	Low rectal GI	0	6.2	9.8	7.8	.0354	.0264	.0041	.3341	.5237	.5495
15	Colostomy GYO	21.6	11.8	17.6	13	.1138	.4886	.1686	.1431	.7582	.2831
16	Colostomy GI	0	4.6	10.8	8.4	.0556	.0101	.0146	.0693	.1933	.4635
17	Pelvic exenteration	15.2	11.4	15.6	12.2	.4390	.9336	.5300	.2335	.8028	.3071
18	Anterior	2.6	4.4	3.4	3.8	.1783	.6695	.1894	.6254	.6293	.8293
19	Posterior	8	2	2.8	2.8	.1191	.1657	.1685	.4982	.5563	1.000
20	Total	4.6	5	9.4	5.6	.8438	.0227	.5704	.0295	.7286	.0112
21	Radical modified vulvectomy	23.6	17.4	22.6	14	.1432	.8115	.0490	.1654	.3596	.0530
22	Continent urinary diversion	4.2	4	3.2	1.4	.8946	.4515	.0607	.5515	.0821	.1245
23	Other urinary diversion	5.2	4.6	10.4	7.4	.8479	.1205	.5017	.0115	.2340	.1490
24	Pelvic lymphadenectomy	129.4	143.8	152	143.6	.4342	.2281	.4191	.4686	.9844	.3782
25	Open	126.8	122.2	86	55.2	.8272	.0547	.0075	.0531	.0053	.0071
26	Laparoscopic	2.6	21.6	11.8	39.8	.0383	.1064	.0055	.2432	.0899	.0124
27	Robotic	0	0	54.2	48.6	N/A	4.5×10^{-6}	.0041	4.5×10^{-6}	.0041	.5381
28	Paraaortic lymphadenectomy	70.6	94.4	83	69.8	.1415	.4235	.9562	.2724	.0234	.2059
29	Open	70.6	87.2	57.2	34.2	.3061	.3667	.0418	.0192	.0017	.0083
30	Laparoscopic	0	7.2	5.2	19.8	.0387	.0753	.0003	.5521	.0033	.0009
31	Robotic	0	0	20.6	15.8	N/A	.0015	.0530	.0015	.0530	.4831
32	Inguinal lymphadenectomy	22.2	14.8	21.8	13.4	.1377	.9256	.0919	.0001	.3477	.0009

[1] *P* values in red/green indicate that the mean case numbers for the second 10-year period are significantly higher/lower, respectively, than the first 10 years.
Five-year incremental comparisons are shown. Consistent with Table 2, there was a change in the route of hysterectomies after the second 5-year increment. The significant reduction in the number of radical hysterectomies occurred progressively through the first three 5-year increments. The reduction in bowel resections/anastomoses within gynecologic oncology occurred after the first 5-year increment and then remained stable. Also consistent with Table 2, the change in lymphadenectomy approach to minimally invasive surgery occurred after the first two 5-year increments.
Abbreviations: GI, gastrointestinal surgery service; GYO, gynecologic oncology service; N/A, not applicable.

approach to lymph node assessment in endometrial cancer patients [10–12].

The number of radical vulvar operations and inguinal lymphadenectomies performed by our fellows has remained steady during the study period. Our program has incorporated the sentinel lymph node procedure for selected patients and, as with pelvic lymphadenectomy, has not been listed separately in the fellow logs. Only a minority of the patients have been candidates for the sentinel procedure, and we do not think this has had a major impact on training fellows to perform an inguino-femoral lymphadenectomy. However, this remains a concern [5].

There are a number of procedures and surgical skill sets that have not been evaluated in this study but require scrutiny in the same context, such as ureteral repair and management of major vascular injury. There are also other less definable influences on surgical education, such as an increased emphasis on faculty productivity and a reduced level of trainee autonomy, that cannot be accounted for.

The strength of the study is that it captures a time period of substantial changes in the practice of gynecologic oncology. A major limitation of this study is the lack of evidence linking the specific procedures reported to outcomes. A major weakness of this study is its use of single-institution data, prohibiting conclusions regarding national trends. Another weakness of the study is that it includes only cases reported by the fellows rather than all cases available to the fellows. It is possible but unlikely that the fellows did not avail themselves of a large number of cases. We are also unable to account for potential differences in practice among the variety of attending faculty over the years, which may also have influenced trends. Furthermore, this study was not able to fully assess other potential reasons for trends, such as referral patterns.

The results of this study suggest the need to reevaluate fellowship training and/or the scope of surgical practice in gynecologic oncology. Before considering such changes it would be important to know whether other fellowship programs and gynecologic oncology practices experience similar trends. If this is a growing national trend, then the faculty responsible for training fellows will become less surgically adept over time, thereby further prolonging the problem.

We believe a proactive evaluation and critical appraisal of necessary volumes and the matched ability of training programs to provide these are essential to ensure high quality comprehensive cancer care for women. There are numerous options to enhance fellow education to consider, including off-service rotations, simulation, increasing the length of fellowship, adding an optional laboratory year, and transitioning to a surgical oncology discipline [5,6,13–16]. In addition, programs must ensure that fellows take full advantage of the clinical materials available, particularly those related to the potential deficiencies described. The fellow selection process should be refined. Subsequent to graduation, professional growth must continue. Mentorship and learning from other related disciplines are important in this respect. Therefore, further evaluation and discussion of the current and trending situation within our specialty is warranted.

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Declaration of competing interest

The authors declare no conflicting interests relevant to the current manuscript.

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Author contributions

Study design: WR.
Conceptualization: MH, RW, SA.
Data curation: MH.
Writing- original draft: MH, WR.
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