

Original Article

Decline in radical hysterectomies for early cervical cancer may affect gynecologic oncology training

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Abstract: Objective: To evaluate the 12-year trend in the number of radical hysterectomies performed for cervical cancer in the US, and the potential impact of this trend on gynecologic oncology fellow surgical training. Methods: We queried the SEER database 13 registries to determine the number of radical hysterectomies performed each year in women with stage IA2 to IIA cervical cancer from 1998 to 2010, and extrapolated this number to the US in its entirety. Based on the number of gynecologic oncology fellows in clinical training each year, we calculated the number of radical hysterectomies available per fellow, if all operations were performed with a fellow. Least squares linear regression was applied to the data to describe trends. Results: In 1998, 3,550 radical hysterectomies were performed and there were 72 clinical fellows, resulting in an estimated 49 radical hysterectomies available per fellow. Through 2010, the number of radical hysterectomies decreased by 98 per year ($R^2=0.80$) and the average number of fellows increased by three per year. Thus, between 1998 and 2010 the number of radical hysterectomies available per fellow decreased by 2.2 cases per year, with only 20 radical hysterectomies estimated to be available per fellow in 2010 ($R^2=0.94$). Conclusion: The declining frequency of radical hysterectomy and the rising number of gynecologic oncology fellows calls for new strategies to improve fellow exposure to radical hysterectomy and consideration of alternative surgical training modalities, such as surgical simulators.

Keywords: Radical hysterectomy, gynecologic oncology, surgical education, caseload, training

Introduction

It is estimated that 12,360 women will be diagnosed with cervical cancer in the United States in 2014, and there will be 4,020 cervical cancer deaths [1]. Although there is only a 0.68% lifetime probability of developing cervical cancer in the US, this disease was the second leading cause of cancer death in women ages 20-39 in 2010. Nearly 50% of patients present with stage IA2, IB or IIA disease [2], for which radical hysterectomy is an appropriate treatment option. Radical hysterectomy represents one of the fundamental procedures in radical pelvic surgery. The surgical skills necessary to perform a radical hysterectomy, such as the ability to achieve a complete ureterolysis through Wertheim's tunnel, provide a foundation for the performance of many other complex pelvic operations.

The incidence of cervical cancer in the US has been decreasing over the last 30 years [3]. This trend is largely attributable to the prevention of invasive disease through increased detection and treatment of pre-invasive lesions, resulting from the widespread implementation of population-based screening programs. This decrease in cervical cancer cases may adversely affect our ability to train gynecologic oncology fellows in the performance of radical hysterectomy. This paper reports the results of a retrospective, descriptive study intended to estimate the ratio of radical hysterectomies performed in the US to the number of fellows in gynecologic oncology over a 12-year period.

Materials and methods

The National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program's 13 registries, which include Atlanta,

Radical hysterectomy decline impacts training

Table 1. Incidence of cervical cancer and frequency of radical hysterectomy by registry, 1998-2010

	New CC cases	Rate of CC*	RH performed for CC	Rate of RH*
San Francisco-Oakland SMSA	1,707	3.2	447	0.9
Connecticut	1,496	3.4	380	0.9
Detroit (Metropolitan)	2,129	4.4	411	0.9
Hawaii	621	3.9	211	1.4
Iowa	1,308	3.6	399	1.1
New Mexico	963	4.2	182	0.8
Seattle (Puget Sound)	1,935	3.6	688	1.3
Utah	740	2.9	192	0.6
Atlanta (Metropolitan)	1,460	4.1	331	0.9
San Jose-Monterey	1,044	3.6	320	1.1
Los Angeles	5,971	5.4	1,598	1.4
Alaska Natives	58	5	14	1.0
Rural Georgia	79	4.9	13	0.9

CC: cervical cancer; RH: radical hysterectomy; *per 100,000 women.

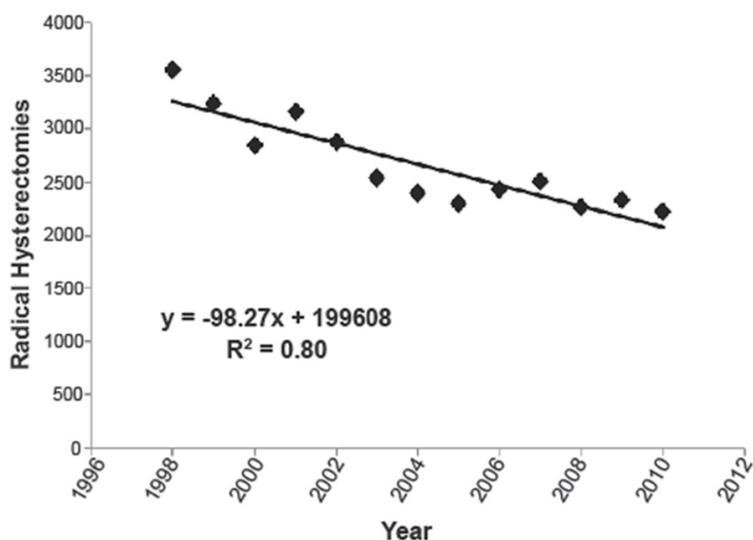


Figure 1. Estimated number of radical hysterectomies for early cervical cancer performed in the US each year, from 1998 to 2010. Number of radical hysterectomies was obtained from SEER and total number of radical hysterectomies in the US calculated. $R^2=0.80$.

Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, Utah, Los Angeles, San Jose-Monterey, Rural Georgia and the Alaska Native Tumor Registry, were queried to determine the number of radical hysterectomies (Site Specific Surgery codes 5x) performed for stage IA2, IB and IIA cervical cancer each year, from 1998 to 2010 [<http://www.seer.cancer.gov>]. As the 13 registries represent 14% of cancer diagnoses in the US, we

extrapolated this data to the US in its entirety to estimate the total number of radical hysterectomies performed for early invasive cervical cancer during each year of this 12-year period, if the frequencies of radical hysterectomy were uniform across regions. While the time spent as a research fellow during a gynecologic oncology fellowship varies between programs from 1-2 years, each fellow completes two clinical years during which they receive their surgical training. As some programs vary the number of fellows accepted during alternating years, the number of gynecologic oncology fellows on clinical duty was estimated by determining the number of fellowship positions available in each program during any given 2-year period. Based on the approximate number of clinical gynecologic oncology fellows in each year of the study, we calculated the maximum number of radical hysterectomies that were potentially available per gynecologic oncology fellow, if all operations were performed with one fellow. We applied least squares linear regression to the data to describe trends, and developed a mathematical model to predict the number of radical hysterectomies available per fellow in the future, if these trends persist.

Results

From SEER, we estimated that a total of 3,550 radical hysterectomies were performed for cervical cancer in 1998, as compared to an estimated 2,229 radical hysterectomies in 2010. The incidence of cervical cancer and frequency of radical hysterectomy in each registry during this time period is shown in **Table 1**. The mean rate of radical hysterectomy for cervical cancer during the study period was 1 per 100,000 women (95% CI 0.87-1.13). Through 2010, the

Radical hysterectomy decline impacts training

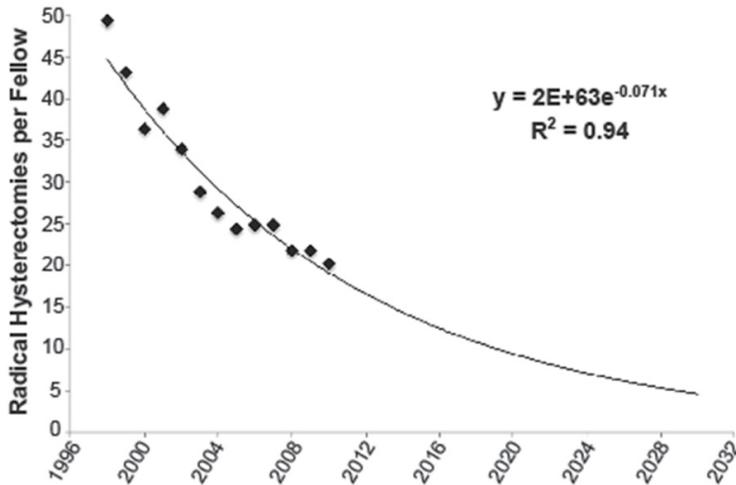


Figure 2. Estimated number of radical hysterectomies for early cervical cancer per fellow per year. Data was extrapolated 20 years further using our mathematical model, to predict the number hysterectomies available per fellow up to the year 2030. $R^2=0.94$.

number of radical hysterectomies for cervical cancer decreased by 98 per year ($R^2=0.80$; **Figure 1**). Approximately 72 gynecologic oncology fellows were in the clinical portion of their training in 1998 [4], with approximately 110 clinical fellows in 2010 [www.abog.org]. The number of clinical gynecologic oncology fellows increased by three per year during the period studied. In 1998, there were an estimated 49 radical hysterectomies available to train each fellow, compared to 20 radical hysterectomies per fellow in 2010. We found a 5% annual rate of decline of available procedures per clinical fellow during the period of this study. Thus, between 1998 and 2010 the number of radical hysterectomies per clinical gynecologic oncology fellow decreased by 2.2 cases per year ($R^2=0.94$). If this trend persists, our model predicts there will be nine radical hysterectomies available per fellow in the year 2020 and five in the year 2030, assuming that every operation is performed with one fellow (**Figure 2**).

Discussion

The results of our study demonstrate a steadily declining frequency of radical hysterectomy for early invasive cervical cancer in the US, during a time period when the number of trainees in gynecologic oncology is increasing. These findings raise questions regarding the most effective strategy to continue to ensure top quality surgical training for gynecologic oncology fel-

lows. There are no benchmarks established by the American Board of Obstetrics and Gynecology as to the number of radical hysterectomies necessary to achieve surgical proficiency. Additionally, the proportion of radical hysterectomies for early invasive cervical cancer that are performed with fellows is unknown. This number can be negatively skewed by other competing responsibilities, and positively skewed if more than one fellow is present for each radical hysterectomy or if fellows are able to be pulled from their research year(s) to participate in such cases. Such factors vary between institutions depending on the specific

training policy at each site. Finally, although the persistently declining incidence of cervical cancer will likely drastically reduce the need for radical hysterectomies for this disease in the US, the surgical skills acquired from mastering this technique are a key component of the gynecologic oncologist's surgical armamentarium, and the trends described here threaten to compromise our ability to train skilled pelvic surgeons.

While the largest contributor to the declining frequency of radical hysterectomy in the US is the decreased incidence of invasive cervical cancer following the introduction of effective screening programs, numerous other factors may have also played a role. For example, cervical cancer is increasingly being diagnosed at an advanced stage [5], at which time the treatment of choice is non-operative. Chemoradiation is the primary treatment for such patients and is highly effective, such that surgical intervention is only used in the small (5-6%) subset of patients who present with a single, localized site of pelvic recurrence that is amenable to resection [6]. An additional contributor to the declining frequency of radical hysterectomy in the US is that the age of cervical cancer diagnosis is relatively young and continues to decrease [5]. This, combined with a trend toward delayed childbearing in the US [7] has led to an increased demand for non-radical, fertility-sparing treatment options for cervical cancer. For

Radical hysterectomy decline impacts training

example, some studies have indicated that, in low-risk patients with a strong desire to maintain fertility, a laparoscopic pelvic lymphadenectomy and simple, non-radical vaginal trachelectomy is a reasonable option [8]. As of 2008, over 900 fertility-conserving procedures for invasive cervical cancer have been reported, with over 300 subsequent pregnancies and 195 live births. While many of these fertility-conserving procedures were non-radical, some included radical trachelectomy, a procedure that does require a surgical expertise similar to radical hysterectomy. Over the last two decades, radical trachelectomy with cerclage placement and pelvic lymphadenectomy has been successfully used for the treatment of invasive cervical cancer in patients who desire fertility preservation, with low recurrence rates (4%) [9]. Training gynecologic oncology fellows to perform radical trachelectomy may develop many of the same skills as radical hysterectomy; however, as the incidence of invasive cervical cancer continues to decline in the US, the total number of radical hysterectomies and trachelectomies will fall as well.

While later stage and earlier age of diagnosis have already likely contributed to the decreasing frequency of radical hysterectomy for invasive cervical cancer, this frequency may further decline if the surgical management of cervical cancer trends in the same direction as that of a number of other malignancies, including breast, colorectal and orthopedic tumors, which have evolved to include diminished radicality without compromising efficacy [10-12]. A more conservative approach has already been employed for other gynecologic malignancies [13], including vulvar cancer where treatment has shifted from en bloc radical vulvectomy and bilateral inguino-femoral lymphadenectomy to a more localized excision of the primary tumor and separate groin incisions for lymphadenectomy. In cervical cancer patients, a number of measures have already been introduced to reduce the radicality of surgery and the subsequent morbidity associated with surgical management. Many patients undergoing radical hysterectomy experience postoperative morbidity in the form of acute or chronic voiding dysfunction due to the disruption of the autonomic innervation to the bladder during resection of uterine supporting ligaments [14]. As this outcome can significantly impair patient quality of life, some now advocate for reducing the radicality of paramet-

rectomy in well-selected patients, in order to achieve an adequate therapeutic benefit while minimizing pelvic floor dysfunction [15]. Others recommend completely eliminating parametrectomy in patients with low-risk, early invasive disease. Pluta and colleagues favor a laparoscopic pelvic lymphadenectomy and simple vaginal hysterectomy in stage 1A1-1B1 cervical cancer patients with negative sentinel lymph nodes and favorable tumor characteristics, such as tumor diameter of less than 2 centimeters and less than 50% cervical stromal invasion [16]. Likewise, several groups have suggested that neoadjuvant chemotherapy followed by extrafascial hysterectomy in patients with early invasive cervical cancer should be considered [17]. As these and other conservative surgical approaches are increasingly employed, the volume of radical pelvic operations for gynecologic oncology trainees is inevitably reduced, further demonstrating the need for alternative surgical training modalities.

The increasing number of gynecologic oncology fellows is a trend that will persist as our subspecialty continues to grow. Studies in endocrine surgery demonstrate that fellow-assisted cases account for only a small portion (6.6%) of total case volume, and that despite an expansion of fellowships with increased numbers of trainees, the percentage of fellow-assisted operations has remained the same [18]. This, along with the close link between the volume of cases performed and surgeon proficiency, indicates the importance of finding a means to preserve surgical volume for training. One mechanism to achieve this may be to concentrate less common surgical procedures at centers of excellence or encourage referrals to training institutions [19-20]. The incorporation of community affiliates into surgical training programs should also be considered, allowing the surgical volume for trainees to be drawn from a wider pool. Additionally, the integration of domestic and international surgical rotations at sites where disease prevalence is higher may increase the potential for trainee involvement in such procedures [21].

The increased use of minimally invasive surgical techniques in gynecologic oncology presents an additional consideration regarding the adequacy of surgical training, as fellows will need to demonstrate proficiency in the same procedure via multiple surgical approaches.

Radical hysterectomy decline impacts training

Urologic oncology training programs are noting that, even when the total caseload for any given procedure remains the same, the number of cases that a trainee partakes in via each surgical approach, such as open, laparoscopic or robotic-assisted, is inherently lower [22]. While the principles of the procedure are the same, regardless of surgical approach, the vantage point, instruments used, and the ability to dissect and maneuver the tissue vary considerably with each approach, and thus proficiency in one approach does not immediately portend proficiency via other approaches. As such, fellows must gain exposure and develop skillsets for each individual approach to radical hysterectomy in order to attain proficiency in each. To address this issue in the setting of decreasing case volume, some surgical oncology training programs advocate for strengthening surgical teaching opportunities independent of caseload, with an effort to enhance surgeon proficiency via focused skill training rather than case volume [23]. In gynecologic oncology, combinations of interactive anatomy lectures, cadaveric dissection, porcine surgery on a recently deceased pig and live ovine surgery have been evaluated as possible models for surgical skills education [24, 25]. In gastroenterology, the application of web-based procedural training is being evaluated [26], while in general surgery the use of virtual reality has been demonstrated as an effective surgical training tool [27]. Simulation technology may also be utilized to augment operative learning, as it offers repetition, can be used at the learner's own pace and provides learner-centered performance evaluation with objective feedback [22]. A surgical skills laboratory with a competence-based curriculum may provide a means for trainees in all stages of their careers to hone new surgical skills and enhance operative expertise [28]. Finally, a study to determine the adequate number of radical hysterectomies necessary for surgical expertise may be needed to establish a guideline by which to measure the proficiency of our trainees.

Our study has several limitations. While the use of registry data allows for a broad sampling of the general population and practice in the US, the extrapolation of this sample to the US in its entirety provides only an approximation of the frequency of radical hysterectomy. Inaccuracies in this estimation may exist as the incidence of cervical cancer varies between the 13 regis-

tries evaluated, and this distribution is unlikely to be uniform across the US. However, despite this varying incidence, the rate of radical hysterectomy for cervical cancer is similar in each registry (**Table 1**), potentially allowing for better extrapolation to the US in its entirety. A review of annual fellow surgical case lists submitted to the American Board of Obstetrics and Gynecology would provide a more accurate representation of fellow case volume across the US, but these reports were not made available for analysis. However, in lieu of this, SEER data serves as a good surrogate for national trends as it has been shown to correlate well with Medicare data in regard to the surgical treatment of cancer in the US [29]. Additionally, this study specifically evaluated radical hysterectomy for patients with early invasive cervical cancer; other indications for radical hysterectomy were not included. Despite the potential inaccuracies in the exact number of procedures per year, this model does provide a good representation of the trend in the frequency of radical hysterectomy for early invasive cervical cancer in the US over this 12-year period. Our calculation of the maximum number of radical hysterectomies potentially available per fellow each year does not account for operations that are performed with more than one fellow, which may result in an underestimation of cases per fellow. However, we also assume that every operation is performed at an institution with fellows which undoubtedly overestimates the number of cases per fellow as not all institutions have gynecologic oncology trainees, including some of the regions represented in the registries used for this study, such as Hawaii. It is difficult to determine the exact number of fellows in each registry during each of the 12 years of this study, due to the intermittent opening and closure of fellowship programs as well as the fluctuating number of fellows enrolled in any given year. However, at the present time there are 7 fellowship programs included in the 13 registries evaluated for this study, with a total of 8 fellows per year [www.abog.org]. This is in comparison to the 46 total programs nationwide currently, with between 55-63 fellows per year depending on the year of enrollment in question. While variations in the exact number of fellows and procedures each year surely exist, our prediction of the number of radical hysterectomies and clinical gynecologic oncology fellows in coming years is based

Radical hysterectomy decline impacts training

on a mathematical model using trends seen over a 12-year period, and is meant to initiate discussion regarding alternative means to educate trainees in these surgical techniques.

There are a number of reasons for the declining rate of radical hysterectomy for invasive cervical cancer, and this rate may continue to decrease as the effects of vaccination against human papilloma virus on the incidence of cervical cancer become apparent in the years to come. Although, in the future, radical hysterectomy for treatment of cervical cancer may not be necessary in the US due to a dying disease, expertise in the operative techniques employed during radical hysterectomy is critical to the adept performance of other specialized and complex pelvic operations. While we acknowledge that a precise forecasting of the number of cases per fellow-in-training is not possible with the available data and with changes in the incidence of cervical cancer, this study provides a fair approximation of the near term future. In the setting of declining case volume and an increasing number of gynecologic oncology subspecialty trainees, our findings emphasize the importance of developing new strategies to attain surgical proficiency.

Disclosure of conflict of interest

The authors have no conflicts of interest.

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Radical hysterectomy decline impacts training

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