Gynecologic Oncology 152 (2019) 133–138

Contents lists available at ScienceDirect

Gynecologic Oncology

journal homepage: www.elsevier.com/locate/ygyno

Trends and comparative effectiveness of inpatient radical hysterectomy for cervical cancer in the United States (2012–2015)

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HIGHLIGHTS

- Rates of inpatient radical abdominal hysterectomy declined significantly between 2012 and 2015.
- A proportionate increase in minimally invasive surgery, notably robotic surgery was noted.
- Minimally invasive surgical approaches have shorter length of stay and significantly less complications.

ARTICLE INFO

Article history:
Received 11 June 2018
Received in revised form 18 September 2018
Accepted 24 September 2018
Available online 10 November 2018

Keywords:
Radical hysterectomy
Cervical cancer
Minimally invasive radical hysterectomy
Comparative effectiveness
National inpatient sample

ABSTRACT

Objective. Report the up-to-date trends in surgical approach for cervical cancer and compare outcomes between open and minimally invasive routes.

Methods. Radical Hysterectomy (RH) cases from the National Inpatient Sample (NIS) dataset between 2012 and 2015 were grouped into abdominal (ARH) and Minimally Invasive Surgery (MIS). The MIS group was subdivided as "Laparoscopic", "Robotic", and "Converted". Univariate and multivariable logistic regression were used to analyze differences in complication rates. The National Surgical Quality Improvement Dataset 2015 was used for validation.

Results. A total of 7180 cases from NIS were identified. Overall, there was 44% decline in RH cases from 2012 (n = 2220) to 2015 (n = 1255). A proportionate increase in robotic cases from 31.5% in 2012 to 41.4% in 2015 was noted. By intention to treat analysis, the rate of at least one complication for abdominal cases was 24.8% compared to 10% for MIS ($p < 0.001$). On multivariate analysis, abdominal cases had higher odd of any one complication (aOR 2.9,95% CI 2.12–4.00), medical complication (aOR 3.25,95% CI 2.15–4.19), infectious complication (aOR 3.76,95% CI 2.1–6.1) but not for surgical complications (aOR 1.7,95% CI 0.5–5.6). AH resulted in longer hospital stay compared to MIS (4.3 vs 1.9 days, $p < 0.001$). Median cost of AH was $12,624, laparoscopic $12,873, robotic $14,029 and converted cases $17,036. NSQIP analysis supplemented the outcomes to 30-days and showed similar findings.

Conclusions. Perioperative complications are significantly lower for MIS procedures. These data should be used for contemporary cost-effective analysis and comprehensive counseling regarding risks and benefits of the surgical approach for cervical cancer.

1. Introduction

The National Comprehensive Cancer Network Guidelines (NCCN) recommend radical hysterectomy for early-stage, localized cervical cancer [1]. Radical hysterectomy can be accomplished either using a minimally invasive (robotic-assisted vs traditional laparoscopy) or open abdominal approach. Several publications have compared the minimally invasive approach to open radical hysterectomy and concluded that minimally invasive surgery leads to improved postoperative outcomes (lower estimated blood loss, lower transfusion rates, reduced hospital length of stay and overall lower intraoperative complications) [2,3]. Furthermore, a meta-analysis of 17 clinical trials concluded that robotic radical hysterectomy specifically was superior to both traditional laparoscopy and open radical hysterectomy in multiple outcome measures such as intraoperative blood loss, length of hospital stay and intraoperative and postoperative complications [4].

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https://doi.org/10.1016/j.ygyno.2018.09.027
0090-8258/

However, recent data (presented as an abstract during the recent Society of Gynecologic Oncology's Annual Meeting 2018) seem to support that open radical hysterectomy confers a survival advantage over minimally-invasive approaches [5]. Although this study is not yet published, there is a potential for these data to lead to sweeping changes in clinical practice. While we await the publication of these studies, we performed this analysis of the National Inpatient Sample (NIS) database to analyze the recent trends in the total number of cases and surgical approach utilized for radical hysterectomy performed for the diagnosis of cervical cancer. We also compared the surgical outcomes between minimally invasive radical hysterectomy and open radical hysterectomy in a contemporary population-based dataset. We hypothesized that rates of minimally invasive surgery would be increasing over time consistent with data from prior years and that the Robotic volume in particular would be higher. We also hypothesized that the abdominal approach would have higher complication rates consistent with previous data.

2. Material and methods

2.1. Data sources

The National Inpatient Sample (NIS) from the Healthcare Cost and Utilization Project (HCUP) was utilized for this cross-sectional database analysis [6]. The NIS is the largest publicly available all payer inpatient database in the United States. This dataset is a stratified sample of hospitals drawn from existing state databases that make their information available to the HCUP with data that can be matched to the American Hospital Association (AHA) annual survey of hospitals. Each discharge includes up to 15 inpatient diagnostic and 15 procedural codes. The first diagnostic code represents the primary reason for admission. All procedures and diagnoses are coded using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). For this analysis, we utilized data from the 2012 to 2015 releases of the NIS database. The NIS dataset has two notable shortcomings: 1) it does not include cases where patients are discharged on the same day as their surgery, and 2) outcomes reported from NIS are for the index hospitalization (i.e. post discharge complications and readmissions are not captured in NIS). In order to overcome these shortcomings of the NIS we also analyzed the National Surgical Quality Improvement (NSQIP) dataset participant user file for the year 2015. Then NSQIP has been extensively studied and the details of this dataset are available here [7].

2.2. Study population

We identified patients ≥18 years and ≤90 years of age with a procedure code for radical hysterectomy performed for cervical cancer (ICD-9-CM codes are presented in Table 1). Cases with a modifier “V6441” were labelled as converted from either traditional laparoscopy or robotic-assisted to open abdominal surgery. As there is no reliable way of determining whether the case was started as traditional laparoscopy or robotic-assisted prior to conversion, all converted cases were combined and labelled as “converted to open”. Cases with diagnostic codes 180.0, 180.1, 180.8 and 180.9 were used to identify women undergoing radical hysterectomy for cervical cancer. For the NSQIP we utilized the following primary Common Procedural Terminology (CPT): abdominal radical hysterectomy (58210) and minimally invasive (58,285 and 58,548) to identify the radical hysterectomy cases.

2.3. Trends in radical hysterectomy cases

Population-level proportions of yearly cases performed by each approach of radical hysterectomy (abdominal, laparoscopic, robotic and converted to abdominal) were calculated using discharge-level weight provided by the HCUP in the NIS dataset.

Table 1
ICD-9-CM codes utilized in the study.

Condition	ICD-9-CM codes
Hysterectomy procedure codes	
Abdominal Hysterectomy	68.6 68.69
Laparoscopic Hysterectomy	68.61 68.71
Robotic Hysterectomy (modifier)	17.x
Lymph node sampling or dissection	40.0 40.1 40.11 40.19 40.2 40.24 40.29 40.3 40.5 40.50 40.52 40.53 40.59 40.9
Converted to open (modifier)	V6441
Diagnostic codes	
Cervical cancer	182.0, 180.1, 180.8, 180.9
Class III obesity (morbid obesity)	278.01 278.03 V85.4 V85.41 V85.42 V85.43 V85.44 V85.45
Class I/II obesity	Includes patients with obesity but not morbid obesity codes
Non-obese	No obesity code in the chart

ICD-9-CM: International Classification of Diseases, Ninth Revision, Clinical Modification.

2.4. Independent variables

The following patient, perioperative, and hospital-level factors were included as independent variables: patient age in years (categorized as: <40, 40–49, 50–59, 60–69, 70–79, and ≥80); Elixhauser comorbidity score as provided by the HCUP (1, 2, or ≥3) [8]; insurance type (Medicare, Medicaid, private, uninsured, other/missing); income categories as provided by the NIS database ($1–37,999, $38–47,999, $48–63,999, ≥$64,000); hysterectomy type (abdominal, laparoscopic, robotic, converted); lymphadenectomy (performed or not performed); hospital ownership (government, private non-profit, private for-profit); hospital size (small, medium, large); and hospital teaching status (rural, urban non-teaching, urban teaching). Obesity was categorized as non-obese, Class I/II obesity or Class III obesity, using methodology previously described [9].

2.5. Outcomes

Population-level proportions of patient demographics and comorbidities by the approach of radical hysterectomy were calculated using discharge-level weight provided by the HCUP. For this portion of the analysis, we included the laparoscopic or robotic cases which were converted to open under the minimally invasive category to provide outcomes based on intention to treat analysis. We subsequently used Stata version 14 (StataCorp, College Station, TX) postestimation command ‘**testparam**’ to determine if the proportional distribution in each category was statistically significant. Stata postestimation commands perform likelihood ratio tests to determine if the proportions in each category are significantly different. We used this approach, as the use of traditional Chi-Square test in weighted data violates the assumption that the data are being independently and identically drawn from a distribution [10].

We evaluated several perioperative outcomes for a relationship with the different types of radical hysterectomy. The perioperative outcomes included any surgical complication, any medical complication, any infectious complication, any reoperation, blood transfusion after surgery, and death during the same hospitalization after surgery. Details on the ICD codes included in each category of outcome are provided in Supplementary Table 1. We first evaluated several patient factors (age, Elixhauser comorbidity score, insurance category, income category, and obesity category) and hospital factors (hospital type, geographic location, teaching status, size) associated with each perioperative outcome. Based on these univariate analyses, we adjusted our multivariate models for age, Elixhauser comorbidity categories, performance of lymphadenectomy, hospital bed size, and patient's insurance status. To avoid overfitting the models, we did not include the hospital ownership status (not significant with any outcome), or urban/rural classification (significant correlation with hospital bed size).

2.6. Cost

Cost was calculated using the information provided by the HCUP database. These files provide the details of the amount billed by the hospital and not the actual cost of care (or payment received from the primary payer). To overcome this limitation, HCUP provides cost-to-charge ratio files based on hospitals' accounting reports to the CMS [11]. We utilized these files to convert all charges to cost. The cost of care in this manuscript is from a payor's perspective and represents the dollar amount reimbursed to the hospital by the insurance company. Details on the distinction between cost and charge are provided on the HCUP website [11].

2.7. Results validation

We utilized the NSQIP for validating our results. Specifically, the NSQIP dataset includes patients who were discharged on the same day of their surgery. In addition, the NSQIP reports complications experienced by a patient up to 30 days in their postoperative period. Outcomes between minimally invasive and abdominal radical hysterectomy were compared using the 2015 release of the NSQIP dataset.

3. Results

A total of 7180 cases of radical hysterectomy were performed for cervical cancer between 2012 and 2015. Of these, 54.8% (95% CI, 51.8–57.8) were abdominal, 36.6% (95% CI, 33.8–39.5) robotic, 7.6% (95% CI, 6.3–9.2%) were laparoscopic, and 0.97% (95% CI, 0.58–1.64) were converted from robotic or laparoscopic to abdominal radical hysterectomy. Fig. 1 highlights the 43.5% overall decline in the annual number of cases from 2220 in 2012 to 1255 cases in 2015. Although robotic hysterectomy cases decreased from 700 in 2012 to 520 cases in 2015, the annual proportion of robotic hysterectomy cases rose from 31.5% in 2012 to 41.4% in 2015. The proportion of laparoscopic radical hysterectomy declined from 7.9% in 2012 to 6% in 2015.

Nearly 60% of the patients were below the age of 50 years old, 30% were <40 years old and 30% between 40 and 49 years old. The majority of the patients held private insurance (50%), other insurance types included Medicaid (27%), Medicare (13%) with 5% being uninsured. Less than 1% of cases were done in hospitals in rural settings and the majority were performed in urban teaching hospitals (86%). Lymph node dissection was performed in 93% of radical hysterectomies. Details of all

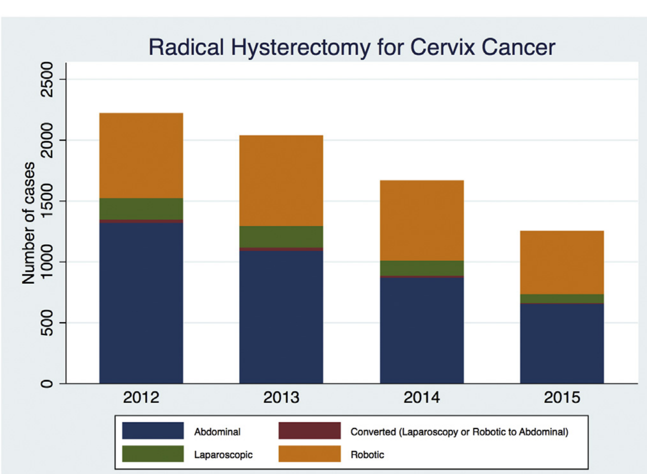

Fig. 1. Trends in inpatient radical hysterectomy performed for the indication of cervical cancer in the United States between 2012 and 2015.

baseline demographic data of the population available are presented in Table 2.

By intention to treat analysis, the overall rate of at least 1 complication from abdominal cases was 24.8% (95% CI 21.9–27.9) compared to 10% (95% CI 7.9–12.7) for minimally invasive cases. On multivariate analysis, abdominal cases had a higher odds of any one complication (aOR 2.9, 95% CI 2.12–4.00, $p < 0.001$), any “medical” complication (aOR 3.25, 95% CI 2.15–4.19, $p \leq 0.001$), any “infectious” complication (aOR 3.76, 95% CI 2.1–6.1, $p \leq 0.001$) but not for “surgical” complication (aOR 1.7, 95% CI 0.5–5.6, $p = 0.38$). More patients undergoing abdominal hysterectomy underwent transfusion (intraoperative or postoperative in the same hospitalization) compared to minimally invasive hysterectomy (18% vs. 2.4%, OR - 9.1, 95% CI 5–14.9, $p < 0.001$). No deaths were noted in this cohort. Patients undergoing abdominal hysterectomy had a longer hospital stay (4.3 days [95% CI 4–4.6], compared to the minimally invasive cohort (1.9 days [95% CI 1.8–2]; $p < 0.001$). Details of each complication and their rates within the abdominal and minimally invasive cohorts, along with the adjusted odds ratios based on multivariate analysis, are detailed in Table 3.

Median cost of abdominal procedures was $12,624 (IQR 9391–17,273), laparoscopic cases $12,873 (IQR 8802–18,312), robotic cases $14,029 (IQR 10321–18,100) and converted to open cases $17,036 (15837–26,190).

NSQIP analysis revealed a total of 254 cases of radical hysterectomy performed for cervical cancer in 2015. Only 6.3% (17/254) of the total cohort was discharged on the same day and would not have been captured by the NIS. Complications occurring within 30-days of surgical procedure were analyzed between the MIS and abdominal cohorts and are presented in Supplementary Table 2. Overall, the results were consistent with the NIS analysis.

4. Discussion

During the years 2012–2015, rates of perioperative complications from abdominal radical hysterectomies far outpaced complications from minimally invasive radical hysterectomies by a significant margin of 24.8% to 10%. More detailed analysis showed significantly more “medical” complications and a higher rate of “infectious” complications. “Surgical” complications were not different between the abdominal and minimally invasive groups. In the context of previous studies, these results are not surprising. Prior work comparing abdominal and minimally invasive approaches studies have consistently demonstrated the advantages of minimally invasive radical hysterectomy over abdominal radical hysterectomy in both recovery, complications and survival [2,3,15]. It is critical to continue to highlight these important differences as the most contemporary data becomes available so that it can be used for comprehensive patient counseling and education regarding the surgical management of early-stage cervical cancer.

Although these data are unable to make inferences regarding differences between laparoscopic and robotic radical hysterectomies, the robotic approach was previously shown to result in better outcomes. In a meta-analysis, Jin et al. reported the results of 17 clinical trials and noted that patients undergoing robotic or laparoscopic radical hysterectomy had lower odds of complications compared to the abdominal approach (OR = 0.21, 95% CI = 0.08–0.65). However, they also observed that patients undergoing a robotic approach had lower odds of postoperative complications when compared to laparoscopic (OR = 0.42, 95% CI 0.20–0.87) [4]. Another recent study reported that robotic radical hysterectomy was superior to laparoscopic radical hysterectomy not only in numerous perioperative outcomes, but also in regard to survival [13]. It showed that there were no relapses or deaths in their 100-patient robotic cohort whereas 4.2% of the 833-patient laparoscopic cohort had recurred and 2.9% had died ($p = 0.03$ for recurrence and $p = 0.07$ for death). Results should be interpreted with caution since the duration of follow-up in the two groups was not reported but based on the case time-frame is likely very different and favored the robotic group.

Table 2
Baseline demographic information on the cohort.

Variable		N	Minimally Invasive	Percentage	Abdominal	Percentage	p-values
Numbers		7180	3245	45.2%	3935	54.8	
Age (in years)	<40	2155	948	29.20%	1190	30.24%	<0.001
	40-49	2170	1015	31.28%	1155	29.35%	<0.001
	50-59	1490	580	17.87%	910	23.13%	<0.001
	60-69	945	445	13.71%	500	12.71%	<0.001
	70-79	315	205	6.32%	110	2.80%	<0.001
	>=80	105	35	1.08%	70	1.78%	0.008
Elixhauser Comorbidity Index	0-1	2785	1335	41.14%	1450	36.85%	<0.001
	2	2080	970	29.89%	1110	28.21%	<0.001
	>3	2315	940	28.97%	1375	34.94%	<0.001
Insurance	Medicare	965	490	15.10%	475	12.07%	<0.001
	Medicaid	1905	765	23.57%	1140	28.97%	<0.001
	Private	3605	1730	53.31%	1875	47.65%	<0.001
	Uninsured	380	120	3.70%	260	6.61%	<0.001
	Other/Missing	325	140	4.31%	185	4.70%	
APDRG classification	1	3935	1870	57.63%	2065	52.48%	<0.001
	2	2465	1105	34.05%	1360	34.56%	<0.001
	3	625	225	6.93%	400	10.17%	0.002
	4	155	45	1.39%	110	2.80%	<0.001
Type of Hysterectomy	Abdominal	3935	0	0.00%	3935	100.00%	NA
	Laparoscopic	545	545	16.80%	0	0.00%	NA
	Robotic	2630	2630	81.05%	0	0.00%	NA
	Converted	70	70	2.16%	0	0.00%	NA
Income (in US Dollars based on Zip Code)	1-37,999	1905	856	26.39%	1015	25.79%	<0.001
	38,000-47,999	1838	841	25.93%	1030	26.18%	<0.001
	48,000-63,999	1665	896	27.62%	1065	27.06%	<0.001
	>=64,000	1772	651	20.06%	825	20.97%	<0.001
Hospital Ownership	Government	1415	485	14.95%	930	23.63%	<0.001
	Private, non-profit	5045	2395	73.81%	2650	67.34%	<0.001
	Private, for-profit	720	365	11.25%	355	9.02%	<0.001
Hospital Size	Small	565	265	8.17%	300	7.62%	<0.001
	Medium	1650	795	24.50%	855	21.73%	<0.001
	Large	4965	2185	67.33%	2780	70.65%	<0.001
Hospital Teaching Status	Rural	40	10	0.31%	30	0.76%	0.113
	Urban Non-Teaching	970	500	15.41%	470	11.94%	0.0250
	Urban Teaching	6170	2735	84.28%	3435	87.29%	<0.001
Obesity Classification	Non-obese	6090	2735	84.28%	3355	85.26%	<0.001
	Class I/II obesity	740	335	10.32%	405	10.29%	<0.001
	Class III Obesity	350	175	5.39%	175	4.45%	<0.001
Lymph Node Dissection	Not Performed	505	215	6.63%	290	7.37%	<0.001
	Performed	6675	3030	93.37%	3645	92.63%	<0.001

NA – Not Applicable.

An additional small study from Pellegrino et al. showed an overall survival of 100% for robotic radical hysterectomy after a median follow-up of 59 months vs an OS of 84% for laparoscopic radical hysterectomy after a median follow-up of 30 months [14]. Differences in outcomes between the robotic and laparoscopic approaches are critical to highlight due to recent data presented in abstract form that observed lower survival rates for minimally invasive radical hysterectomy vs an abdominal approach [5]. That study enrolled a much higher ratio of laparoscopic to robotic approaches than observed in the contemporary practice demonstrated in this NIS data, in addition to a large cohort of patients from outside the United States.

Overall, there has been a 40% drop in total number for inpatient radical hysterectomies performed in the United States between 2012 and 2015. This reduction in the utilization of radical hysterectomy is multifactorial. First, the uptake of the human papilloma vaccine (HPV) has steadily increased in the United States [12]. Second, there has been an increase in the uptake of fertility preserving procedures in early stage carcinoma [13]. Third, there is increasing recognition that in some early stage cases less radical surgery is adequate and radical hysterectomy might not be necessary [14]. Lastly, there has been an increase in same-day discharge after minimally invasive radical hysterectomy [15]. These patients are not captured in the NIS dataset and could explain the downward trend of inpatient radical hysterectomy. Although the proportion of these patients is low as the median number of days in patients undergoing radical hysterectomy (between 2007 and 2013) was noted to be 1.7 days [16].

The rates of abdominal radical hysterectomy have fallen significantly from 60% of all radical hysterectomies performed in 2012 to 50% in 2015. Wright et al. previously reported trends of minimally invasive radical hysterectomy compared to abdominal radical hysterectomy for cases done between 2006 and 2010 from the Perspective database. In that time interval, the rates of minimally invasive radical hysterectomy increased from 1.8% in 2006 to 22.5% in 2010 [17]. Our results show a continuing trend with rates of minimally invasive radical hysterectomy with an increase from 40.5% in 2012 to 48% in 2015. These trends of increasing utilization of minimally invasive surgery are likely driven by the significant advantages for numerous perioperative outcomes and shorter length of stay that favor minimally invasive approaches [3,17].

In addition to numerous studies demonstrating the benefits of minimally invasive hysterectomy regarding perioperative outcomes, there are some data evaluating their oncologic safety. One retrospective study compared laparoscopic radical hysterectomy ($n = 263$) to abdominal radical hysterectomy ($n = 263$) and reported similar 5-year recurrence free survival rates for both groups (92.8% vs. 94.4%, $p = 0.5$) [18]. A recent multi-center study reported by Sert et al. compared 259 patients undergoing robotic radical hysterectomy to 232 undergoing abdominal radical hysterectomy showed that the overall survival (97.3% vs 96.1%, $p = 0.48$) and the recurrence rate was similar (91.1% vs 90.9%, $p = 1.00$) at 39 months [2]. Another retrospective report comparing 58 patients who underwent a robotic radical hysterectomy to 39 patients who underwent an abdominal radical hysterectomy concluded that 5-year progression-free survival (89.7% vs 84.6%, $p = 0.271$) as well

Table 3
Univariate and Multivariate analysis of outcomes based on approach (minimally invasive vs. abdominal) based on intention to treat analysis.

	Minimally invasive[b] (N = 3245)	Abdominal (N = 3935)	Univariate analysis		Multivariate analysis[a]	
			Odds ratio (95% CI)	p-Value	Odds ratio (95% CI)	p-Value
Any 1 complication	10.02	24.80	3.1	<0.001	2.92 (2.12–4.03)	<0.001
Any surgical complication (%)	3.10	5.46	1.73	0.052	1.61 (0.91–2.83)	0.102
Hematoma/seroma	0.16	1.02				
Bleeding	0.63	1.91				
Ureter injury	0.31	0.51				
Bladder injury	2.00	1.14				
Bowel injury	0.00	0.89				
Any medical complications (%)	5.35	18.68	3.45	<0.001	3.25 (2.15–4.19)	<0.001
CNS complications	0.79	0.89				
Respiratory failure	1.73	5.34				
Cardiac complications	0.16	1.02				
Venous thromboembolism	0.16	1.02				
Renal complications	0.79	2.16				
GI bleed	0.00	0.25				
Ileus or bowel obstruction	1.73	7.88				
Any infectious complications (%)	2.20	10.17	4.26	<0.001	3.76 (2.07–6.08)	<0.001
Surgical site infections	0.00	1.40				
Other infections	0.16	0.13				
Urinary tract infections	1.42	3.43				
Sepsis	0.00	1.14				
Pneumonia	0.63	3.56				
Clostrium difficile	0.00	0.51				
Reoperation (%)	0.63	1.40	2.24	0.17	1.71 (0.5–5.6)	0.38
Transfusion (%)	2.36	18.04	9.10	<0.001	8.6 (4.97–14.92)	<0.001
Death (%)	0	0	NA	NA	NA	NA

CNS complications.
[a] Data adjusted for age, Elixhauser comorbidity score, insurance type, hospital bed size, obesity status and performance of lymph nodes.
[b] Minimally Invasive surgery is the referent category.

as overall survival (96.6% vs 92.3%, p = 0.80) were similar between the two approaches [10]. Nevertheless, the recent abstract presentation of an international, multi-center randomized controlled trial suggests that minimally invasive radical hysterectomy may lead to worse survival than the abdominal approach with some data remaining to be collected and analyzed [5]. To facilitate further research in comparative effectiveness and cost-effectiveness of abdominal vs. minimally invasive radical hysterectomy, the data contained herein provide contemporary trends in radical hysterectomies along with recent historical postoperative complications and length of stay in the prime of the era of minimally invasive radical surgery for early-stage cervical cancer.

The major strength of this study is the use of a large national database which allows for a large sample size and analytic power. Moreover, this study provides a population-based trend in adoption of minimally invasive radical hysterectomy as well as complication rates of each surgical approach that would be expected in routine practice settings. It merits mention for the reader that claims-based research is not without limitations. These data rely on accurate coding to ensure validity. Previous studies have noted that the complications/outcomes may not be rigorously coded in administrative data and this may lead to inaccurate rates of both surgical and non-surgical outcomes and subsequent information bias [19]. Moreover, these estimates are for complications occurring during the same hospitalization and not within the first 30-days which is a standard assessment in post-surgical outcomes. Lastly, the National Inpatient Sample database only captures inpatient episodes, so these data also are unable to capture any radical hysterectomies with same-day discharge (or those staying as short stay of 23 h) that would be considered outpatient rather than inpatient. This may be one reason contributing to the observed decline in the total number of radical hysterectomies performed annually. Lastly, the higher complication rate in abdominal hysterectomy could represent a selection bias, as these patients included in this study were not randomized.

In summary, for the years of 2012–2015 in a large US population-based cohort, these data from the NIS join consistent findings of previous reports that minimally invasive radical hysterectomy results in a significantly lower rates of perioperative outcomes, blood transfusions and shorter hospital length of stay compared to an abdominal approach. The trend of an increasing proportion of radical hysterectomies being performed in a minimally invasive fashion continued throughout the same period - especially for robotic-assisted cases. These results are important for gynecologic oncologists to use when counseling patients regarding the most appropriate surgical approach for the treatment of early-stage cervical cancer.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ygyno.2018.09.027.

Conflict of interest

The authors have no conflicts of interest to disclose.

Author contribution

RS, SU: Contributed to the design, statistical analysis of the data, interpretation of the results and writing of the manuscript.

JRL, RKR, LWR: Contributed to the design, interpretation of the results and writing of the manuscript.

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