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Original Article

Primary sarcoma of the cervix: an analysis of patient and tumor characteristics, treatment patterns, and outcomes

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Conflicts of Interest
No potential conflict of interest relevant to this article was reported.

ABSTRACT

Objective: Primary sarcoma of the cervix is rare and is associated with worse outcomes as compared to other histologies. The purpose of this study was to identify national treatment patterns and outcomes based on histological subtype using the National Cancer Database (NCDB).
Methods: The NCDB was queried for patients with cervical cancer from 2004–2015. Clinico-demographic treatment details were obtained and compared between patients with squamous cell carcinoma (SCC), adenocarcinoma, and sarcoma of the cervix. Multivariable Cox regression and the Kaplan-Meier method was used to examine survival.
Results: 107,177 patients met inclusion criteria including 81,245 (75.8%) women with SCC, 24,562 (22.9%) women with adenocarcinoma, and 1,370 (1.3%) women with sarcoma. Of the patients with cervical sarcoma, 680 (49.6%) patients had carcinosarcoma or malignant mixed Müllerian tumor, 255 (18.6%) patients had leiomyosarcoma, 197 (14.4%) patients had adenosarcoma, 28 (2.0%) patients had endometrial stromal sarcoma (ESS), 85 (6.2%) patients had rhabdomyosarcoma, and 125 (9.1%) patients had sarcoma not otherwise specified (NOS). Patients with sarcoma were older and more likely to be treated primarily with surgery. On multivariable Cox regression, sarcoma had decreased overall survival (OS) as compared to patients with SCC (hazard ratio=2.17; 95% CI=1.99–2.37; p<0.001). Among patients with sarcoma, 5-year OS was 89.2% for adenosarcoma, 66.2% for rhabdomyosarcoma, 55.6% for leiomyosarcoma, 45.8% for ESS, 31.6% for carcinosarcoma, and 29.2% for sarcoma NOS.
Conclusions: Primary cervical sarcomas have inferior outcomes compared to SCC and adenocarcinoma. Sarcoma NOS and carcinosarcoma have the worst prognosis among sarcoma subtypes.

Keywords: Sarcoma; Cervix

INTRODUCTION

Squamous cell carcinoma (SCC) accounts for approximately 75% of cervical cancer and adenocarcinoma accounts for the remaining 25% [1,2]. The incidence of adenocarcinoma has increased in recent years since screening methods may be less effective for detecting

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adenocarcinoma as compared to SCC [3]. Other less common histologies include neuroendocrine carcinoma, small cell tumors, glassy-cell carcinomas, and sarcomas.

Treatment of such rare cervical tumors is not currently included in the National Comprehensive Cancer Network Guidelines for cervical cancer and current treatment strategies may be extrapolated from data regarding uterine sarcomas and soft tissue sarcomas. Information regarding the incidence and characteristics of sarcoma of the cervix is based on smaller case series [4]. In a hospital-based tumor registry, 8 cervical sarcomas were identified among 1,583 cervical malignancies [4]. Carcinosarcoma was found to be the most common subtype in that series and most patients presented with vaginal bleeding and a large pelvic mass at diagnosis. A more recent, larger population-based analysis utilizing the Surveillance, Epidemiology, and End Results (SEER) database was performed in 2010 by Bansal et al. [5] and included 323 patients with cervical sarcoma and demonstrated inferior outcomes for patients with sarcoma of the cervix. In this larger analysis, carcinosarcoma accounted for 40% of cases and the prognosis for patients with sarcomas was inferior to that of squamous cell and adenocarcinoma when matched by stage.

The purpose of our study was to examine identify national treatment patterns and outcomes based on histological subtype using a large, national cohort.

MATERIALS AND METHODS

The National Cancer Database (NCDB) is a nationwide, hospital-based registry that consists of patients who received care at cancer centers accredited by the American College of Surgeons Commission on Cancer (CoC) and currently captures approximately 70% of all patients newly diagnosed with cancer [6]. The CoC's NCDB and the accredited facilities participating in the NCDB are the source of the de-identified data used in this study. However, they have not verified and are not responsible for the statistical validity or conclusions derived by the authors of this study. Because the NCDB contains de-identified patient data, this study effort did not meet our Institutional Review Board's (IRB) criteria for human subjects research and thus approval and review from IRB was not indicated. The use of de-identified data in this study was in compliance with terms specified in the NCDB Participant User File Data Use Agreement. Individual patients, hospitals, and healthcare providers were not identified.

The NCDB was queried for patients with cervical cancer diagnosed from 2004–2015. Demographic, clinical, and treatment details were obtained and compared via the χ^2 test between patients with SCC, adenocarcinoma, and sarcoma of the cervix as well as between sarcoma subtypes.

The primary goal of this analysis was to study the patterns of care and survival of cervical cancer based on histology. Vital status was available but not cause of death. Demographic, clinical, and treatment details were obtained and compared via the Pearson's χ^2 test between different histologic types (SCC, adenocarcinoma, and sarcomas) as well as among sarcoma subtypes (carcinosarcoma, leiomyosarcoma, adenosarcoma, endometrial stromal sarcoma [ESS], rhabdomyosarcoma, and sarcoma not otherwise specified [NOS]). Patient demographic details included age and race. Clinical and treatment details included tumor stage, tumor size, tumor grade, Charlson-Deyo comorbidity (CDCC) score, histology, pelvic

and para-aortic lymph node status, receipt of surgery, radiation, and/or chemotherapy, median income quartiles, categorization of academic or non-academic cancer center, U.S. region (Northeast, Midwest, South, West) and insurance type (none, private insurance, Medicare, Medicaid, Other Government, Unknown).

Overall survival (OS) curves comparing patients were generated using the Kaplan-Meier method and compared via the log-rank test. Univariable and multivariable Cox regression was used to determine covariables associated with differences in OS. Variables with a p-value <0.10 on univariable analysis were planned to be included in the multivariable analysis The variables included in these analyses were age, race, tumor stage, tumor size, tumor grade, CDCC score, histology, pelvic and para-aortic lymph node status, median income quartiles, categorization of academic or non-academic cancer center, U.S. region (Northeast, Midwest, South, West) and insurance type (none, private insurance, Medicare, Medicaid, Other Government, Unknown). All analysis was performed using SPSS version 20 (IBM Inc., Armonk, NY, USA).

RESULTS

107,177 patients met inclusion criteria including 81,245 (75.8%) women with SCC, 24,562 (22.9%) women with adenocarcinoma, and 1,370 (1.3%) women with sarcoma. Of the patients with cervical sarcoma, 680 (49.6%) patients had carcinosarcoma (or malignant mixed Müllerian tumor), 255 (18.6%) patients had leiomyosarcoma, 197 (14.4%) patients had adenosarcoma, 85 (6.2%) patients had rhabdomyosarcoma, 28 (2.0%) patients had ESS, and 125 (9.1%) patients had sarcoma NOS. Patients with sarcoma of the cervix were older and had a larger proportion of non-white patients as compared to SCC and adenocarcinoma. A larger proportion of patients, 20%, with cervical sarcoma had tumors greater than 8 cm in size compared to 4.3% of patients with SCC and 3.2% of patients with adenocarcinoma. Less patients with sarcoma of the cervix had positive pelvic lymph nodes as compared to SCC. Demographic and clinical characteristics of all patients are found in **Table 1**.

Among patients with cervical sarcoma, patients with leiomyosarcoma has the largest proportion (36.9%) of tumors greater than 8 cm as compared to other sarcoma subtypes as well as the largest proportion of non-white patients (38.9%). Regarding node-positive disease, patients with carcinosarcoma had the highest percentage of positive pelvic lymph nodes (10.6%) and positive para-aortic lymph nodes (5.0%). A larger percentage (65.9%)

Table 1. Select demographic and clinical characteristics of all patients

Characteristics	SCC (n=81,245)	Adenocarcinoma (n=24,562)	Sarcoma (n=1,370)	p-value
Age (yr)				<0.001
18–50	42,391 (52.2)	14,417 (58.7)	450 (32.8)	
51–60	17,818 (21.9)	4,558 (18.6)	333 (24.3)	
61–70	11,548 (14.2)	3,115 (12.7)	312 (22.8)	
71–80	6,228 (7.7)	1,646 (6.7)	167 (12.2)	
>80	3,254 (4.0)	826 (3.4)	108 (7.9)	
Stage				<0.001
I	21,388 (26.3)	8,967 (36.5)	138 (10.1)	
II	16,156 (19.9)	2,857 (11.6)	86 (6.3)	
III	13,395 (16.5)	1,669 (6.8)	80 (5.8)	
IV	3,533 (4.3)	520 (2.1)	30 (2.2)	
Unknown	26,773 (33.0)	10,549 (42.9)	1,036 (75.6)	

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Table 1. (Continued) Select demographic and clinical characteristics of all patients

Characteristics	SCC (n=81,245)	Adenocarcinoma (n=24,562)	Sarcoma (n=1,370)	p-value
Tumor size (cm)				<0.001
≤4	27,381 (33.7)	11,737 (47.8)	274 (20.0)	
4.1–8.0	20,721 (25.5)	4,253 (17.3)	354 (25.8)	
>8	3,503 (4.3)	783 (3.2)	274 (20.0)	
Size unknown	29,640 (36.5)	7,789 (31.7)	468 (34.2)	
Grade				<0.001
1	4,759 (5.9)	5,843 (23.8)	81 (5.9)	
2	26,934 (33.2)	7,298 (29.7)	76 (5.5)	
3	25,144 (30.9)	4,964 (20.2)	397 (29.0)	
Unknown	24,408 (30.0)	6,457 (26.3)	816 (59.6)	
Pelvic lymph nodes				<0.001
Negative	16,970 (20.9)	7,290 (29.7)	347 (25.3)	
Positive	8,292 (10.2)	1,819 (7.4)	94 (6.9)	
Not assessed/unknown	55,983 (68.9)	15,453 (62.9)	929 (67.8)	
Para-aortic lymph nodes				<0.001
Negative	16,492 (20.3)	5,782 (23.5)	310 (22.6)	
Positive	2,770 (3.4)	668 (2.7)	42 (3.1)	
Not assessed/unknown	61,983 (76.3)	18,112 (73.7)	1,019 (74.3)	
Race				<0.001
White	60,833 (74.9)	20,694 (84.3)	937 (68.4)	
Black	14,552 (17.9)	2,142 (8.7)	337 (24.6)	
Other	5,860 (7.2)	1,726 (7.0)	96 (7.0)	
Charlson/Deyo Comorbidity Score				<0.001
0	69,263 (85.3)	21,393 (87.1)	1,106 (80.7)	
1	9,314 (11.5)	2,600 (10.6)	207 (15.1)	
2+	2,668 (3.3)	569 (2.3)	57 (4.2)	
Insurance				<0.001
Not insured	8,291 (10.2)	1,568 (6.4)	92 (6.7)	
Private insurance	34,801 (42.8)	14,691 (59.8)	635 (46.4)	
Medicaid	18,978 (23.4)	3,207 (13.1)	146 (10.7)	
Medicare	15,775 (19.4)	4,134 (16.8)	447 (32.6)	
Other govt/unknown	3,400 (4.2)	962 (3.9)	50 (3.6)	
Region				<0.001
Northeast	11,840 (19.2)	3,509 (19.9)	268 (22.0)	
Midwest	14,208 (23.0)	4,025 (22.9)	288 (23.7)	
South	25,749 (41.7)	6,569 (37.3)	463 (38.0)	
West	9,966 (16.1)	3,503 (19.9)	198 (16.3)	
Facility type				<0.001
Non-academic	53,407 (65.7)	16,728 (68.1)	823 (60.1)	
Academic	27,838 (34.3)	7,834 (31.9)	547 (39.9)	
Treatment				-
No surgery or radiation	6,816 (8.4)	1,739 (7.1)	196 (14.3)	
Surgery alone	24,298 (29.9)	12,163 (49.5)	659 (48.1)	
Radiation alone	36,110 (44.4)	5,440 (22.1)	179 (13.1)	
Surgery and radiation	14,021 (17.3)	5,220 (21.3)	336 (24.5)	
Surgery				-
No	42,926 (52.8)	7,179 (29.2)	375 (27.4)	
Yes	38,319 (47.2)	17,383 (70.8)	995 (72.6)	
Radiation				<0.001
No	31,114 (38.3)	13,902 (56.6)	855 (62.4)	
Yes	50,131 (61.7)	10,660 (43.4)	515 (37.6)	
Chemotherapy agents				<0.001
No chemotherapy	38,543 (47.4)	15,578 (63.4)	846 (61.8)	
Single agent	30,789 (37.9)	5,644 (23.0)	99 (7.2)	
Multiple agents	7,331 (9.0)	2,421 (9.9)	378 (27.6)	
Unspecified	4,582 (5.6)	919 (3.7)	47 (3.4)	

Values are presented as number (%).
SCC, squamous cell carcinoma.

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of patients with rhabdomyosarcoma were less than age 50 whereas a larger percentage of patients with carcinosarcoma were over the age of 60 as compared to other subtypes. Patients with carcinosarcoma and rhabdomyosarcoma had more patients who received combination external beam radiotherapy and brachytherapy. The carcinosarcoma and sarcoma NOS subgroups had more patients managed without an operation. The adenosarcoma subtype had the largest percentage (95.4%) managed with surgery and the lowest percentage treated without chemotherapy (93.9%). Patients with rhabdomyosarcoma had the largest percentage of patients who received a multi-agent chemotherapy regimen (57.6%). Demographic and clinical characteristics and treatment details of patients with sarcoma of the cervix are found in **Table 2**.

Table 2. Select demographic and clinical characteristics of patients with sarcoma of the cervix

Characteristics	Carcinosarcoma/ MMMT (n=680)	Leiomyosarcoma (n=255)	Adenosarcoma (n=197)	Endometrial stromal (n=28)	Rhabdomyosarcoma (n=85)	Sarcoma, NOS (n=125)	p-value
Age (yr)							<0.001
18–50	91 (13.4)	119 (46.7)	115 (58.4)	13 (46.4)	56 (65.9)	56 (44.8)	
51–60	160 (23.5)	62 (24.3)	58 (29.4)	5 (17.9)	18 (21.2)	30 (24.0)	
61–70	221 (32.5)	53 (20.8)	13 (6.6)	2 (7.1)	8 (9.4)	15 (12.0)	
71–80	123 (18.1)	16 (6.3)	7 (3.6)	7 (25.0)	2 (2.4)	12 (9.6)	
>80	85 (12.5)	5 (2.0)	4 (2.0)	1 (3.6)	1 (1.2)	12 (9.6)	
Tumor size (cm)							<0.001
≤4	133 (19.6)	36 (14.1)	60 (30.5)	6 (21.4)	18 (21.2)	21 (16.8)	
4.1–8.0	196 (28.8)	69 (27.1)	33 (16.8)	8 (28.6)	26 (30.6)	22 (17.6)	
>8	127 (18.7)	94 (36.9)	11 (5.6)	5 (17.9)	10 (11.8)	27 (21.6)	
Size unknown	224 (32.9)	56 (22.0)	93 (47.2)	9 (32.1)	31 (36.5)	55 (44.0)	
Grade							-
1	18 (2.6)	10 (3.9)	43 (21.8)	6 (21.4)	0 (0.0)	4 (3.2)	
2	16 (2.4)	19 (7.5)	29 (14.7)	4 (14.3)	0 (0.0)	8 (6.4)	
3	271 (39.9)	65 (25.5)	7 (3.6)	7 (25.0)	15 (17.6)	32 (25.6)	
Unknown	375 (55.1)	161 (63.1)	118 (59.9)	11 (39.3)	70 (82.4)	81 (64.8)	
Pelvic lymph nodes							<0.001
Negative	179 (26.3)	51 (20.0)	60 (30.5)	9 (32.1)	25 (29.4)	23 (18.4)	
Positive	72 (10.6)	6 (2.4)	2 (1.0)	1 (3.6)	4 (4.7)	9 (7.2)	
Not assessed/unknown	429 (63.1)	198 (77.6)	135 (68.5)	18 (64.3)	56 (65.9)	93 (74.4)	
Para-aortic lymph nodes							<0.001
Negative	171 (25.1)	39 (15.3)	49 (24.9)	8 (28.6)	22 (25.9)	21 (16.8)	
Positive	34 (5.0)	3 (1.2)	0 (0.0)	0 (0.0)	0 (0.0)	5 (4.0)	
Not assessed/unknown	475 (69.9)	213 (83.5)	148 (75.1)	20 (71.4)	63 (74.1)	99 (79.2)	
Race							<0.001
White	451 (66.3)	180 (70.6)	153 (77.7)	22 (78.6)	52 (61.2)	79 (63.2)	
Black	187 (27.5)	56 (22.0)	24 (12.2)	4 (14.3)	31 (36.5)	35 (28.0)	
Other	42 (6.2)	19 (7.5)	20 (10.2)	2 (7.1)	2 (2.4)	11 (8.8)	
Treatment							<0.001
No surgery or radiation	126 (18.5)	23 (9.0)	5 (2.5)	3 (10.7)	9 (10.6)	30 (24.0)	
Surgery alone	232 (34.1)	145 (56.9)	165 (83.8)	18 (64.3)	63 (74.1)	36 (28.8)	
Radiation alone	124 (18.2)	14 (5.5)	4 (2.0)	2 (7.1)	2 (2.4)	33 (26.4)	
Surgery and radiation	198 (29.1)	73 (28.6)	23 (11.7)	5 (17.9)	11 (12.9)	26 (20.8)	
Surgery							<0.001
No	250 (36.8)	37 (14.5)	9 (4.6)	5 (17.9)	11 (12.9)	63 (50.4)	
Yes	430 (63.2)	218 (85.5)	188 (95.4)	23 (82.1)	74 (87.1)	62 (49.6)	
Radiation							<0.001
No	358 (52.6)	168 (65.9)	170 (86.3)	21 (75.0)	72 (84.7)	66 (52.8)	
Yes	322 (47.4)	87 (34.1)	27 (13.7)	7 (25.0)	13 (15.3)	59 (47.2)	
Chemotherapy agents							<0.001
No chemotherapy	362 (53.2)	168 (65.9)	185 (93.9)	21 (75.0)	31 (36.5)	79 (63.2)	
Single agent	73 (10.7)	7 (2.7)	6 (3.0)	3 (10.7)	1 (1.2)	9 (7.2)	
Multiple agents	217 (31.9)	71 (27.8)	5 (2.5)	2 (7.1)	49 (57.6)	34 (27.2)	
Unspecified	28 (4.1)	9 (3.5)	1 (0.5)	2 (7.1)	4 (4.7)	3 (2.4)	

Values are presented as number (%).
MMMT, malignant mixed Müllerian tumor; NOS, not otherwise specified.

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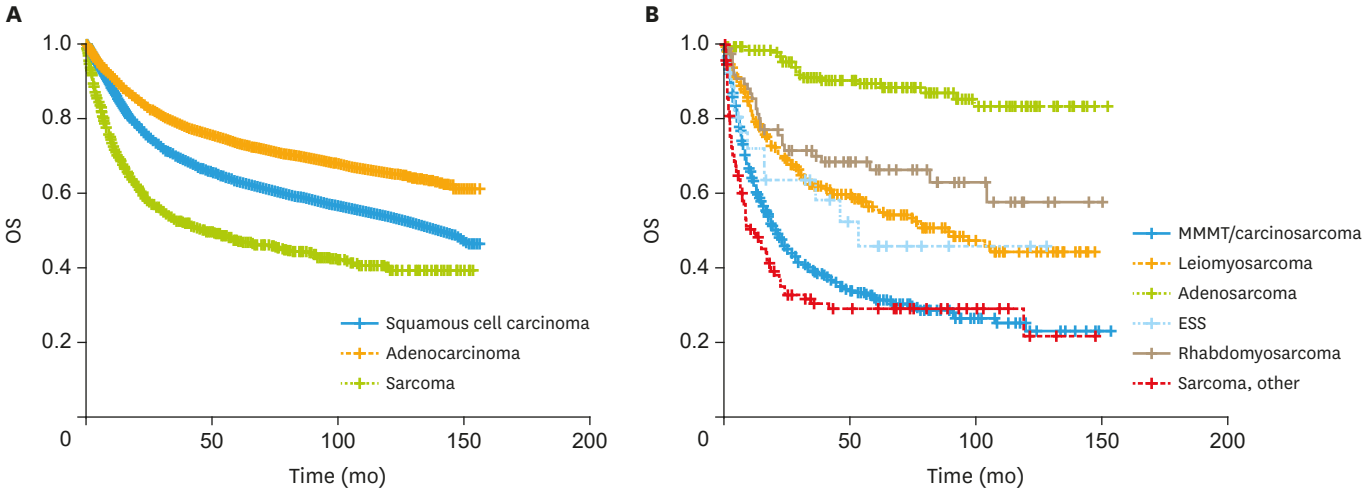

Fig. 1. Kaplan-Meier analysis of 5-year OS. (A) Five-year OS for all patients were 63.3% for SCC, 73.7% for adenocarcinoma, and 47.7% for sarcoma, respectively (p<0.001). (B) Five-year OS for patients with cervical sarcoma were 89.2% for adenosarcoma, 66.2% for rhabdomyosarcoma, 55.6% for leiomyosarcoma, 45.8% for ESS, 31.6% for carcinosarcoma, and 29.2% for sarcoma NOS, respectively.
ESS, endometrial stromal sarcoma; NOS, not otherwise specified; OS, overall survival; SCC, squamous cell carcinoma.
p<0.001.

Five-year OS for all stages was 63.3% for SCC, 73.7% for adenocarcinoma, and 47.7% for sarcoma (p<0.001). Kaplan-Meier analysis of OS for all patients based on histology is shown in **Fig. 1A**. On multivariable Cox regression, patients with cervical sarcoma had decreased OS as compared to patients with SCC (hazard ratio=2.17; 95% CI=1.99–2.37; p<0.001). Other factors predictive for decreased OS included older age, treatment outside of the Northeast, Medicaid insurance status, larger tumor size, node-positive disease, increased CDCC score, and higher stage. Increased income was associated with increased survival. A multivariable Cox regression of OS for all patients in shown in **Table 3**. Among patients with sarcoma of the cervix, 5-year OS was 89.2% for adenosarcoma, 66.2% for rhabdomyosarcoma, 55.6% for leiomyosarcoma, 45.8% for ESS, 31.6% for carcinosarcoma, and 29.2% for sarcoma NOS (p<0.001) (**Fig. 1B**).

DISCUSSION

Our analysis represents the largest current series exploring the treatment patterns and survival for sarcoma of the cervix. Carcinosarcoma was the most common histologic subtype followed by leiomyosarcoma and adenocarcinoma. We found 5-year OS of patients with cervical sarcoma to be worse than that of those with the more common cervical cancer histologies, SCC and adenocarcinoma. Among patients with cervical sarcoma, survival was worst among those with sarcoma NOS, followed by carcinosarcoma and ESS. Patients with adenosarcoma had the highest 5-year OS.

Similar to our findings, Bansal et al. [5] found inferior outcomes for cervical sarcoma as compared to SCC and adenocarcinoma and their SEER analyses yielded a similar distribution of histologic subtypes with carcinosarcoma making up the majority followed by leiomyosarcoma and adenosarcoma. In comparison, carcinosarcoma makes up about 40% of uterine sarcomas, leiomyosarcoma comprises 40%, ESS comprises 15%, and the remaining 5% are a heterogenous group of sarcomas [7]. Whereas Bansal et al. [5] found that women

Table 3. Multivariable Cox regression for OS for all patients

Variables	OR (95% CI)	p-value
Age	1.02 (1.01–1.03)	<0.001
Race		
White	1	
Black	1.03 (0.99–1.06)	0.071
Other	0.76 (0.72–0.80)	<0.001
Tumor size (cm)		
≤4	1	
4.1–8.0	1.39 (1.33–1.45)	<0.001
>8	2.01 (1.91–2.13)	<0.001
Size unknown	1.48 (1.42–1.53)	<0.001
Stage		
I	1	
II	1.21 (1.16–1.27)	<0.001
III	2.11 (2.02–2.20)	<0.001
IV	3.08 (2.92–3.25)	<0.001
Unknown	1.31 (1.25–1.36)	<0.001
Grade		
1	1	
2	1.30 (1.23–1.39)	<0.001
3	1.63 (1.53–1.73)	<0.001
Unknown	1.28 (1.20–1.36)	<0.001
Pelvic lymph nodes		
Negative	1	
Positive	1.46 (1.33–1.52)	<0.001
Not assessed/unknown	1.30 (1.22–1.39)	<0.001
Para-aortic lymph nodes		
Negative	1	
Positive	1.42 (1.33–1.52)	<0.001
Not assessed/unknown	1.05 (0.99–1.12)	0.083
Charlson/Deyo Comorbidity Score		
0	1	
1	1.29 (1.25–1.34)	<0.001
2+	1.75 (1.66–1.84)	<0.001
Insurance		
Not insured	1	
Private Insurance	0.91 (0.87–0.95)	<0.001
Medicaid	1.16 (1.11–1.22)	<0.001
Medicare	1.16 (1.10–1.22)	<0.001
Other govt/unknown	0.86 (0.80–0.92)	<0.001
Median income quartiles ($)		
<38,000	1	
38,000–47,999	0.98 (0.95–1.01)	0.194
48,000–62,999	0.95 (0.92–0.98)	0.003
>63,000	0.90 (0.87–0.93)	<0.001
Region		
Northeast	1	
Midwest	1.15 (1.12–1.19)	<0.001
South	1.11 (1.08–1.15)	<0.001
West	1.07 (1.03–1.12)	<0.001
Histology		
SCC	1	
Adenocarcinoma	1.16 (1.12–1.20)	<0.001
Sarcoma	2.17 (1.99–2.37)	<0.001

CI, confidence interval; OR, odds ratio; OS, overall survival; SCC, squamous cell carcinoma.

with cervical sarcomas tended to be younger than women with SCC and adenocarcinomas, the current analysis demonstrated that a larger percentage of patients with cervical sarcoma were in the older age groups. Additionally, patients with cervical sarcoma had larger tumors

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and included a larger percentage of non-white patients. An analysis of uterine sarcomas from a large population-based database yielded similar findings: carcinosarcoma was the most common subtype of uterine sarcoma and uterine sarcoma occurred more in older age and more frequently among women of black race [8].

When compared to uterine carcinosarcomas, cervical carcinosarcomas may be more confined to the cervix at presentation and frequently have a non-glandular epithelial component [9,10]. With regards to histologic classification, carcinosarcomas (previously called malignant mixed Müllerian tumors) of the uterus are no longer considered sarcomas and may be treated more like a carcinoma [11,12]. Less data are available for the histologic classifications of cervical sarcoma and whether carcinosarcoma of the cervix should be reclassified in a similar manner. The patients with cervical carcinosarcoma in the current analysis were older than those with other sarcoma subtypes. Additionally, the carcinosarcoma subgroup had the largest percentage of high-grade tumors and had the greatest percentage of node-positive disease. Likewise, the SEER analysis found that a higher percentage of patients with carcinosarcoma who underwent lymphadenectomy had positive lymph nodes (19%) as compared to other subtypes [5]. Although carcinosarcoma was more likely to be managed by surgery in the current series, it had the highest percentage of patients treated with radiation alone.

The current study included 255 cases of primary cervical leiomyosarcoma, a rare tumor with a limited number of case reports [13]. Similar to leiomyosarcomas in other locations, the current analysis demonstrated a low incidence of lymph node involvement for cervical leiomyosarcomas [14]. Bansal et al. [5] found that among 67 cases of leiomyosarcoma, none of the patients who underwent lymphadenectomy had nodal disease. We found that these tumors were more likely to have a higher tumor grade and were larger in size as compared to other sarcoma subtypes. Approximately one-half of patients with cervical leiomyosarcoma were managed with surgery alone and about one quarter of cases were treated with surgery and radiation.

Adenosarcoma of the cervix is another rare tumor with benign epithelial and malignant stromal components that typically appears in reproductive age [15]. These tumors have been shown to have a favorable prognosis [16]. Uterine adenosarcomas have also been shown to have favorable outcomes [17]. The 197 cases of cervical adenosarcomas in the current study had particularly favorable OS, with almost 90% of patients alive at 5 years. This subgroup had the largest proportion of tumors less than 4 cm and had almost 60% of patients in the 18–50 age group. This is consistent with other data demonstrating a younger age at diagnosis in comparison to carcinosarcoma [5]. Additionally, this subgroup had the largest proportion of patients managed by surgery alone.

Extrauterine ESS are rare tumors which may be found in locations such as the peritoneum, ovary, and omentum [18,19]. Histologically, they resemble endometrial ESS and may arise in foci of endometriosis [4,18,19]. Primary ESS of the cervix is extremely rare and only a small number of cases have been reported [20,21]. The larger SEER analysis of cervical sarcoma included 4 cases of cervical ESS [5]. The current dataset presents 28 cases captured in the United States over approximately a decade. The majority of these tumors were found in the 18–50 age group. Additionally, the majority were treated with surgery alone and 17.9% received surgery and radiation. Chemotherapy was infrequently used for these tumors. Five-year OS was 45.8% for this subtype.

Rhabdomyosarcoma of the cervix typically presents in the second decade of life as compared to rhabdomyosarcoma of the vagina which usually presents in patients <4 years old [22]. In the current study, patients with rhabdomyosarcoma had the largest percentage of patients in the 18–50 age group. This subgroup also had the highest percentage of patients who received chemotherapy with over half of patients receiving multiple chemotherapy agents. This is line with current recommendations for multimodality therapy entailing operation in conjunction with multi-agent chemotherapy with or without radiation [22-26].

Finally, the group of tumors coded as sarcoma NOS likely represents a heterogenous group of tumors that did not have sufficient pathologic data to classify them into any of the other sarcoma subtypes. The majority were treated with surgery alone with a smaller number managed with surgery and radiation.

There are challenges and limitations with hospital-based registries. While data reporting to the NCDB is highly standardized, there may still be variances with data coding and abstraction. The most notable limitation in this cohort may be the possibility of misclassification of primary uterine sarcomas as primary cervical carcinomas. The majority of patients with cervical sarcoma did not have information regarding stage therefore we could not compare outcomes between histologies based on stage. Data regarding local recurrence and salvage treatment is not available in the NCDB therefore we could not determine the effect of multi-modality treatment on local recurrence. Details regarding the type of surgery used were not available for each patient who underwent operative management. Additionally, data regarding the specific type of chemotherapy agents used is not coded in the NCDB. Finally, we were unable to determine cause of death as this information is not coded in the NCDB.

In conclusion, primary sarcoma of the cervix is rare and aside from adenosarcoma, has inferior outcomes as compared to SCC and adenocarcinoma of the cervix. We found differences in characteristics and outcomes among the subgroups of sarcomas analyzed. Primary sarcoma of the cervix is managed primarily with operation with less patients receiving multi-modality treatment.

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