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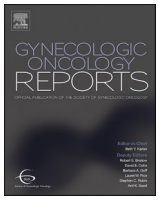

The burden of cervical cancer survivorship: Understanding morbidity and survivorship needs through hospital admissions

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ABSTRACT

Objective: To describe disease- and treatment-related survivorship burden amongst survivors of cervical cancer and identify risk factors for hospital admissions after initial treatment.
Methods: Retrospective chart review including patients treated for cervical cancer from 2014 to 2020 at a single urban academic institution. Clinical, demographic, and hospital admission characteristics were summarized. Associations between patient characteristics and likelihood of admission were examined using univariate and multivariate regression.
Results: Of 366 patients undergoing surveillance following completion of primary treatment, 156 (43 %) were hospitalized for cancer or treatment-related sequela in the median follow-up of 3.6 years (IQR 1.4–6.4), with a median of 2 admissions (IQR 1–4.5) per patient and 570 unique admissions. While 65 (35 %) of admitted patients had multiple reasons for admission, the most common reasons for admission were: gastrointestinal complications (43 %), infection (38 %), genitourinary complications (33 %), and pain control (23 %). A substantial proportion of admitted patients underwent interventions including surgical procedures (57 %), transfusion of blood products (40 %), and interventional radiology procedures (28 %) and utilized supportive care services including case management (53 %), physical therapy (40 %), and occupational therapy (36 %). On multivariate analysis, odds of admission were higher among Black patients (aOR 2.4, $p < .01$), uninsured patients (aOR 2.7, $p < .05$), those with lower performance status (aOR 1.4, $p < .05$), and those with recurrence (aOR 5.5, $p < .001$).
Conclusion: Survivors of cervical cancer represent a high-risk population frequently hospitalized after initial treatment. Black patients, uninsured patients, those with recurrence, and those with lower performance status faced higher odds of admission. Comprehensive, team-based care is necessary to address complex survivorship needs.

1. Introduction

While cervical cancer incidence has decreased over time, close to 14,000 new patients will still be diagnosed in the US in 2023 with trends in increased rates of advanced cancers (About the National Breast and Cervical Cancer Early Detection Program | CDC. Published September 15, 2023). In 2022, there were over 300,000 survivors of cervical cancer living in the United States (Absolom et al., 2021). Due to improvements in screening and treatment strategies, more and more survivors are living with severe long-term sequela and side effects of treatment including radical surgery and/or chemotherapy and radiation. In 2022, there were over 300,000 survivors of cervical cancer living in the United States (Absolom et al., 2021). Due to the distinctive nature of cervical cancer and its treatment, patients experience uniquely burdensome complications ranging from sexual dysfunction, bladder and bowel dysfunction, lymphedema, menopausal symptoms, and chronic pain to post-radiation complications such as ureteral strictures and fistula formation (Benard et al., 2008; Burns and CosTELlo J, Ryan-Woolley B, Davidson S, 2007; Clemmens et al., 2008). As long-term survival continues to improve, providers must work towards an improved understanding of the long-term burden of survivorship on patients and healthcare systems.

Research around cervical cancer survivorship often emphasizes patient-reported outcomes, such as quality of life (QOL), distress and depression ratings, and patient perspectives regarding physical and emotional wellbeing and sexual dysfunction (Cobbinah and Lewis,

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2018; Conway et al., 2020; Greimel et al., 2009; Harris et al., 2009; Harris et al., 2019; Henretta et al., 2011). These patient-reported outcomes provide valuable insight into the psychosocial burden faced by survivors of cervical cancer, but less is known about the specifics of health care utilization during the survivorship period. Hospital admissions and related procedures and consultations serve as a quantitative measure of the burden of survivorship, as hospitalization confers not only emotional and physical costs but also significant financial costs both to patients and healthcare systems (Huepenbecker and Meyer, 2022; Joynt et al., 2011). Previous studies of 30-day readmissions following gynecologic oncology surgery have already demonstrated that primary diagnosis of cervical cancer is associated with increased risk of readmission, suggesting that this is a particularly vulnerable patient population with significant unmet needs (Kearns et al., 2022; Maher and Denton, 2008; McManus et al., 2021). However, survivors of cervical cancer continue to experience significant complications which may result in unplanned hospital admissions well beyond the first 30 days post-treatment. An improved understanding of hospital admissions and healthcare utilization during the surveillance period is crucial to augment existing patient-reported outcomes in survivorship literature and to identify potential areas for intervention.

Given the paucity of data in this area, our primary objective was to identify reasons and risk factors for hospital admissions after completion of primary treatment among survivors of cervical cancer. Secondary objectives were to quantitatively describe admission characteristics including length of stay, route of admission, discharge location, and inpatient services utilized.

2. Methods

2.1. Study design

A retrospective review was performed of patients with a diagnosis of cervical cancer seen at a single academic institution, the University of Chicago, between January 2014 and December 2020. Institutional Review Board approval was obtained before study initiation (IRB21-1358).

Patients with a diagnosis of cervical cancer who were 18 years or older at diagnosis were identified using billing records (ICD-10: C53.0, C53.1, C53.8, C53.9; ICD-9: 180.0, 180.1, 180.8, 180.9). All data were collected from patient electronic medical records. Data were collected regarding demographic, clinical, treatment, and admission characteristics, including any admission following initial treatment for treatment-related adverse effects or admissions related to disease recurrence. For cancers that were diagnosed at a late stage and not treated with curative intent, admissions data were collected following completion of the planned initial treatment course. Data were excluded regarding hospital admissions for planned treatment of the primary tumor, including initial brachytherapy and surgery. Study data were collected and managed using REDCap electronic data capture tools hosted at the University of Chicago (Miller et al., 2022; Millet et al., 2022).

2.2. Study measures

(i) Demographic, clinical, and treatment details

Baseline patient and tumor characteristics at the time of diagnosis were collected, including age, body mass index (BMI), race, ethnicity, insurance, Charlson Comorbidity Index (CCI), Eastern Cooperative Oncology Group (ECOG) score, International Federation of Gynecology and Obstetrics (FIGO) stage, and histology of primary tumor. Data regarding recurrence status and treatment course of the primary tumor were collected, including whether the patient received surgery, radiation therapy, chemotherapy, immunotherapy, hormonal therapy, and/or other treatment as part of a clinical trial.

(ii) Reason for admission

Discharge diagnoses were collected from the discharge summary associated with each admission. In cases where multiple discharge diagnoses were listed, each unique reason was recorded. Discharge diagnoses were grouped for the purpose of analysis into the following categories: gastrointestinal complications (rectovaginal fistula, radiation proctitis, small bowel obstruction, nausea, vomiting, diarrhea, constipation, melena), genitourinary complications (vesicovaginal fistula, hydronephrosis, acute kidney injury, electrolyte abnormalities, hematuria), infection (urinary tract infection, bacteremia, sepsis, surgical site infections), vaginal bleeding, pain control for cancer or treatment-related pain, hematologic (cytopenia related to treatment or anemia of chronic disease, deep vein thrombosis, pulmonary embolism), recurrence (treatment or workup for known or suspected recurrence), elective procedures for treatment-related sequela (such as cerclage placement and removal or exchange of a percutaneous nephrostomy tube), and failure to thrive.

(iii) Hospital admission characteristics

Hospital admission characteristics included length of stay, route of admission (emergency department, transfer from an outside hospital or facility, outpatient clinic, direct admission from home, scheduled admissions for surgeries or other procedures), discharge location (home, skilled rehabilitation facility or skilled nursing facility, hospice, or deceased during admission), procedures or services performed (antibiotics, transfusion of blood products, goals of care conversation, surgical procedure, interventional radiology procedure, and imaging), and utilization of inpatient specialty care services (case management, social work, palliative care consultation, occupational therapy, physical therapy, and nutrition counseling).

(iv) Outcome measures

Outcome measures of interest included (i) overall rate of hospital admission (admitted vs not admitted) for treatment or disease-related sequela at any time following completion of initial treatment and (ii) rate of recurrent hospital admissions, defined as ≥ 3 admissions occurring any time after completion of initial treatment.

2.3. Statistical analysis

Patient and hospital admission characters were described using summary statistics. Categorical variables were summarized and compared using Chi-squared tests of association, and continuous variables were compared using the Wilcoxon rank-sum test. Univariate logistic regression was performed to assess the association of each predictor variable with (i) odds of experiencing one or more cancer- or treatment-related admission after completion of primary treatment and (ii) odds of experiencing recurrent (≥ 3) admissions post-treatment. Variables found to be significantly associated with admission on univariate analysis were included in multivariable analysis. Data were analyzed using STATA 16.1 (StataCorp LLC, College Station, Texas, USA). Alpha was set at 0.05 for significance.

3. Results

3.1. Patient characteristics

Three-hundred and sixty-six patients with cervical cancer were identified and included. Demographic characteristics and cancer-related clinical and treatment characteristics are detailed in Table 1. The majority of patients (72 %) were in remission for the duration of the study period. Data was collected for a median follow-up period of 3.6 years (IQR 1.4–6.4 years; range 1 month to 37.6 years) from date of diagnosis to last visit or death.

3.2. Frequency of and reasons for admission

One-hundred and fifty-six patients (43 %) experienced one or more disease or treatment-related hospital admissions after completion of primary treatment, with a median time from treatment completion to first admission of 13.3 months (IQR 2.4 months to 3.7 years; range 0

Table 1
Baseline clinical and demographic characteristics, univariate and multivariate analysis of risk factors associated with hospital admission after completion of primary treatment.

Clinical or demographic factor	Total (N = 366)	No admissions (N = 210)	≥1 admission(s) (N = 156)	*P-value**	Univariate Regression, OR (95 % CI)	*P-value*	Multivariate Regression, aOR (95 % CI)	*P-value*
	Count (%) or median (IQR)							
Age	47 (38–57)	46 (38–58)	48 (37–57)	*0.97*	1.0 (0.98–1.0)	*0.71*		
BMI	27 (23–33)	29 (23–33)	27 (23–33)	*0.14*	0.99 (0.96–1.0)	*0.31*		
Race				***<0.001***				
White	214 (58)	49 (23)	75 (48)		Ref		Ref	
Black	124 (34)	142 (68)	72 (46)		3.0 (1.9–4.8)	***<0.001***	2.4 (1.3–4.3)	***<0.01***
Other	28 (7.7)	19 (9.0)	9 (5.8)		0.93 (0.40–2.2)	*0.87*	1.2 (0.45–3.3)	*0.69*
Ethnicity				*0.30*				
Non-Hispanic	326 (89)	184 (87)	142 (91)		Ref			
Hispanic	40 (11)	26 (12)	14 (9)		0.70 (0.35–1.4)	*0.30*		
Insurance				***<0.001***				
Private	199 (54)	135 (64)	64 (41)		Ref		Ref	
Medicaid	55 (15)	25 (12)	30 (19)		2.5 (1.4–4.6)	***<0.01***	1.1 (0.50–2.6)	*0.75*
Medicare	74 (20)	39 (19)	35 (22)		1.9 (1.1–3.3)	***0.022***	1.1 (0.57–2.3)	*0.71*
Uninsured/self-pay	38 (10)	11 (5.2)	27 (17)		5.2 (2.4–11)	***<0.001***	2.7 (1.0–7.3)	***0.043***
CCI	3 (2–4)	3 (2–4)	3 (2–4)	*0.23*	1.0 (0.91–1.2)	*0.61*		
ECOG score	0 (0–1)	0 (0–1)	1 (0–1)	***<0.001***	1.7 (1.3–2.2)	***<0.001***	1.4 (1.0–1.9)	***0.042***
FIGO Stage				***<0.001***				
IA or IB, surgery only	136 (37)	97 (46)	39 (25)		Ref		Ref	
IB, chemoRT	38 (10)	20 (9.5)	18 (12)		2.2 (1.1–4.7)	***0.032***	0.90 (0.25–3.3)	*0.87*
II, III, IV	167 (46)	77 (37)	90 (58)		2.9 (1.8–4.7)	***<0.001***	0.90 (0.34–2.4)	*0.84*
Unknown	25 (6.8)	16 (7.6)	9 (5.8)		1.4 (0.57–3.4)	*0.46*	0.73 (0.20–2.7)	*0.64*
Histology				***<0.01***				
SCC	230 (63)	124 (59)	106 (68)		Ref		Ref	
Adenocarcinoma	97 (27)	68 (32)	29 (19)		0.50 (0.30–0.83)	***<0.01***	0.71 (0.37–1.3)	*0.29*
Other[a]	39 (11)	18 (8.6)	21 (13)		1.4 (0.69–2.7)	*0.37*	2.2 (0.78–11)	*0.96*
Primary treatment				***<0.001***				
Surgery only	89 (24)	65 (31)	24 (15)		Ref		Ref	
ChemoRT or RT alone	160 (44)	66 (31)	94 (60)		3.9 (2.2–6.8)	***<0.001***	2.1 (0.67–6.4)	*0.20*
Chemotherapy alone	16 (4.4)	9 (4.3)	7 (4.5)		2.1 (0.71–6.3)	*0.18*	1.2 (0.27–5.1)	*0.82*
Surgery + RT ± chemo	68 (19)	43 (20)	25 (16)		1.6 (0.80–3.1)	*0.19*	0.82 (0.34–2.0)	*0.67*
Other[b]	33 (9.0)	27 (13)	6 (3.9)		0.60 (0.22–1.6)	*0.32*	0.59 (0.16–2.1)	*0.42*
Recurrence				***<0.001***				
No	264 (72)	180 (86)	84 (54)		Ref		Ref	
Yes	102 (28)	30 (14)	72 (46)		5.1 (3.1–8.5)	***<0.001***	5.5 (3.1–9.8)	***<0.001***

OR = odds ratio.
CI = Confidence Interval.
aOR = adjusted odds ratio.
CCI = Charlson Comorbidity Index.
ECOG = Eastern Cooperative Oncology Group.
FIGO = International Federation of Gynecology and Obstetrics.
SCC = squamous cell carcinoma.
**P-values* represent Chi-square for categorical variables or Wilcoxon rank sum for continuous variables.
[a] Of these 39 patients, there were 15 with unknown histology, 7 small cell neuroendocrine, 5 poorly differentiated carcinoma, 4 sarcoma, 3 clear cell, 1 glassy cell, 1 cervical adenoid basal carcinoma, and 1 stratified mucus-producing carcinoma.
[b] Of these 33 patients, 15 underwent CKC or LEEP, 14 did not undergo any primary treatment due to personal decision, death, or being lost to follow-up, and 4 underwent initial treatment that included a clinical trial.

Table 2
Reasons for hospital admission, stratified by time period since treatment.

Reason for admission, Count (%)*	Any Admission	First Admission				
	N = 156	Overall, N = 156	≤30 days, N = 28	31–90 days, N = 15	>90 days, N = 113	*P-value***
Gastrointestinal	67 (43)	46 (29)	8 (29)	3 (20)	35 (31)	*0.68*
Infection	59 (38)	31 (20)	11 (39)	7 (47)	13 (12)	***<0.001***
Genitourinary	52 (33)	31 (20)	4 (14)	4 (27)	23 (20)	*0.57*
Pain control	36 (23)	18 (12)	2 (7)	1 (7)	15 (13)	*0.64*
Recurrence	33 (21)	19 (12)	2 (7)	0 (0)	17 (15)	*0.22*
Hematologic	23 (15)	10 (6)	0 (0)	1 (7)	9 (8)	*0.28*
Vaginal bleeding	13 (8)	8 (5)	1 (4)	2 (13)	5 (4)	*0.25*
Elective procedure	9 (6)	5 (3)	0 (0)	0 (0)	5 (4)	*0.75*
Failure to thrive	7 (4)	2 (1)	1 (4)	1 (7)	0 (0)	*0.075*

*Percentages represent columns. Percentages may not sum to 100 because patients were often admitted with multiple co-existing reasons.
**P-value represents Chi-square analysis or Fisher's exact, as appropriate for sample size, testing the association between reason for first admission and timing of first admission (≤30 days vs 31–90 days vs > 90 days).

days to 37.4 years). One hundred and thirteen patients (31 % of full cohort, 72 % of those admitted) experienced their first admission more than 90 days after completion of primary treatment. Remaining patients experienced their first admission either acutely at 1–30 days (28 patients, 7.7 % of total, 18 % of admitted) or between 31 and 90 days (15 patients, 4.1 % of total, 9.6 % of admitted) from completion of treatment.

Of the 156 patients who were admitted at least once, 104 (67 %) were subsequently admitted again, with 64 of 156 (41 %) and 52 of 156 (33 %) experiencing ≥ 3 and ≥ 4 admissions, respectively (Table 3). The median number of admissions per patient, for those admitted, was 2 (IQR 1–4.5; range 1–25). Across all patients during the study period, there were a total of 570 unique admissions. The median time from first to second admission was 1.9 months (IQR 19.5 days to 10.3 months; range 2 days to 17 years), while time intervals between subsequent admissions were a median of 1.8 to 2.1 months (range 5 days to 8.1 years).

Of the 264 patients who were in remission for the duration of the study period, 84 (32 %) experienced one or more hospitalizations, while 72 (71 %) of the 102 patients with recurrence experienced admission ($p < 0.001$; Table 1). Of the 570 unique admissions during the study period, 240 (42 %) were experienced by those in remission. Among those in remission who experienced hospitalization, the median number of admissions was 2 (IQR 1–4).

Of those admitted, 65 patients (35 %) had discharge diagnoses belonging to more than one category. The five most common reasons for admission included: gastrointestinal problems (43 %), infection (38 %), genitourinary problems (33 %), pain control (23 %), and treatment or workup for confirmed or suspected recurrence (20 %; Table 2). Reasons for first admission were similar across the different time periods (30 days vs 31–90 days vs > 90 days), with the exception that infection was a less common reason for admission > 90 days from treatment (39 % vs 47 % vs 12 %, $p < 0.001$; Table 2).

3.3. Admission characteristics and service utilization

The median length of stay across all admissions was 4 days (IQR 2–7; range 1–32). Patients were most often admitted through the emergency department (28 %) and discharged home (53 %) (Fig. 1). Of the 52 patients who were admitted more than 4 times, 7 (14 %) expired in the hospital and 13 (25 %) were discharged to a hospice facility or home hospice during their final admission (Table 3).

A substantial proportion of admitted patients underwent inpatient interventions during at least one of their admissions, including imaging (68 %), surgical procedures (including exams under anesthesia) (57 %), antibiotic administration (52 %), transfusion of blood products (40 %), interventional radiology procedures (28 %), and goals of care conversations (20 %; Fig. 1). A higher proportion of patients required surgical intervention in the first admission compared to the final (46 % vs 25 %, $p < .01$), whereas a higher proportion required a goals of care conversation in the final admission compared to the first (15 % vs 4.5 %, $p < .001$; Table 3). Admitted patients frequently utilized supportive and specialty care during at least one admission (Fig. 1). Table 3 details the proportion of admitted patients who required each type of intervention and each specialty or supportive care service, stratified by admission number.

3.4. Risk factors for admission

Results of univariate and multivariate analysis of factors associated with one or more post-treatment hospitalization are shown in Table 1. On multivariate analysis, after adjusting for significant variables from univariate analysis, Black patients (aOR 2.4, $p < .01$), uninsured patients (aOR 2.7, $p = .043$), those with worse ECOG score (aOR 1.4, $p = .042$), and those with recurrence (aOR 5.5, $p < .001$) were more likely to experience one or more unplanned hospital admission (Table 1).

Table 3
Hospital admission characteristics, stratified by admission number.

	Admission Number					
	Overall	First	Second	Third	Final, if ≥ 4	*P-value**
Total patients, n (%)[a]	156 (43)	156 (43)	104 (28)	64 (17)	52 (14)	–
LOS, days, median (IQR)	4 (2–7)	4 (2–9)	4 (2–7)	3 (1–6)	4 (2–9)	–
Route of admission, n (%)[b]						
ED	–	55 (35)	41 (39)	30 (47)	32 (62)	–
Transfer	–	15 (9.6)	7 (6.7)	4 (6.3)	0 (0)	–
Outpatient	–	27 (17)	24 (23)	9 (14)	5 (9.6)	–
Direct from home	–	6 (3.8)	2 (1.9)	5 (7.8)	9 (17)	–
Scheduled	–	32 (21)	24 (23)	13 (20)	5 (9.6)	–
Other/unknown	–	21 (14)	6 (5.8)	3 (4.7)	1 (1.9)	–
Discharge location, n (%)[b]						
Home	–	136 (87)	87 (84)	53 (83)	28 (54)	–
SNF/SAR	–	11 (7.1)	5 (4.8)	7 (11)	4 (7.7)	–
Hospice	–	3 (1.9)	8 (7.7)	3 (4.7)	13 (25)	–
Deceased	–	0 (0.0)	1 (1.0)	0 (0.0)	7 (14)	–
Other/unknown	–	6 (3.8)	3 (2.9)	1 (1.6)	0 (0)	–
Interventions, n (%)[b]						
Imaging	128 (68)	71 (46)	45 (43)	40 (63)	19 (37)	*0.26*
Surgery[c]	108 (57)	71 (46)	32 (31)	17 (27)	13 (25)	*<0.01*
Antibiotics	98 (52)	51 (33)	40 (39)	21 (33)	20 (39)	*0.45*
Transfusion	76 (40)	35 (22)	24 (23)	14 (22)	11 (21)	*0.85*
IR	53 (28)	24 (15)	20 (19)	9 (14)	7 (14)	*0.74*
Goals of care	38 (20)	7 (4.5)	13 (13)	2 (3.1)	8 (15)	*<0.01*
Specialty care, n (%)[b]						
Case manager	100 (53)	49 (31)	21 (20)	7 (11)	9 (17)	*0.050*
Physical therapy	75 (40)	28 (18)	13 (13)	10 (16)	17 (33)	*0.025*
Social work	68 (36)	18 (12)	20 (19)	6 (9.4)	14 (27)	*<0.01*
Occupational therapy	68 (36)	18 (12)	11 (11)	12 (19)	21 (40)	*<0.001*
Nutrition	58 (31)	19 (12)	10 (9.6)	8 (13)	12 (23)	*0.056*
Palliative care	44 (23)	10 (6.4)	12 (12)	6 (9.4)	11 (21)	*<0.01*

LOS = length of stay.
SNF/SAR = skilled nursing facility/subacute rehabilitation facility.
IR = interventional radiology.
**P-values* represent result of Chi-square analysis comparing first admission to final admission
[a] Percentages represent proportion of the total 366 patients included in the study.
[b] Percentages represent proportion of the total patients admitted one, two, three, or greater than three times, as appropriate.
[c] Including exams under anesthesia.

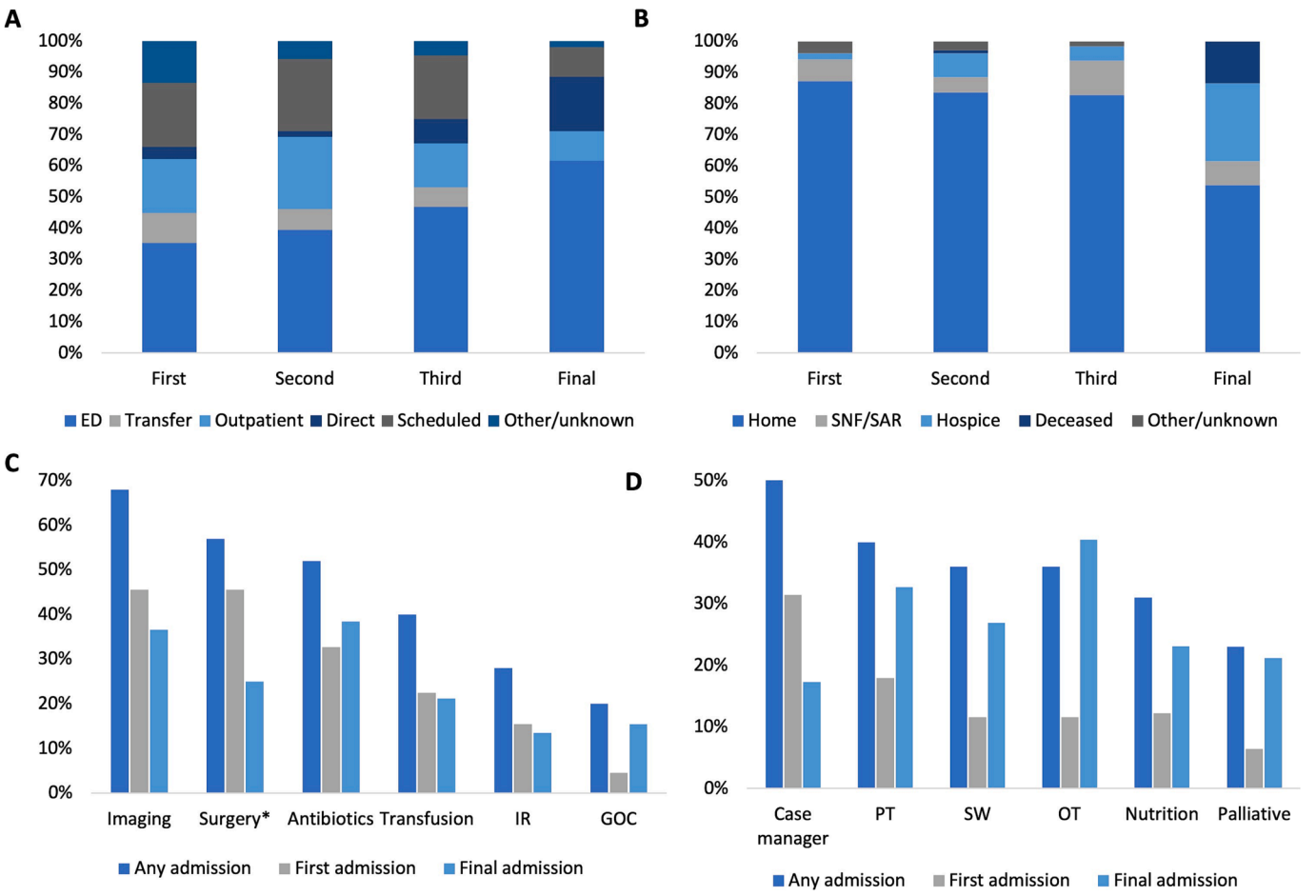

Fig. 1. Admission characteristics, including (A) route of admission, (B) discharge location, (C) interventions performed, and (D) specialty and supportive care services utilized.

Table 4 details univariate and multivariate analysis of factors associated with recurrent (≥3) hospital admissions following completion of treatment. On multivariate analysis, Black patients (aOR 2.4, $p = 0.022$), those with higher FIGO stage at diagnosis (aOR 5.1, $p = 0.013$), and those with recurrence (aOR 3.4, $p < .001$) were more likely to experience recurrent (≥3) hospital admission (Table 4). Patients with non-squamous cell carcinoma and non-adenocarcinoma were less likely to experience recurrent (≥3) admissions (aOR 0.17, $p = 0.014$; Table 4).

4. Discussion

Our study demonstrates the burden of cervical cancer survivorship both to patients and healthcare systems. Forty-three percent of the patients in our sample were hospitalized for cancer or treatment-related sequela in the median follow-up of 3.6 years from completion of primary treatment, with nearly three quarters of first admissions occurring more than 90 days from completion of treatment, indicating that survivors of cervical cancer represent a high-risk population with complex needs that span longer than the acute post-treatment phase. Notably, although patients with recurrence faced higher odds of admission, nearly one third of patients in remission experienced a hospitalization, and 42 % of the total 570 unique admissions during the study period were attributable to patients in remission. Moreover, the vast majority (72 %) of the patients in our cohort were in remission for the duration of the study period. Taken together, these data highlight the survivorship burden faced even by those who are considered to be in remission and cured of disease. Our results augment existing literature which has established the patient-reported burden of cervical cancer survivorship. (Clemmens et al., 2008; Cobbinah and Lewis, 2018; Conway et al., 2020) Compared to previous studies reporting that 29.3 % of gynecologic cancer patients experience an unplanned admission in the first year following treatment, rates of admission were higher in our population. (Peerenboom et al., 2022) The reason for this is likely twofold: first, our study involves an extended time period, indicating that treatment- and disease- related sequela impact survivors of cervical cancer beyond the first year post-treatment, and second, our study was based at an academic center which serves an underinsured and underserved patient population, with 56 % of patients in our cohort having at least locally advanced disease at the time of diagnosis.

More concerningly, of patients admitted after completion of primary treatment, we found that 17 % were admitted three or more times, with a median of 13.3 months from treatment completion to first admission and approximately 2 months between each admission thereafter. This finding supports the previously proposed 'revolving door' of readmissions in gynecologic cancer, (Huepenbecker and Meyer, 2022) and suggests that this pattern extends into the survivorship period.

Beyond the sheer number of admissions, our results highlight the complexity of care required for each hospitalization. Over one third of admitted patients had discharge diagnoses belonging to multiple clinical categories. In addition, admitted patients frequently required inpatient interventions and specialty and supportive care services, with over half of admitted patients in our study requiring an operating room procedure or antibiotic administration and over half requiring case management services. These results support existing literature which argues that survivors of cervical cancer face complex disease- and treatment-related symptom burden, (Pfaendler et al., 2015) pointing to the need for team-

Table 4
Univariate and multivariate analysis of risk factors associated with recurrent (≥3) hospital admissions after completion of primary treatment*.

Demographic, clinical, or treatment factor	Univariate, OR (95 % CI)	*P-value*	Multivariate, aOR (95 % CI)	*P-value*
Age	1.0 (0.98–1.0)	*0.80*		
BMI	0.98 (0.94–1.0)	*0.22*		
Race (ref = White)				
Black	3.0 (1.7–5.3)	***<0.001***	2.4 (1.1–4.9)	***0.022***
Other	1.3 (0.40–3.9)	*0.69*	1.5 (0.42–5.2)	*0.54*
Ethnicity (ref = Non-Hispanic)				
Hispanic	1.0 (0.42–2.4)	*0.99*		
Insurance (ref = Private)				
Medicaid	2.6 (1.2–5.5)	***0.012***	0.97 (0.36–2.6)	*0.96*
Medicare	2.1 (1.0–4.3)	***0.037***	1.4 (0.61–3.3)	*0.41*
Uninsured/self-pay	3.1 (1.4–7.1)	***<0.01***	1.5 (0.51–4.3)	*0.47*
CCI	1.1 (0.92–1.2)	*0.40*		
ECOG score	1.4 (1.0–1.8)	***0.024***	1.1 (0.78–1.5)	*0.59*
Stage (ref = IA or IB, surgery only)				
IB, chemoRT	3.0 (0.97–9.3)	*0.056*	3.6 (0.68–18)	*0.13*
II, III, IV	6.3 (2.8–14)	***<0.001***	5.1 (1.4–19)	***0.013***
Unknown	2.2 (0.54–8.9)	*0.28*	2.0 (0.32–13)	*0.46*
Histology (ref = SCC)				
Adenocarcinoma	0.40 (0.20–0.83)	***0.014***	0.50 (0.21–1.2)	*0.10*
Other[a]	0.29 (0.087–0.99)	***0.048***	0.17 (0.042–0.70)	***0.014***
Primary treatment (ref = Surgery only)				
ChemoRT or RT alone	5.2 (2.1–13)	***<0.001***	0.62 (0.14–2.7)	*0.53*
Chemotherapy alone	3.2 (0.71–14)	*0.13*	0.59 (0.089–3.9)	*0.59*
Surgery and RT ± chemo	2.1 (0.71–6.2)	*0.18*	0.74 (0.19–2.8)	*0.65*
Other[b]	0.89 (0.17–4.7)	*0.89*	0.26 (0.035–1.9)	*0.19*
Recurrence (ref = No)				
Yes	3.9 (2.2–6.8)	***<0.001***	3.4 (1.7–6.5)	***<0.001***

*N = 64 (17 %) patients admitted ≥ 3 times vs N = 302 (83 %) patients admitted < 3 times.
OR = odds ratio.
CI = Confidence Interval.
aOR = odds ratio.
CCI = Charlson Comorbidity Index.
ECOG = Eastern Cooperative Oncology Group.
SCC = squamous cell carcinoma.
[a] Of the total 39 patients with 'other' histology, there were 15 with unknown histology, 7 small cell neuroendocrine, 5 poorly differentiated carcinoma, 4 sarcoma, 3 clear cell, 1 glassy cell, 1 cervical adenoid basal carcinoma, and 1 stratified mucus-producing carcinoma.
[b] Of the total 33 patients with 'other' treatment, 15 underwent CKC or LEEP, 14 did not undergo any primary treatment due to personal decision, death, or being lost to follow-up, and 4 underwent initial treatment that included a clinical trial.

based care and comprehensive evaluation of multiple systems.

In our sample, risk factors for post-treatment hospital admission were both clinical and demographic in nature; patients with disease recurrence, those with lower ECOG score at diagnosis, Black patients, and uninsured patients were all more likely to be admitted following treatment. More concerningly, the patients with the most frequent admissions (3 or more) were also more likely to be Black, have recurrence, and have advanced disease at diagnosis. Racialized and socioeconomic disparities have already been demonstrated in cervical cancer disease incidence and 5-year survival; (Pyrzak et al., 2020; Rivera et al., 2017; SEER*Explorer Application. Accessed June 25, 2021) we present congruent findings with respect to unplanned hospital admissions for survivors of cervical cancer. Interventions to address structural racism and other social determinants of health must involve a multilevel approach involving policy change, resource redistribution, screening and navigation programs, which extends beyond the scope of this article. (Siegel et al., 2023; Tucker-Seeley, 2021) However, our findings underscore the importance of applying the structural determinants of health lens to cervical cancer survivorship research and patient care.

The most common reasons for hospital admission in our study were (i) gastrointestinal problems, including small bowel obstructions, fistulas, and proctitis; (ii) infections, ranging from simple cystitis to uremia; and (iii) genitourinary complications, such as vesicovaginal fistulas, hydronephrosis, and acute kidney injury. In a previous study of emergency department utilization by cancer patients, presenting complaints of sepsis and bowel obstruction were associated with increased likelihood of admission (Uppal et al., 2016). Thus, for survivors of cervical cancer, attention to gastrointestinal and urinary complaints in the outpatient setting may offer an opportunity for early intervention. For example, one potential intervention involves the use of electronic patient-reported outcomes (ePRO) monitoring tools, which have been shown to improve physical wellbeing and result in earlier responsiveness to symptoms during active treatment (Velikova et al., 2002; Warren et al., 2008). Similar tools are under investigation during the survivorship period, although not specific to cervical cancer (Wenzel et al., 2005). Our results suggest that, for survivors of cervical cancer, gastrointestinal, genitourinary, and pain-related symptoms should be emphasized when designing ePROs for this specific patient population.

Given the complex medical and social needs of survivors of cervical cancer demonstrated in our study, another potential intervention could be the implementation of an interdisciplinary medical home structure that emphasizes team-based care, similar to patient-centered medical homes used in other chronic disease models such as diabetes (Whitney et al., 2019). These frameworks integrate multidisciplinary teams (dieticians, nurses, pharmacists, primary care and specialist physicians, social workers, and therapists) and have been shown to improve clinical outcomes, decrease emergency department visits and hospitalizations, and reduce costs (Whitney et al., 2019). Our results suggest that survivors of cervical cancer may benefit from medical homes that incorporate teams which specifically include case managers, physical therapists, social workers, pain management, GI specialists, and urologists. Notably, the aforementioned interventions may be useful and necessary to improve the quality of survivorship care; however, the role of well-established yet often underutilized prevention and screening strategies cannot be understated (Wilbur et al., 2016).

Hospital admissions for cancer patients not only confer an emotional and physical burden to patients and their families but also come with significant financial costs, both to individuals and to healthcare systems. Given the substantial burden of survivorship demonstrated in our study, programs such as the National Breast and Cervical Cancer Early Detection Program, which seeks to alleviate the financial burden of cervical cancer, are of the utmost importance (Wuerthner and Avila-Wallace, 2016). This program may cover care that is not limited to cervical cancer, i.e. other medical care, and typically does not stipulate income eligibility criteria, thus representing a vital effort to lessen financial burden faced by this patient population. In addition to the costs to individual patients, hospitalizations account for the largest proportion of cancer-related healthcare spending during the year after dianosis (Joynt et al., 2011). In one study of gynecologic oncology admissions, which included patients both with active disease and survivors, the mean cost of an index admission for cervical cancer patients was $13,557, while the mean cost for 30-day readmissions was $11,632 (Huepenbecker and Meyer, 2022). In our study, there were a total of 570 unique admissions in the median 3.6 years post-treatment, inferring a total cost of roughly six to seven million dollars during this time period. Further economic

analyses are necessary to determine the relative value and cost-saving potential of targeted outpatient interventions.

Strengths of our study include the use of individual-level data from a large cohort at a high-volume urban academic medical center. In addition, our cohort represents a racially and socioeconomically diverse population, with 34 % of patients identifying as Black or African-American and 25 % either uninsured or insured by Medicaid. Utilizing individual-level data from this large, diverse cohort, we present vital hypothesis-generating data that has not been previously reported. One limitation is that there may be missing data regarding admissions to outside facilities due to the inconsistent transfer of information between electronic medical record systems. As a result, our study may underestimate the number of patients who were admitted following treatment. In particular, these patients may be those who face additional social and structural barriers to accessing healthcare, such as those who must travel a farther distance to the medical center or live in rural areas. A second limitation is the retrospective, quantitative design of our study. While our results provide specific baseline data to design interventions and guide research in this area, qualitative studies and prospective trials of multi-disciplinary team navigation approaches are needed to further study the efficacy, relative value, and acceptability of various interventions.

Author Contribution Section (CRediT roles)

Rayne Peerenboom, BA: conceptualization, data curation, formal analysis, investigation, methodology, visualization, writing – original draft, writing – review & editing.

Sarah Ackroyd, MD, MPH: conceptualization, formal analysis, methodology, visualization, supervision, project administration, writing – review & editing.

Nita Lee, MD, MPH: conceptualization, methodology, supervision, project administration, writing – review & editing.

CRediT authorship contribution statement

Rayne Peerenboom: . **Sarah Ackroyd:** Conceptualization, Data curation, Investigation, Methodology, Supervision, Validation, Visualization, Writing – review & editing. **Nita Lee:** Conceptualization, Methodology, Supervision, Validation, Visualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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