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ORIGINAL RESEARCH

Evaluation of Geographic Disparities in Cervical Cancer Survival Across Maine

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Introduction: National data suggests that there are geographic disparities in oncology care within the United States. It is unknown whether these disparities present a problem for women with gynecologic malignancies located in Maine.

Methods: Data from each cervical cancer case diagnosed or treated under the MaineHealth system between 2007 and 2011 were acquired from the MaineHealth Network Registry. Average annual incidence and 5-year survival were calculated for each county in Maine and mapped using geographic information systems software. Next, cases were divided into 2 groups: patients residing less than or equal to 60 miles from the sole gynecologic oncology practice in Maine and those residing over 60 miles from the practice. The 5-year survival rates of each group were compared using chi-square testing. Demographics and risk factors of the 2 groups were compared with the 2-sample t-test or Fisher's exact test.

Results: The average annual incidence of cervical cancer in each county of Maine between 2007 and 2011 ranged from 0 to 0.91 new cases per 10000 female persons. The 5-year survival rate within each county ranged from 0% to 100%. The 5-year survival rate of women with cervical cancer residing less than or equal to 60 miles from the gynecologic oncology practice based in Maine was 63.0%, while the rate of those residing farther than 60 miles was 71.9% ($P = .12$).

Conclusions: No significant geographic disparities in survival outcomes were found for women diagnosed with cervical cancer in Maine between 2007 and 2011.

Keywords: cancer, geographic disparities, rural health, gynecology

There is a growing emphasis on identifying and correcting disparities in health care.¹ Multiple types of disparity exist, including gender, racial, socioeconomic status, and geographic location. Geographic disparities involve differences in health status or care access between 2 geographically defined populations.² A recent study by Henley et al. illustrated the extent to which geographic disparities affect health care in the United States.³ This study examined the difference in mortality from invasive cancers between metropolitan and nonmetropolitan rural counties across the nation. It concluded that rural counties, despite having lower incidence rates, had higher mortality rates

than metropolitan counties. These findings suggest that geographic disparities in oncology care are a nationwide problem.

The state of Maine is primarily rural, with 61.3% of the population residing in areas comprising less than 2500 individuals.⁴ Geographic disparities are of particular concern in states like Maine due to the shortage of health care providers in rural areas and the location of specialty providers in urban areas.⁵ Gynecologic oncologists are among those specialty providers located to urban areas due to the need for volume, infrastructure for complex surgery, care coordination with other medical specialties, and ancillary facilities that can conduct chemotherapy infusion and radiation therapy. A recent study found that 36% of counties in the United States are located greater than 50 miles

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from a gynecologic oncologist, putting 14.8 million women at risk of geographic disparities in care if they were to develop a gynecologic malignancy.⁶ Given this location of gynecologic oncologists, and the reported national correlation between rurality and poor cancer outcomes, there is reasonable concern that geographic disparities might exist for women with gynecologic malignancies in Maine.³ It is unknown whether patients with gynecologic malignancies living in the rural areas of Maine (or other states) face worse outcomes than those who reside closer to gynecologic oncology practices.

Geographic disparities might occur for women with many different types of cancer. However, there is greater concern for women with cervical cancer due to the nature of treatment. Cervical cancer is the third leading gynecologic malignancy in the developed world, and its treatment is complex.⁷ Treatment is multimodal, frequently requiring some combination of surgery, chemotherapy, and/or radiation therapy. Definitive chemoradiation for cervical cancer is complex. It typically involves daily pelvic radiation therapy for approximately 25 fractions and weekly cisplatin-sensitizing chemotherapy, followed by intracavitary brachytherapy.⁸ Surgery and radiation therapy can be done in only a limited number of facilities, with the lone gynecologic oncology practice in the state or an affiliated radiation oncologist typically located in an urban area. Due to the complexity of this care-delivery model, traveling to access services is particularly difficult for patients living in rural areas far from gynecologic oncology care and the necessary adjunctive services. A single-site study published in 2015 revealed that treatment completion for women with gynecologic cancers, while high overall, depended on the distance to treatment.⁹

We hypothesized that among women with cervical cancer living in Maine, survival rates may be worse for women residing far from their gynecologic oncologist when compared to those residing nearby.³ We conducted an observational pilot study to determine whether outcomes differ for a cohort of patients in Maine who were diagnosed with cervical cancer based on the distance of their residence from their primary gynecologic oncology practice. This sole practice was located in the southern and most populated part of the state.

METHODS

This study was approved by the Maine Medical Center Institutional Review Board in March 2018.

Data collection and management

Data by MaineHealth Oncology Information Services. All patients diagnosed or treated by a MaineHealth provider for a malignancy are automatically entered into this registry. The Maine Health Network Registry includes 89% of all gynecologic oncology patients in the state of Maine. All these patients were treated by the sole gynecologic oncology practice in Maine under the MaineHealth system and included in the study. The 11% of patients not included in the registry sought treatment outside of the MaineHealth system and were excluded from the study.

All women residing in Maine who were diagnosed with cervical cancer and seen by a MaineHealth gynecologic oncologist between 2007 and 2011 were eligible for inclusion in the study (n = 182). This date range was chosen to allow for calculation of 5-year survival for all patients over a 5-year time span. This span was chosen to increase the number of patients in the study and prevent changes in treatment recommendations over time from being a significant confounder. Patients were excluded from the study if their survival was unable to be calculated due to loss to follow-up (n = 26). Thus, 156 patients were enrolled in the study. Variables extracted from each case included patient age, date of diagnosis, disease stage, zip code, county, vital status, time from diagnosis to most recent contact, insurance status, tobacco history, and race. Computed variables for each case included 5-year survival status and distance in miles from zip code to the sole gynecologic oncology practice in Maine. Additional variables needed for incidence calculations included female population of each zip code and county, which were acquired from the United States Census Bureau.¹⁰ Data was stored and accessed using Microsoft Excel.

Data analysis

The average annual incidence of cervical cancer between 2007 and 2011 was calculated for each zip code and county in Maine. This calculation used the date of diagnosis for each case and 2010 Census tract data for the general female population of each

geographic unit. The average annual incidence of each zip code and county were also mapped to visually represent this data. Incidence rates were averaged over the 5-year study to protect patient confidentiality.

To explore the relationship between the distance to treatment and survival, the distance from the zip code to the primary gynecologic oncology practice for each patient was used to separate cases into 2 study groups: patients residing greater than 60 miles from the practice and patients residing less than or equal to 60 miles away. A distance cutoff of 60 miles was chosen as an estimate of the minimum distance that would burden patients needing to frequently obtain health care, and to ensure each group had a reasonable number of cases to maximize statistical power. The 5-year survival rate for each of the 2 groups was calculated using the 5-year survival status of each case within the groups. The survival rates were also calculated based on each zip code and county within Maine, and the rates were mapped using geographic information systems (GIS). Survival rates were averaged over the 5-year study to protect patient confidentiality.

Demographic and outcome data were summarized using descriptive statistics. Continuous data was shown as mean, and categorical data was shown as frequency (n, %). Differences between the 2 distance groups were compared by chi-square (χ^2) test or Fisher's exact test as appropriate (categorical data), or by t-test (continuous data). A significance level of .05 was chosen for all tests. All statistical tests were done using the data analysis tools within Microsoft Excel.

Data mapping

Maps were produced with the GIS software Global Mapper by Blue Marble Geographics (Hallowell, ME) using the calculated average annual incidence rate and 5-year survival rate for each zip code and county in Maine. Because the small population sizes of several counties in Maine could jeopardize patient confidentiality and identification, maps of zip code data were not included in this report.

RESULTS

A select number of demographic variables and risk factors were compared between the 2 study groups: patients located less than or equal to 60

miles from the sole gynecologic oncology practice and patients located greater than 60 miles away (Table 1). These variables included age, race, insurance status, cancer stage, and tobacco use history. The mean difference in age between the 2 groups, calculated by 2-sample t-testing, was 0.69 ($P = .79$, 95% CI [-4.31, 5.68]). Differences in race, insurance status, disease stage, and tobacco use history were compared using Fisher's exact test ($P = .59$, .77, .70, and .86, respectively). There were no significant differences between the 2 groups.

The average annual incidence of cervical cancer in each county of Maine between 2007 and 2011 ranged from 0 new cases per 10000 female persons in Washington and Piscataquis Counties to 0.91 new cases per 10000 female persons in Somerset County (Table 2, Figure 1). The 5-year all-stage survival rate for women with cervical cancer in the state of Maine between 2007 and 2011 was 67%. When examining each county of Maine, the 5-year survival ranged from 0% in Oxford County to 100% in Hancock and Aroostook Counties (Table 2, Figure 2).

The 5-year survival rates of the 2 distance-based groups of cervical cancer patients were calculated. The 5-year survival rate of women residing less than or equal to 60 miles from the practice was 63.0%, while the rate of women residing farther than 60 miles from the practice was 71.9% ($\chi = 1.30$, $P = .12$).

DISCUSSION

Calculations and mapping of average annual incidence revealed that new cases of cervical cancer are fairly widespread across the state (Table 1, Figure 1). The 2 counties with an incidence of 0 new cases per 10000 female persons are rural, and thus the low incidence may reflect smaller sample sizes rather than, for example, superior preventive care. Somerset County is rural and has a disproportionately high number of new cervical cancer cases. While local needs assessments in this area may help to determine the cause of this high incidence rate, the incidence in rural counties should be interpreted with caution. Given the small overall population, these rates are generally unstable over time.¹¹

Survival maps produced with GIS did not suggest a correlation between distance to the primary gynecologic oncology practice and 5-year survival.

Table 1. Comparison of selected demographics and risk factors between study groups.

Variable	Patients ≤ 60 miles from Maine GO (n = 92)	Patients > 60 miles from Maine GO (n = 64)	P value
Age, mean	51.83	51.14	.79
Race, no (%)			.59
White	88 (96%)	64 (100%)	
Black	2 (2%)	0 (0%)	
Other	2 (2%)	0 (0%)	
Insurance status, no (%)			.77
Insured	79 (86%)	58 (91%)	
Not insured	12 (13%)	6 (9%)	
Unknown	1 (1%)	0 (0%)	
Disease stage, no (%)			.70
I	40 (43%)	25 (39%)	
II	14 (15%)	10 (16%)	
III	24 (26%)	15 (23%)	
IV	13 (14%)	11 (17%)	
Unknown	1 (1%)	3 (5%)	
Tobacco use history, no (%)			.86
History of use	51 (55%)	35 (55%)	
No history of use	35 (38%)	26 (41%)	
Unknown	6 (7%)	3 (5%)	

*Percentages within subgroups that do not add up to exactly 100% are due to rounding.
GO, gynecologic oncologist.

In fact, the highest 5-year survival rate was in the farthest county (Aroostook), while the lowest rate was in the county much closer to treatment centers (Oxford). This observation contradicts the hypothesis that survival rates would be lower for those who reside farther from care.

Statistical comparison of 5-year survival rates between the 2 study groups further supported that survival rates are not lower for patients with cervical cancer who reside farther from care in Maine. We were surprised that the 5-year survival rate appeared higher for patients residing further from care. However, further analysis using chi-square testing yielded a *P* value of .12, indicating that there was no significant difference in survival between the 2 study groups. Of note, both survival rates are fairly consistent with the national 5-year survival rate for all-stage cervical cancer of 68%.¹²

This study did not reveal geographic disparities in the survival of cervical cancer patients in Maine. However, disparities occur elsewhere and may still exist throughout the state for patients with other gynecologic malignancies or serious chronic illnesses. Geographic disparities and research regarding them remain significant for this reason and several others. First, research addressing this phenomenon allows providers to identify whether the specific populations they serve may be vulnerable to disparities in care. A problem cannot be corrected if we do not know it exists. Second, studies that illustrate geographic variations in incidence and survival could indicate where more services are needed. If differences in survival are detected, they could help to establish oncology outreach clinics, introduce infusion capabilities or radiation modalities to existing health care centers, or invest in treatment housing (similar to the Ronald McDonald House model) for far-traveling patients.¹³

Table 2. Average annual incidence of cervical cancer and 5-year survival rates of patients with cervical cancer in Maine by county, 2007-2011.

County	No. of new cases	Female population	Average annual incidence per 10 000 female persons	No. of patients surviving 5 years	5-year survival rate
Androscoggin	15	55 036	0.55	12	80%
Aroostook	6	36 510	0.33	6	100%
Cumberland	40	145 062	0.55	24	60%
Franklin	6	15 722	0.76	5	83%
Hancock	3	27 753	0.29	3	100%
Kennebec	25	62 663	0.77	16	64%
Knox	3	20 067	0.30	1	30%
Lincoln	7	17 573	0.80	5	71%
Oxford	3	29 148	0.27	0	0%
Penobscot	3	78 039	0.08	2	67%
Piscataquis	0	8 838	0.00	--	--
Sagadahoc	6	18 211	0.66	2	33%
Somerset	12	26 323	0.91	7	58%
Waldo	5	19 781	0.51	4	80%
Washington	0	16 658	0.00	--	--
York	22	101 128	0.44	17	77%

Geographic disparity studies are particularly valuable if different specialties find they need similar resources in remote locations. For example, if future geographic studies of gynecologic and other cancers suggest a need for a new chemotherapy infusion site in the northern regions of Maine, they could drive efforts to establish a new site for treatment.

There are limitations within this study. The first is the small sample size of cervical cancer patients and resulting limited statistical power. While we did observe every case of cervical cancer in the MaineHealth Network Registry between 2007 and 2011, cervical cancer has a relatively low incidence in the United States thanks to the advent of the Pap smear.¹⁴ This low incidence, and thus small sample size, limited our comparison to 2 groups and also influenced the distance cutoff to maximize statistical power. The second limitation of this study involved the constraints of using registry data. The MaineHealth Network Registry only includes cases that are diagnosed or treated under the umbrella of MaineHealth, which, for gynecologic malignancies, is only 89% of the patients residing

in Maine. Therefore, the study did not include every cervical cancer patient within the state of Maine. However, it did include every patient cared for by the sole gynecologic oncology practice based in Maine. Additionally, when using registry data, one must sacrifice data variables of interest for the convenience of access. For example, it would have been useful to examine other demographic and risk factor variables for cervical cancer patients, such as socioeconomic status and Pap smear history. It would have also been useful to know the treatment regimen for these patients and whether it influenced their survival. For example, in patients with intermediate-risk cervical cancer, we could consider whether geographic consideration influenced decisions between treating with radical hysterectomy or definitive chemoradiation. These variables were not recorded in the registry and could not be incorporated into analysis. Future efforts could involve a chart review, enabling these gaps to be filled. The third limitation of this study was loss to follow-up. Between 2007 and 2011, there were 26 patients diagnosed with cervical cancer in Maine who could not be included in the analysis because their vital status could not be assured. Many of

Figure 1. Map of average annual incidence of cervical cancer in Maine by county, 2007-2011.

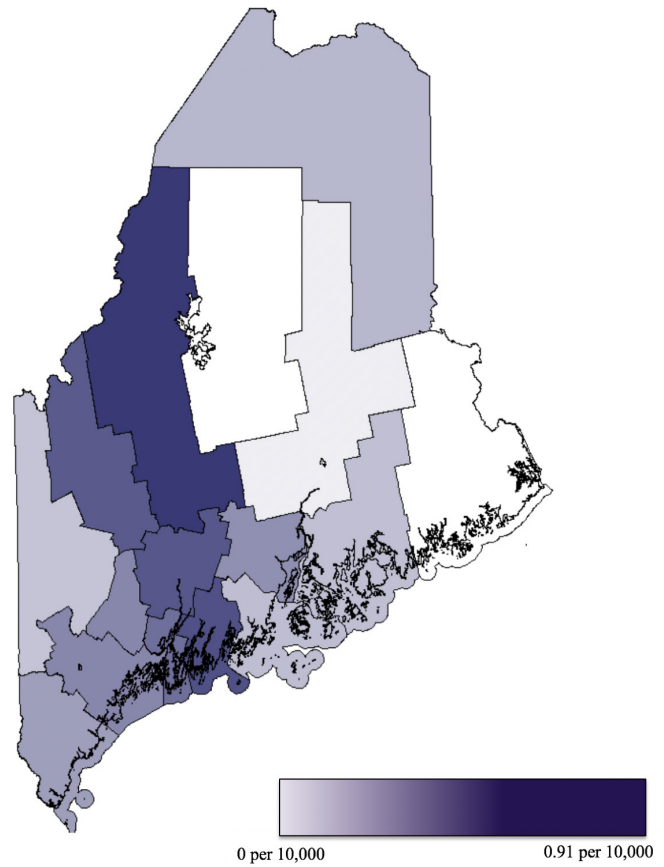
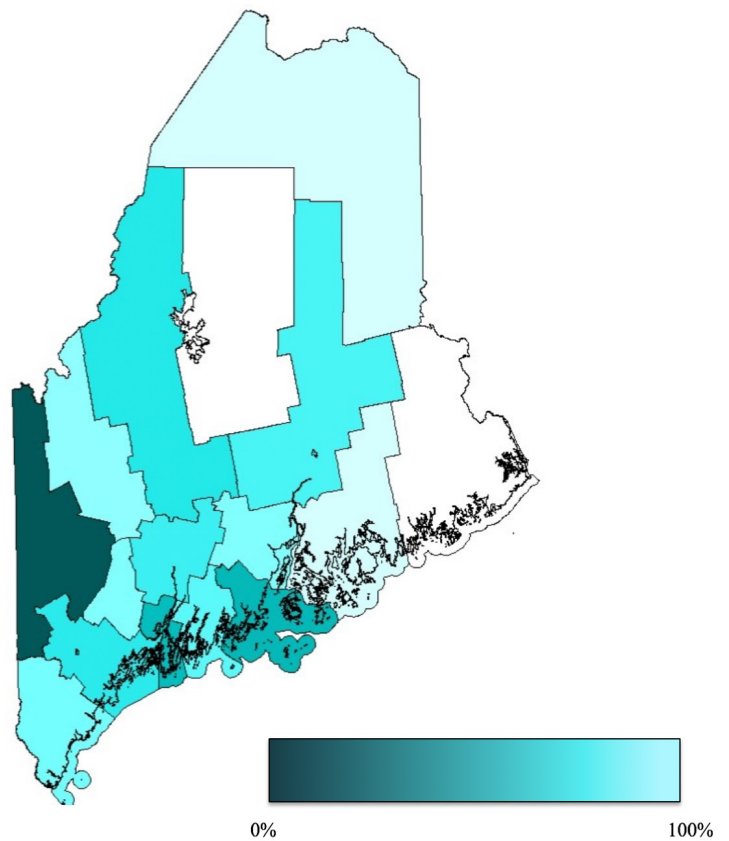


Figure 2. Map of 5-year survival rates of patients diagnosed with cervical cancer in Maine by county, 2007-2011. Counties in white did not have any diagnosed cases.



these patients were seen once for their surgery and not seen by their gynecologic oncologist again. Instead, they followed up in local rural settings due to geographic considerations. Therefore, these patients' vital status was not updated in the registry. It does not appear that differences in distance to treatment were influential: 14 of the patients lost to follow-up resided within 60 miles of the Maine gynecologic oncology practice (13.2% of the nearby group), and 12 resided over 60 miles (15.8% of the far group).

CONCLUSION

We did not find a significant geographic disparity in the 5-year survival of patients with cervical cancer in Maine treated by MaineHealth between 2007 and 2011.

Our findings do not suggest a need to expand resources for treatment of cervical cancer in rural areas of Maine based on survival outcomes alone. However, this outlook could change over time, especially as rural hospitals close their doors and more OB/GYNs leave rural practice.^{15,16} It is also possible that patients with other gynecologic malignancies face geographic disparities and may benefit from expanded services. Therefore, complacency is not recommended. Outcome assessments should be performed at regular intervals. It may also be beneficial to repeat this study with a focus on endometrial or ovarian cancer, gynecologic malignancies that are much more prevalent in Maine. This method could also be repeated on cervical cancer patients in a different geographical area, which might yield interesting results, albeit confirmatory or conflicting. With more available cases, there would be greater statistical power to identify a difference in outcomes if one truly exists.

Further investigation is required to determine whether geographic disparities exist for gynecologic oncology patients in Maine. If they exist, it is important that they are identified and that innovative methods are developed to reduce the impact of geography on patients' health.

Conflicts of Interest: None

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