Determinants of NCI Cancer Center Attendance in Medicare Patients with Lung, Breast, Colorectal, or Prostate Cancer

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BACKGROUND: Geographic access to NCI-Cancer Centers varies by region, race/ethnicity, and place of residence, but utilization of these specialized centers has not been examined at the national level in the U.S. This study identified determinants of NCI-Cancer Center attendance in Medicare cancer patients.

METHODS: SEER-Medicare (Surveillance Epidemiology and End Results) data were used to identify individuals with an incident cancer of the breast, lung, colon/rectum, or prostate from 1998–2002. NCI-Cancer Center attendance was determined based on utilization claims from 1998–2003. Demographic, clinical, and geographic factors were examined in multilevel models. We performed sensitivity analyses for the NCI-Cancer Center attendance definition.

RESULTS: Overall, 7.3% of this SEER-Medicare cohort (N=211,048) attended an NCI-Cancer Center. Travel-time to the nearest NCI-Cancer Center was inversely related to attendance, showing 11% decreased likelihood of attendance for every 10 minutes of additional travel-time (OR=0.89, 95%CI 0.88–0.90). Receiving predominantly generalist care prior to diagnosis was associated with a lower likelihood of attendance (OR=0.79, 95%CI 0.77–0.82). The other factors associated with greater NCI-Cancer attendance were later stage at diagnosis, fewer comorbidities, and urban residence in conjunction with African-American race.

CONCLUSIONS: Attendance at NCI-Cancer Centers is low among Medicare beneficiaries, but is strongly influenced by proximity and general provider care prior to diagnosis. Other patient factors are predictive of NCI-Cancer Center attendance and may be important in better understanding cancer care utilization.

KEY WORDS: attendance ; determinants; cancer centers; Medicare.

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INTRODUCTION

Primary care physicians increasingly encounter patients who present with a cancer diagnosis or with symptoms leading to cancer diagnosis. This may be due to greater longevity, reduced cardiovascular deaths, and better survival after a initial cancer diagnosis.[1]

Almost all patients with a known or suspected cancer diagnosis are referred for subspecialty care. While some evidence studies indicate that patients have better outcomes when cared for by oncologist subspecialists or National Cancer Institute (NCI) Cancer Centers[2–5], little is known regarding determinants of cancer patient referrals.

NCI-Cancer Centers are of particular interest as the most specialized of cancer care settings in the US. NCI-Cancer Centers compete for the designation and federal funding based on demonstrated excellence in cancer control, clinical care, and basic and clinical research. With 32 states now home to at least one NCI-Cancer Center[6] oncology care is increasingly likely to be influenced by their presence.

While it has been shown that proximity to services, type of residence (rural vs. urban), region, race/ethnicity, income, education, and physician contact are associated with the type of cancer care patients receive[7–13], the role of these factors in patient attendance at NCI-Cancer Centers is not known. Measuring the determinants of NCI-Cancer Center attendance is a critical element in understanding cancer care coordination, and the allocation of oncology resources. This study identifies factors associated with NCI-Cancer Center attendance in Medicare patients diagnosed with lung, breast, colorectal, and prostate cancer from 1998–2002.

METHODS

We developed multilevel models to identify factors associated with NCI-Cancer Center attendance by incorporating the following clinical, demographic, and geographic factors: a) *Clinical*—cancer site, stage, comorbidities, and dominant physician type for care prior to diagnosis; b) *Demographic*—age, sex, race, median income and education for ZIP code of residence; c) *Geographic* –type of residence (urban vs. rural), travel-time to the nearest NCI-Cancer Center, and per-capita oncologist supply for area of residence.

Study Population and Data

We obtained SEER-Medicare data for incident primary cases of breast, lung, colorectal, or prostate cancer from 1998–2002, with inked claims through 2003. Currently, the 14 SEER registries represent ~26% of the U.S. population[14]. Linkage of SEER records for persons 65 years or older to Medicare claims is approximately 94% complete[15]. For the cancer sites included in this analysis—lung, breast, colorectal, and prostate, the majority of cases occur in individuals over age 65 years of age[16]. Hawaii registry data were not obtained as we were unable to use the restricted variable, patient ZIP code, for this state. Washington State residents were excluded due to missing data for the NCI-Cancer Center in the Seattle/Puget Sound registry. We also excluded individuals not enrolled concurrently in Medicare Parts A (inpatient) and B (outpatient and physician services), since we would be unable to ascertain claims other than for hospital stays. Similarly, we excluded beneficiaries with enrollment in an HMO in the 12 months prior to diagnosis, as managed care plans are not required to submit individual claims for reimbursement. Additional exclusions were based on <66 years of age at diagnosis, indeterminate month of diagnosis, entitlement due to end-stage renal disease, cancer diagnosis prior to 1998, death within one month of diagnosis, and absence of MedPAR or Outpatient File claims in the first 12 months following diagnosis. Part B claims based solely on physician billing are not linked to the Hospital File from which NCI-Cancer Center status of the claim origin was determined, and thus were not used in the NCI-CC attendance definition. The proportion of cancer patients with no Outpatient File or MedPAR claims in the first 12 months was 1.1% at the lowest (breast cancer) and 5.6% at the most (prostate cancer) without any, thus suggesting that substantial bias is unlikely.

Additional data included Rural Urban Commuting Area (RUCA version 2.0) classifications, travel-time to nearest NCI-Cancer Center, and per-capita oncologist supply[17]. Type of residence was assigned by linking patient ZIP code to its RUCA classification[18]. Travel-times were calculated based on the shortest travel-time route from each ZIP code tabulation area (ZCTA) population centroid to the nearest NCI-Cancer Center based on a national road network including speed limits (TeleAtlas, Lebanon, NH)[17]. Travel-time was computed using a closest facility algorithm[19] in ArcView GIS(3.3) Network Analyst (Environmental Systems Research Institute, Redlands, CA), which creates unique origin-destination pairs then determines the one-way travel-time between them. Per-capita oncologist density was calculated by summing oncologist counts by ZIP code of practice location to the hospital referral region (pHRR) level and dividing by population counts (U.S. Census 2000). During the study period, 47 institutions held continuous designation as a comprehensive or clinical NCI-Cancer Center; of these, 15 (32%) were located within SEER areas.

Analysis

NCI-Cancer Center attendance was defined as two or more claim-days for inpatient or outpatient procedural care at an NCI-Cancer Center within 12 months of the index cancer diagnosis as recorded by SEER. A claim-day was defined as one calendar date on which one or more of the above claims occurred; inpatient stays were considered as one claim, and Outpatient File claims occurring during an inpatient stay were not counted. An index cancer was defined as a first primary cancer of the breast, lung, colon/rectum, or prostate within the study period. Claims were identified as occurring at an NCI-Cancer Center through the SEER-Medicare Hospital file[20]. To account for possible referral and/or health care encounter patterns that might influence attendance we measured dominant physician care type in the 6 months prior to diagnosis. This measure was derived by tabulating physician encounters as recorded in Part B claims as with a generalist or specialist, and assigning primary care predominance to those with ≥ 50% generalist care. We also adjusted for comorbid conditions identified through International Classification of Diseases (ICD-9) codes for all hospital and physician encounters within 12 months prior to diagnosis and then calculating a Charlson score, modified to exclude solid tumors[21–23]. Receipt of cancer-directed surgery in the first year following diagnosis was determined using appropriate procedure codes from ICD-9 and Current Procedural Terminology (CPT) and SEER records. We used receipt of cancer-directed surgery in subanalyses, but did not include it in our main model due to the potentially bidirectional relation between surgery and NCI-Cancer Center attendance.

Racial/ethnic categories were defined as Caucasian, African-American, Asian, Hispanic, and Native American, or "other". These categories were mutually exclusive and taken from self-report to the Social Security Administration and recorded in Medicare. Sample size was sufficient for the predictive models only for Caucasians and African-Americans. Further, we hypothesized a priori an interaction of race and urbanity, which we confirmed and thus used an interaction term for these variables. Group-level variables included median income and educational attainment for the ZIP code of residence at the time of diagnosis. Median income and median education (in years) by ZIP were highly correlated (correlation coefficient=0.99); thus we only included median income in our analyses. Covariates were included in the models to adjust for individual and group-level characteristics, including sex, age at diagnosis, SEER registry of diagnosis, and pHRR-level per-capita oncologist supply. Marital status and year of diagnosis were evaluated, but were not significant in univariate, stratified or multivariate models, thus were excluded in the models.

We developed an adjusted logistic regression model of NCI-Cancer Center attendance, which accounted for interactions between race and urban residence. It also included variables shown to contribute independently to NCI-Cancer Center attendance, based on a change in odds ration (OR) of ≥15% in main effect variables when added to the model. To account for potential clustering within pHRRs, we also fitted a random intercept model[24]. Intra-cluster correlations were exceedingly low (0.02–0.04), with no material differences in parameter estimates observed between the multiple logistic regression and logistic random effects models. We report only results based on logistic regression models.

To evaluate model stability in relation to NCI-Cancer Center attendance definition, we performed a sensitivity analysis by changing the attendance threshold criteria. We compared model performance with our base definition of ≥ 2 claim-days in the first 12 months from diagnosis to NCI-Cancer Center attendance defined as: 1) ≥1 claim-day in the first 12 months from diagnosis; 2) only surgical claim(s); 3) proportion of claim-days at an NCI-Cancer Center within first year ≥ 50%. All

analyses were performed using Stata statistical software v9.2 (Stata Corporation, College Station, TX).

RESULTS

Our study population included 211,048 Medicare beneficiaries with a primary cancer of the breast, lung, colon/rectum, or prostate. Of these individuals, 15,377 (7.3%) had two or more claim-days at an NCI-Cancer Center within one year of diagnosis. The large sample size yielded χ^2 tests with P-values < 0.05 for all independent variables except sex, marital status, and year of diagnosis (not shown). Characteristics of the NCI-Cancer Center attendees showed: a higher proportion of African-Americans attending NCI-Cancer Centers than non-NCI-Cancer Centers, a lower predominance of primary care prior to diagnosis, more urban residents, younger age at diagnosis, shorter travel-times to nearest NCI-Cancer Center, and greater oncologists density in pHRR of residence (Table 1. Among patients attending an NCI-Cancer Center, almost 61% lived ≤30 min, 77% lived within one hour, and 92% lived within two hours. The remaining 8% of NCI-Cancer Center attendees living more than two hours away may include "snow birds" whose ZIP code of residence as recorded in Medicare does not correspond to their seasonal locale.

Significant predictors of NCI-Cancer Center attendance in the fully adjusted model included: travel-time (in 10 min.) to nearest NCI-Cancer Center (OR=0.89; 95%CI=0.88–0.90), predominance of primary care prior to diagnosis (OR=0.79; 95%CI=0.77–0.82), later stage at diagnosis (Stage 4: OR=1.20; 95%CI=1.13–1.28), race and urbanity combined, number of comorbidities, and median income for ZIP code of residence (Table 2. Urban African-Americans were over one and a half times as likely to attend as urban Caucasians (OR=1.66; 95%=CI 155–1.77). As the number of comorbidities increased, the likelihood of NCI-Cancer Center attendance decreased (1–2: OR=0.89; 95%CI=0.86–0.93, 3–4: OR=0.80; 95%CI=0.75–0.85, 5+: OR=0.66; 95%CI=0.60–0.73). Median household income for ZIP code of residence was associated with increased NCI-Cancer Center attendance for the lowest and highest quintiles (referent: lowest quintile): 2nd quintile OR=0.82; 95%CI=0.77–0.87, 3rd quintile OR=0.82; 95%CI= 0.77–0.87, 4th quintile OR=0.92; 95%CI=0.87–0.98, 5th quintile OR=1.18; 95%CI=1.11–1.26). In evaluating our attendance definition, we found the predictive model of NCI-Cancer Center attendance to be largely insensitive to changes in claims thresholds (data not shown).

Table 1. Characteristics of NCI-Cancer Center attendees* and Other Individuals with an Incident Diagnosis of Lung, Breast, Colorectal, or Prostate Cancer as Recorded in SEER from 1998–2002 (N=211,048)

	NCI-Cancer Center Attendance	
	Yes	No
	N (%)	N (%)
Total	15377 (7.3)	195671 (92.7)
Age at diagnosis (yrs.)		
65–69	4394 (28.6)	40295 (20.6)
70–74	4796 (31.2)	52515 (26.6)
75–79	3581 (23.3)	48815 (24.9)
80–84	1762 (11.5)	31924 (16.3)
≥85	844 (5.5)	22486 (11.5)
Cancer site		
Breast	3554 (23.1)	46439 (23.7)
Lung	3749 (24.4)	45380 (23.2)
Colorectal	2864 (18.6)	46669 (23.8)
Prostate	5210 (33.9)	57183 (29.2)
Female	6791 (44.2)	93370 (47.7)
Race/ethnicity		
Caucasian	12690 (82.5)	170607 (87.2)
African American	1993 (13.0)	16015 (8.2)
Other	213 (1.4)	2212 (1.1)
Asian	303 (2.0)	3558 (1.8)
Hispanic	167 (1.1)	2959 (1.5)
Native American	11 (<1.0)	320 (0.2)
Predominance of primary care†	6514 (42.4)	93762 (47.9)
Rurality		
Urban or suburban	12963 (84.3)	154599 (79.0)
Large town or rural areas	2414 (15.7)	41072 (21.0)
Comorbidities		
0	9966 (64.8)	118077 (60.3)
1–2	3736 (24.3)	50340 (25.7)
3–4	1263 (8.2)	19499 (10.0)
5+	412 (2.7)	7755 (4.0)
Cancer directed surgery‡	9161 (59.6)	112284 (57.4)
Stage at diagnosis		
1	3383 (22.0)	46731 (23.9)
2	2023 (13.2)	30864 (15.8)
3	2180 (14.2)	26713 (13.6)
4	2350 (15.3)	26260 (13.4)
Unknown	5441 (35.4)	65103 (33.3)
	Median (Interquartile Range)	
Travel-time to nearest (min.)		
NCI-Cancer Center	24 (13–52)	51 (23–138)
Median income of ZIP ($1000)	46.8 (35.2–61.7)	45.5 (34.5–59.2)
Physician supply (per 1000)		
Primary care physicians	1.2 (0.9–1.6)	1.3 (1.0–1.9)
Oncologists	3.5 (2.4–4.0)	2.6 (2.0–3.8)

* *NCI-Cancer Center attendance was defined as having two or more claim-days in the first 12 months following diagnosis.*

† *Predominance of primary care was defined as having the number of primary care visits greater than or equal to that of specialist visits in the 6 months prior to diagnosis.*

‡ *Cancer-directed surgery was defined as a resection of the lung, breast, colon/rectum, or prostate for patients with cancer of the respective organ, based on ICD-9 and CPT codes.*

DISCUSSION

Overall, NCI-Cancer Center attendance among patients with breast, lung, colorectal, or prostate cancer was only 7.3% of the SEER-Medicare population. The most influential determinants of NCI-CC attendance were travel-time, place of residence, particularly for African Americans, and predominant type of care before diagnosis. Urban African-Americans were more likely to attend an NCI-Cancer Center compared to urban Caucasians. Cancer patients whose care in the six months prior to diagnosis was predominated by generalists rather than specialists were less likely to attend an NCI-Cancer Center. Disease-specific factors were also important to attendance, including cancer site, stage at diagnosis, and the presence of comorbidities. Individuals diagnosed with lung cancer were more likely to attend than those diagnosed with breast, colorectal, or prostate cancers. For all cancers combined, later stage at diagnosis and the presence of fewer comorbidities were both positively associated with NCI-Cancer Center attendance. Factors contributing to these referral patterns may include provider referral patterns or patient referral preferences. The relative capacity to care for cancer patients in a given community is also likely to be important.

Table 2. Odds Ratios for Predictive Models of NCI-Cancer Center attendance* in Medicare Beneficiaries (N=211,048) with an Incident Diagnosis of Breast, Lung, Colon/Rectal, or Prostate Cancer as Identified in SEER-Medicare Data from 1998–2002

Final Model Variables	Odds Ratio† (95%CI)
Travel-time to nearest NCI-CC (in tens of minutes)	0.89 (0.88–0.90)
Predominance of primary care‡	0.79 (0.77–0.82)
Stage at diagnosis	
1	1.00 (referent)
2	0.97 (0.91–1.03)
3	1.15 (1.09–1.23)
4	1.20 (1.13–1.28)
Unknown	1.09 (1.03–1.15)
Cancer site	
Breast	1.00 (referent)
Lung	1.10 (1.04–1.17)
Colorectal	0.83 (0.79–0.88)
Prostate	1.00 (0.94–1.06)
Race/ethnicity and urbanity	
Caucasian – Urban	1.00 (referent)
Non-urban	1.26 (1.19–1.34)
African American – Urban	1.66 (1.55–1.77)
Non-urban	0.84 (0.61–1.15)
Comorbidities	
0	1.00 (referent)
1–2	0.89 (0.86–0.93)
3–4	0.80 (0.75–0.85)
5+	0.66 (0.60–0.73)
Median income (quintile)§	
1st (lowest)	1.00 (referent)
2nd	0.82 (0.77–0.87)
3rd	0.82 (0.77–0.87)
4th	0.92 (0.87–0.98)
5th	1.18 (1.11–1.26)

* *NCI-Cancer Center attendance was defined as having two or more claim-days at a designated NCI-Cancer Center within the first 12 months after diagnosis.*

† *Odds ratios were adjusted for age at diagnosis, SEER registry of residence at diagnosis, travel-time to nearest academic medical center, and per capita oncologist supply for hospital referral region (HRR) of residence at diagnosis.*

‡ *Predominant primary care was defined as having the number of primary care visits greater than or equal to that of specialist visits in the 6 months prior to diagnosis.*

§ *Median household income reported by ZIP code.*

This study does not examine the outcomes associated with NCI-Cancer Center care, which may differ substantially by type of cancer, stage, or by the specific Center. Further research into the patient benefits of different locations of cancer care would help establish benchmarks that could guide further growth and improvement efforts in oncology services.

In previous studies, greater travel-time, travel distance, and rural residence each have been associated with decreased geographic access to health care[3,8,12,25–28]. Recent evidence suggests that utilization of specific treatments is related to travel distance[8,25,28]. Our results indicate that longer travel-time is associated with decreased utilization of the most specialized cancer care settings. Our findings are consistent with a previous study demonstrating that referral of lung cancer patients to university hospital Cancer Centers in New England was significantly lower with greater travel distances[12]. Our results suggest that travel-time did not impact overall receipt of cancer care, but greatly influenced attendance at NCI-Cancer Centers. Thus perhaps most patients do not travel far from their local/regional health care facilities, and a requisite for NCI-Cancer Center attendance is proximity. In a previous study, we have shown that over 42% of the U.S. population lives within an hour of an NCI-Cancer Center[17]; thus a sizable number of individuals may be influenced by proximity to these centers. Since proximity to NCI-Cancer Centers varies by demographic groups[17], the impact on specific subpopulations should be considered, particularly given the seemingly low attendance (7.3%) of Medicare beneficiaries in this cohort. Community programs to promote travel assistance to cancer care facilities may be warranted in rural areas.

Race/ethnicity was important to NCI-Cancer Center attendance in this study. African-Americans living in urban locations (86.6% of African-Americans in our study population) were ~1.5 times more likely than their Caucasian counterparts to attend an NCI-Cancer Center. This result is consistent with a previous study that examined surgical utilization at NCI-Cancer Centers, in which African Americas received more surgical procedures than Caucasians[2]. There are at least two explanations for this pattern: 1. African-Americans may be more likely to use urban-based hospitals, and 2. African-Americans are more likely to use teaching-not-for-profit hospitals, which would include most NCI-Cancer Centers, which also are located in urban areas. There is currently little empirical support for the first explanation. The second explanation is supported by a study demonstrating a 75% greater probability of using a teaching hospital among African-Americans compared to Caucasians[13]. Interestingly, the observation that African-Americans are more likely to utilize NCI-Cancer Centers than Caucasians occurs at the same time that studies have documented inferior cancer care for African-Americans compared to Caucasians[7,29–31]. What is not known is how these treatment disparities are impacted by institution type. Several studies suggest that treatment and outcomes vary more by place of care than by race/ethnicity[10,32].

Referral patterns are likely to play a role in NCI-Cancer Center attendance. We found a lower likelihood of attendance for individuals whose care prior to cancer diagnosis was predominantly from generalist physicians. One explanation is that specialists may be more likely to have referral networks to tertiary specialists or sub-specialists compared to generalists. Another possibility is that generalist providers may have more established community-based partnerships with oncologists at specialized centers; thus, their patients have less need to travel to an NCI-Cancer Center. This result was unlikely to be due to rural residence, local oncologist supply, or the distribution of NCI-Cancer Centers within SEER regions, since we adjusted for these variables

Stage at diagnosis and number of comorbidities had different associations with NCI-Cancer Center attendance. Later stage was associated with a higher chance of NCI-CC attendance. Because we saw a greater likelihood of African-American attendance, and evidence shows later stage of diagnosis in this group[33,34], we examined the relation between stage and race in our study population, and found no evidence for an interaction in relation to attendance. It is possible that patients with late stage disease attend NCI-Cancer Centers to gain maximal clinical benefit in a context of poor prognosis.

On the other hand, we found that an increasing number of comorbidities were associated with a lower likelihood of NCI-Cancer Center attendance. A plausible explanation is that these individuals are the most ill or incapacitated and may rely on the most proximal, convenient health care resource. Also, it is possible that patients with more comorbidities have greater

frequency and continuity of contact with primary care providers, and thus rely on established relationships in their communities to a greater extent.

Several limitations are noteworthy in this study. Some racial groups had too few individuals attending NCI-Cancer Centers in the SEER regions to reliably include in models. Also, because we based our analyses on Medicare claims, these findings may be generalizable only to cancer patients older than 65 years. Further, as claims data are derived for billing, coding biases may be present. We based this study on claims data to provide a population-based perspective, and, thus, were unable to explicitly examine patient or provider preferences, individual-level income, number of cancer care facilities available, availability of transportation, and physician referral patterns.

We developed a cancer center attendance definition a priori which we tested empirically within our study population. We accounted for NCI-Cancer Center attendance based on surgery, but further exploration of types of services utilized at NCI-Cancer Centers seems warranted, since patient utilization may range from a single, second-opinion visit to the totality of care. Finally, evidence for better quality or outcomes at NCI-Cancer Centers is incomplete; thus the relative costs and benefits of attendance in not known. Only with this information can primary care clinicians assist individual cancer patients in their own referral decisions

In conclusion, 7.3% of Medicare beneficiaries with lung, breast, colorectal, or prostate cancer attended an NCI-Cancer Center. Currently, our understanding of appropriate utilization of these specialized centers is incomplete, and may vary by cancer site and regional supply of oncology services. NCI-Cancer Center attendance is significantly influenced by travel-time, utilization of primary care prior to diagnosis, and status as an urban African-American. These findings have implications for coordination of primary and hospital-based care, and for resource allocation of the most specialized cancer care, including access to outreach oncology clinics.

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Conflict of Interest statement: *The authors deny any conflicts of interest.*

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