Trends in Cancer Treatment Service Availability Across Critical Access Hospitals and Prospective Payment System Hospitals

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Background: Rural residents experience worse cancer prognosis and access to cancer care providers than their urban counterparts. Critical access hospitals (CAHs) represent over half of all rural community hospitals. However, research on cancer services provided within CAHs is limited.

Objective: The objective of this study was to investigate trends in cancer services availability in urban and rural Prospective Payment System (PPS) hospitals and CAHs.

Design: Retrospective, time-series analysis using data from 2008 to 2017 American Hospital Association Annual Surveys. Multivariable logistic regressions were used to examine differential trends in cancer services between urban PPS, rural PPS, and CAHs, overall and among small (< 25 beds) hospitals.

Subjects: All US acute care and cancer hospitals (4752 in 2008 to 4722 in 2017).

Measures: Primary outcomes include whether a hospital provided comprehensive oncology services, chemotherapy, and radiation therapy each year.

Results: In 2008, CAHs were less likely to provide all cancer services, especially chemotherapy (30.4%) and radiation therapy (2.9%), compared with urban (64.4% and 43.8%, respectively) and rural PPS hospitals (42.0% and 23.3%, respectively). During 2008–2017, compared with similarly sized PPS hospitals, CAHs were more likely to provide oncology services and chemotherapy, but with decreasing trends. Radiation therapy availability between small PPS hospitals and CAHs did not differ.

Conclusions: Compared with all PPS hospitals, CAHs offered fewer cancer treatment services and experienced a decline in service capability over time. These differences in chemotherapy services were mainly driven by hospital size, as small urban and rural PPS hospitals had lower rates of chemotherapy than CAHs. Still, the lower rates of radiotherapy in CAHs highlight disproportionate challenges facing CAHs for some specialty services.

Key Words: cancer, chemotherapy, radiation therapy, oncology, critical access hospitals

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Cancer is the second leading cause of death in rural America, with rural residents having higher cancer incidence and mortality rates for many cancer sites than their urban counterparts, especially for lung, colorectal, and cervical cancers.[1–5] Contributors to poor cancer outcomes in rural areas are multifaceted. Compared with their urban counterparts, rural patients are less likely to have health insurance coverage,[6] be aware of cancer prevention strategies,[7] adhere to cancer treatments,[6] and live close to cancer care.[8,9] Rural residents also have lower rates of cancer screenings, higher rates of late-stage diagnoses, and are more likely to have delayed treatment than their urban counterparts.[10–15] When rural patients are diagnosed with cancer, they are also less likely to undergo surgical procedures or radiotherapy with surgery,[11,16] raising a concern about quality of cancer care.

Rural communities face disproportionate health challenges due to financial distress, health care professional shortages, hospital closures, geographic isolation, and a high chronic disease burden, among others.[17] Further, the majority of rural residents live in areas without sufficient cancer care.[18] Specifically, only 1.0% and 6.6% of the rural population lives within 60 minutes of a National Cancer Institute–designated cancer center or satellite institution, respectively.[18] In addition, 1 in 5 rural residents lives >60 miles from a medical oncologist.[19] Though equal access to cancer care services is the ideal, rural hospitals often experience financial challenges,[8]

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and subsequently, have difficulties maintaining acute care services, implementing cancer care-related technology, and attracting cancer specialists.[17,20] Since 2008, 150 rural hospitals have closed (as of October 30, 2020), 50 of which were critical access hospitals (CAHs).[21]

The CAH designation, established in 1997, was designed to improve access to health care services in rural areas as well as mitigate financial burdens for facilities.[22] Hospitals that seek the CAH designation must accept certain restrictions and requirements, most notably a 25-bed limit for inpatient beds, at least 35-mile proximity from another hospital, and restrictions in the length of stay to an average of 96 hours per admission. In return, CAH facilities are reimbursed on a cost basis for Medicare claims, rather than under the Prospective Payment System (PPS), which pays Medicare claims at a predetermined and fixed amount based upon the service delivered. The number of CAHs has increased from 41 in 1997 to 1293 in 2008 and reached 1350 in 2019.[22] The increase in CAH conversions also came with a wider variety of services offered in rural areas such as radiology, laboratory services, emergency departments, pharmacy, and outpatient cancer services.[23,24]

The restrictions associated with CAH designation make it difficult for these rural hospitals to maintain inpatient cancer service lines, however, as the median length of stay for a cancer patient is around 5–12 days depending on tumor sites and prognosis.[25,26] Nonetheless, several CAHs manage to operate Commission on Cancer (CoC) approved cancer programs, indicating that some of these small hospitals are able to provide a wide range of oncology services. Despite these offerings, CAHs are excluded from Centers for Medicare and Medicaid Services (CMS) nationwide community-based oncology initiatives, namely the Oncology Care Model (OCM).[27,28] The extent to which CAHs and other rural hospitals are engaged in bringing cancer treatment services to their communities is not currently known, making it difficult to explore effective care models that align with the needs and constraints of underserved rural communities.

Our objective was to examine the availability of cancer treatment services across CAHs and non-CAHs over time using nationwide longitudinal hospital survey data. We document current cancer services, changes over time, and relevant differences between urban and rural PPS hospitals and CAHs. The findings will help inform clinical, public health, and legislative policymakers, as well as other stakeholders, with targeted information as to the current status of CAHs' provision of cancer treatment services.

METHODS

Study Population and Study Design

We conducted a retrospective, time-series analysis using American Hospital Association (AHA) Annual Surveys and Area Health Resources Files (AHRF) from 2008 to 2017.[29,30] The AHA Annual Survey is administered to hospitals yearly and includes questions about organizational structure, service lines, alternative payment models, technology adoption, health care utilization, and other topics about their structure and service provision. The AHRF is maintained by the Health Resources and Services Administration Bureau of Health Workforce and provides county-level information on the health care workforce, population characteristics, and other variables.

Our sample was limited to hospitals that primarily provide general medicine and/or cancer services, ranging from 4752 hospitals in 2008 to 4722 hospitals in 2017. We excluded hospitals with other specialty primary codes (eg, rehabilitation, orthopedic, heart, or psychiatric) and PPS-exempt cancer hospitals as these hospitals are neither under the PPS umbrella nor have CAH status (Supplementary Fig. 1, Supplemental Digital Content 1, http://links.lww.com/MLR/C325). Each year, the AHA Annual Survey had an ~80% response rate, but imputes missing values using historical data and/or statistical estimates, ensuring complete data on all hospitals.[29] To observe changes in individual hospitals, we demerged 58 hospitals that were consolidated and reported them separately even after consolidation, using each hospital's most recent records. Specifically, we traced back the consolidated hospitals using their primary identifiers before consolidation. All hospitals were censored in their years of closure, if applicable.

In a separate sensitivity analysis, we further limited to hospitals that had no >25 beds (1453 in 2008 to 1398 in 2017), to tease out the effects of hospital size when comparing PPS hospitals and CAHs.

Measurement

The primary independent variable was hospital type, categorized into 3 groups—urban PPS hospitals, rural PPS hospitals, and CAHs. CAH status each year was based on status effective before December 31, on documentation by the Flex Monitoring Team and, if applicable, on closure dates documented by the Sheps Center for Health Services Research, University of North Carolina at Chapel Hill.[21] Rural status was defined as micropolitan or noncore counties as determined by the United States Department of Agriculture, with 2013 Urban Influence Codes of 3 or greater.[31] Urban Influence Codes categorize counties based on population size and/or proximity to a metropolitan or micropolitan area.

The dependent variable was the presence or absence of 2 therapeutic services (chemotherapy and radiation therapy) and the comprehensive oncology service status for each hospital each year. According to the AHA Annual Survey,[29] comprehensive oncology services status was defined as "Inpatient and outpatient services for patients with cancer, including comprehensive care, support and guidance in addition to patient education and prevention, chemotherapy, counseling, and other treatment methods." Chemotherapy was defined as an organized program for the treatment of cancer through the use of drugs or chemicals. Radiation therapy was defined as having any of the following capacities: image-guided radiation therapy, intensity-modulated radiation therapy, proton beam therapy, shaped beam radiation system, and stereotactic radiosurgery.[29]

To adjust for hospital characteristics that were different across facility types and associated with the provision of cancer services, we extracted the following factors from the AHA Annual Surveys: number of staffed beds, ownership

(public nonfederal, private for-profit, and private nonprofit hospitals), system affiliation, accreditation (The Joint Commission, American Osteopathic Association, and/or Det Norske Veritas), ratio of Medicaid and Medicare inpatient days to total inpatient days, and United States Census region (Northeast, Midwest, West, and South). To control for sociodemographic characteristics, we obtained county-level unemployment rates, rates of population living in poverty (defined as ≤100% federal poverty line), whether a hospital's county was designated as a health professional shortage area, as well as the age, sex, and racial/ethnic distributions of the counties' residents, from the AHRF. To adjust for the market competition status, we calculated 1-way driving distances from a hospital to its nearest hospital with cancer treatment services, using a shortest driving route of ZIP codes centroids calculated by MapQuest application.[32] These driving distances were further categorized into < 15, 15–30, 30–60, and 60 miles.

Statistical Analysis

We first compared hospital-level and county-level characteristics between urban PPS, rural PPS hospitals, and CAHs in 2008 and 2017 and calculated the percentage change in the proportion of hospitals offering each type of service over the decade. Cochrane-Armitage tests were used to compare the linear trend in proportions of hospitals providing a cancer service over time by hospital type. We then conducted χ^2 tests and Kruskal-Wallis rank-sum tests to compare hospital-level and county-level characteristics across hospitals, with and without each type of cancer service.

Two sets of time-series multivariable logistic regression were used. We first examined trends in the availability of each cancer service between urban and rural PPS hospitals and CAHs across *all hospitals* (hereafter, all-hospital models). Owing to a concern regarding the independent effect of hospital size and hospital type, a subset analysis was also performed in which the data set was restricted to *hospitals with 25 or fewer beds* in 2008 (hereafter, small-hospital models). The time-series component of the model, which accounted for autocorrelation between each study year, captured the impact of time (2008–2017) and enabled the model to provide more accurate estimates for other time-variant covariates. Multicollinearity was assessed using the variance inflation factor; in all-hospital models, bed size and number of full-time equivalent physicians were highly correlated with the hospital type (variance inflation factor > 8) so they were dropped from final models. Model fit was assessed using the Akaike Information Criterion; the final models included ownership, system affiliation, accreditation, ratio of Medicare and Medicaid inpatient days to total inpatient days, driving distances to the nearest hospital with cancer treatment services, county-level poverty rates, age groups, racial distribution of residents, rates of Hispanic residents, and state indicators.

All analyses were done in SAS, version 9.4 (SAS Institute Inc., Cary, NC), MapPoint North America 2013, and Stata, version 14.0. University of South Carolina Institutional Review Board exempted this study protocol.

RESULTS

Differences in Hospital and County Characteristics by Hospital Type

Compared with urban PPS and rural PPS hospitals, in 2008, CAHs were more likely to be owned by public nonfederal sectors (12.7%, 27.7%, and 43.7%, respectively), to be located in Midwest regions (21.5%, 24.1%, and 50.3%), less likely to be system-affiliated (65.1%, 46.1%, and 38.3%) or accredited by The Joint Commission, American Osteopathic Association, and/or Det Norske Veritas (91.5%, 70.8%, and 5.5%). CAHs had lower ratios of Medicaid inpatient days and Medicare inpatient days and are farther away from the nearest cancer treatment provider compared with urban hospitals (Table 1). These differences were similar in 2017, except for the proportion of CAHs reporting accreditation, which increased from 5.5% in 2008 to 25.6% in 2017.

Compared with urban PPS hospitals, rural PPS hospitals and CAHs were more likely to be in counties with the highest quartile of poverty rates, and to have higher proportions of White and American Indian/American Native residents but lower proportions of Hispanic, Black, and Asian residents (Supplementary Table 1, Supplemental Digital Content 1, http://links.lww.com/MLR/C325). CAHs were more likely to be in counties with higher rates of residents ages 45 or older than rural PPS hospitals or urban hospitals.

Many of the differences across CAHs and PPS hospitals are still held when comparing CAHs to small urban and rural PPS hospitals (Supplementary Table 2, Supplemental Digital Content 1, http://links.lww.com/MLR/C325), except for hospital ownership and system affiliation. In 2017, compared with small urban and rural PPS hospitals, CAHs were more likely to be private nonprofit hospitals (54.5%, 15.5%, and 33.3%, respectively) and/or system-affiliated (45.1%, 41.2%, and 35.9%, respectively).

Trend in Cancer Services by Hospital Type

In 2008, nearly 70% of urban hospitals reported providing comprehensive oncology services and chemotherapy, compared with slightly over 40% of rural PPS hospitals and a quarter of CAHs (Table 2). Radiation therapy was the least commonly provided service, with less than half of urban hospitals, a quarter of rural PPS hospitals, and only 3% of CAHs reporting its provision. Figure 1 shows proportions of hospitals providing each cancer service by year during the study period across all hospitals (Fig. 1A) and across small hospitals (Fig. 1B). Overall, urban hospitals were consistently more likely to provide all 3 cancer services than rural PPS hospitals, followed by CAHs. From 2008 to 2017, the percent of urban hospitals providing cancer services increased annually for radiation therapy but plateaued for oncology and chemotherapy. In contrast, rural PPS hospitals showed continued increases in all 3 services. While the proportion of CAHs providing oncology and chemotherapy services decreased significantly across the period, the proportion of CAHs offering radiation therapy increased.

When limiting the analysis to small hospitals that had 25 or fewer beds in 2008, CAHs were more likely to provide oncology and chemotherapy but less likely to provide

TABLE 1. Hospital Characteristics by Rurality and CAH Status in 2008 and 2017

	Urban PPS		Rural PPS*		CAH	
Characteristics	**2008 (N = 2587)**	**2017 (N = 2589)**	**2008 (N = 950)**	**2017 (N = 804)**	**2008 (N = 1215)**	**2017 (N = 1329)**
Hospital bed size (%)						
< 100 beds	25.6	25.7	71.0	71.8	100.0	100.0
100–299 beds	46.0	45.9	27.4	26.6	—	—
> 300 beds	28.4	28.4	1.7	1.6	—	—
Hospital ownership (%)						
Public nonfederal	12.7	9.9	27.7	24.0	43.7	40.1
Private nonprofit	63.4	64.0	53.1	57.7	52.6	55.1
Private for-profit	23.9	26.1	19.3	18.3	3.7	4.8
Teaching hospitals	10.3	8.9	0.2	0.3	—	—
System affiliation	65.1	78.4	46.1	57.8	38.3	45.3
Accredited hospitals†	91.5	84.6	70.8	67.2	5.5	25.6
Commission on cancer-accredited	44.3	46.5	14.3	17.8	1.3	1.1
Medicaid inpatient days ratio (%)						
Quartile I: ≤ 2%	10.6	10.4	14.8	18.7	50.3	63.4
Quartile II: > 2%–5%	20.1	18.1	32.8	36.9	29.1	25.6
Quartile III: > 5%–10%	27.1	27.0	30.8	29.9	11.4	7.9
Quartile IV: > 10%	42.1	44.5	21.5	14.6	9.2	3.2
Medicare inpatient days ratio (%)						
Quartile I: 0%–12.5%	7.5	10.1	16.7	33.0	34.2	65.5
Quartile II: 12.6%–20%	16.5	20.4	27.9	34.0	43.9	26.1
Quartile III: 20.1%–30%	38.5	51.5	34.4	29.2	16.5	7.1
Quartile IV: > 30%	37.6	18.0	21.0	3.9	5.4	1.3
% in-county residents age ≥ 45 y old						
Quartile I: 12.2%–36.9%	43.8	22.6	13.4	8.3	11.7	6.6
Quartile II: 37.0%–41.1%	30.3	29.4	25.8	11.8	15.7	9.1
Quartile III: 41.2%–45.3%	18.4	28.6	37.1	32.0	29.6	19.8
Quartile IV: 45.4%–78.1%	7.5	19.4	23.8	47.9	43.0	64.6
% in-county residents in poverty						
Quartile I: 0%–11.9%	38.2	40.3	17.5	16.8	36.0	36.6
Quartile II: 12.0%–15.4%	35.1	29.1	21.1	22.5	30.1	28.1
Quartile III: 15.5%–18.8%	17.2	19.4	26.2	24.1	17.0	17.8
Quartile IV: 18.9%–55.1%	9.4	11.2	35.3	36.6	16.9	17.5
Census region (%)						
Northeast	17.6	16.7	9.1	9.5	5.1	5.5
Midwest	21.5	21.6	24.1	26.2	50.3	47.3
West	21.5	21.7	11.6	9.8	20.1	21.5
South	39.5	40.0	55.3	54.5	24.5	25.7
Shortage area (%)						
None	12.8	7.9	25.0	11.2	19.6	7.9
Part	41.8	90.4	42.5	74.8	32.6	68.3
Whole	45.4	1.7	32.5	14.1	47.8	23.8
Road miles to nearest cancer hospital (%)						
< 15	79.3	81.8	9.1	9.7	11.0	9.7
15–30	16.0	13.9	48.3	44.5	49.1	47.0
30–60	3.8	3.9	35.4	38.7	32.2	33.9
> 60	0.8	0.5	7.3	7.1	7.8	9.5
Proportion of female residents [mean (SD)]	50.8 (1.2)	50.9 (1.1)	50.3 (2.1)	50.1 (2.0)	49.9 (2.0)	49.6 (1.9)
Proportion of Hispanic residents [mean (SD)]	15.4 (16.4)	18.0 (17.0)	7.5 (13.1)	9.0 (13.8)	6.8 (11.0)	9.0 (12.7)
Proportion of residents by race [mean (SD)]						
White	80.3 (14.2)	78.0 (14.4)	86.0 (16.8)	85.3 (16.9)	91.6 (13.8)	90.4 (14.0)
Black	14.2 (13.5)	14.8 (13.5)	11.1 (16.3)	11.2 (16.3)	4.7 (10.9)	5.0 (11.0)
American Indian or American Native	0.9 (1.6)	1.1 (1.8)	2.0 (6.2)	2.2 (6.4)	2.6 (8.2)	3.1 (8.6)
Asian	4.4 (5.7)	5.9 (6.7)	0.8 (2.2)	1.1 (2.5)	1.0 (3.4)	1.3 (3.5)
Pacific Islander or Hawaiian	0.2 (0.7)	0.2 (0.7)	0.1 (0.9)	0.2 (1.2)	0.2 (1.1)	0.2 (1.3)

Data were derived from 2008 and 2017 American Hospital Association Annual Survey.
*Non-CAHs are hospitals under the PPS, as opposite to the cost-based payment system for CAHs.
†Hospitals accredited by Joint Commission, American Osteopathic Association or Det Norske Veritas, in a given year.
CAH indicates critical access hospital; PPS, Prospective Payment System.

radiation therapy than urban PPS hospitals. During the study period, CAHs had significantly decreasing trends of oncology and chemotherapy service availability, whereas small urban PPS hospitals presented an increasing trend in both services. There were no significant changes in trends of radiation therapy for all 3 hospital types.

TABLE 2. Hospital Characteristics by Cancer Treatment Services in 2008 and 2017

	Any Oncology Services* [n (%)]		Chemotherapy† [n (%)]		Radiation‡ [n (%)]	
Characteristics	**2008**	**2017**	**2008**	**2017**	**2008**	**2017**
Nationally	2490 (52.4)	2470 (52.3)	2433 (51.2)	2409 (51.0)	1388 (29.2)	1546 (32.7)
Hospital type						
Urban PPS	1774 (68.6)	1788 (69.1)	1665 (64.4)	1670 (64.5)	1132 (43.8)	1252 (48.4)
Rural PPS	410 (43.2)	378 (47.0)	399 (42.0)	374 (46.5)	221 (23.3)	246 (30.6)
CAH	306 (25.2)	304 (22.9)	369 (30.4)	365 (27.5)	35 (2.9)	48 (3.6)
Hospital bed size						
< 100 beds	712 (27.9)	727 (28.3)	760 (29.8)	749 (29.1)	209 (8.2)	273 (10.6)
100–299 beds	1080 (74.5)	1037 (73.9)	994 (68.6)	968 (69.0)	609 (42.0)	676 (48.2)
> 300 beds	698 (92.9)	706 (94.4)	679 (90.4)	692 (92.5)	570 (75.9)	597 (79.8)
Hospital ownership						
Public nonfederal	427 (38.0)	355 (36.2)	458 (40.8)	371 (37.8)	200 (17.8)	188 (19.1)
Private nonprofit	1769 (63.6)	1820 (63.8)	1698 (61.0)	1771 (62.1)	1036 (37.2)	1162 (40.7)
Private for-profit	294 (34.7)	295 (33.3)	277 (32.7)	267 (30.1)	152 (18.0)	196 (22.1)
Teaching hospitals						
Yes	263 (97.8)	230 (99.6)	257 (95.5)	230 (99.6)	229 (85.1)	215 (93.1)
No	2227 (49.7)	2240 (49.9)	2176 (48.5)	2179 (48.5)	1159 (25.9)	1331 (29.6)
System affiliation						
Yes	1489 (57.6)	1836 (59.3)	1424 (55.1)	1754 (56.6)	857 (33.1)	1192 (38.5)
No	1001 (46.2)	634 (39.0)	1009 (46.6)	655 (40.3)	531 (24.5)	354 (21.8)
Accredited hospitals						
Yes	2097 (67.5)	2011 (65.5)	1971 (63.5)	1895 (61.7)	1300 (41.9)	1351 (44.0)
No	393 (23.9)	459 (27.8)	462 (28.1)	514 (31.1)	88 (5.4)	195 (11.8)
Commission on cancer-accredited						
Yes	1298 (100.0)	1360 (100.0)	1223 (94.2)	1294 (95.2)	960 (74.0)	1100 (80.9)
No	1192 (34.5)	1110 (33.0)	1210 (35.0)	1115 (33.2)	428 (12.4)	446 (13.3)
Medicaid inpatient days ratio						
Quartile I: ≤ 2%	336 (32.7)	317 (25.1)	372 (36.2)	341 (27.0)	80 (7.8)	87 (6.9)
Quartile II: > 2%–5%	601 (50.7)	501 (45.3)	593 (50.0)	483 (43.7)	328 (27.7)	285 (25.8)
Quartile III: > 5%–10%	722 (63.7)	754 (72.3)	688 (60.7)	709 (68.0)	443 (39.1)	504 (48.3)
Quartile IV: > 10%	831 (59.1)	898 (68.5)	780 (55.5)	876 (66.8)	537 (38.2)	670 (51.1)
Medicare inpatient days ratio						
Quartile I: 12.5%	288 (37.5)	442 (31.6)	317 (41.3)	477 (34.1)	89 (11.6)	169 (12.1)
Quartile II: > 12.5%–20%	459 (37.5)	557 (48.6)	449 (36.7)	529 (46.1)	219 (17.9)	330 (28.8)
Quartile III: > 20%–30%	990 (65.0)	1117 (67.2)	944 (62.0)	1073 (64.5)	602 (39.5)	826 (49.7)
Quartile IV: > 30%	753 (60.9)	354 (68.9)	723 (58.5)	330 (64.2)	478 (38.6)	221 (43.0)
Census region						
Northeast	440 (73.1)	430 (73.9)	420 (69.8)	412 (70.8)	271 (45.0)	289 (49.7)
Midwest	811 (58.1)	787 (56.3)	816 (58.4)	788 (56.4)	392 (28.1)	408 (29.2)
West	442 (48.6)	446 (48.1)	444 (48.8)	456 (49.2)	255 (28.1)	278 (30.0)
South	797 (43.2)	807 (44.5)	753 (40.8)	753 (41.5)	470 (25.5)	571 (31.5)
Shortage area						
None	431 (53.5)	242 (60.5)	439 (54.5)	240 (60.0)	231 (28.7)	156 (39.0)
Part	1062 (56.5)	2153 (55.9)	1034 (55.0)	2090 (54.3)	591 (31.4)	1367 (35.5)
Whole	997 (48.3)	75 (15.9)	960 (46.5)	79 (16.7)	566 (27.4)	23 (4.9)
% in-county residents age ≥ 45 y old						
Quartile I: 12.2%–36.9%	795 (56.7)	406 (54.9)	766 (54.6)	383 (51.8)	485 (34.6)	281 (38.0)
Quartile II: 37.0%–41.1%	704 (57.7)	598 (61.2)	663 (54.3)	557 (57.0)	424 (34.7)	403 (41.2)
Quartile III: 41.2%–45.3%	609 (51.3)	713 (56.6)	588 (49.5)	689 (54.7)	330 (27.8)	469 (37.2)
Quartile IV: 45.4%–78.1%	382 (40.6)	753 (43.2)	416 (44.2)	780 (44.7)	149 (15.8)	393 (22.5)
% in-county residents in poverty						
Quartile I: 0%–11.9%	968 (60.8)	1006 (60.4)	963 (60.5)	970 (58.2)	513 (32.2)	587 (35.2)
Quartile II: 12.0%–15.4%	833 (56.5)	706 (54.0)	817 (55.4)	695 (53.1)	469 (31.8)	445 (34.0)
Quartile III: 15.5%–18.8%	429 (47.6)	456 (48.9)	403 (44.7)	441 (47.3)	257 (28.5)	311 (33.4)
Quartile IV: 18.9%–55.1%	260 (33.2)	302 (37.0)	250 (31.9)	303 (37.1)	149 (19.0)	203 (24.9)
Road miles to nearest cancer hospital						
< 15	1584 (69.8)	1606 (69.1)	1495 (65.8)	1496 (64.4)	977 (43.0)	1083 (46.6)
15–30	623 (42.4)	557 (41.5)	622 (42.3)	576 (43.0)	277 (18.8)	288 (21.5)
30–60	225 (27.2)	259 (30.1)	241 (29.2)	277 (32.2)	108 (13.1)	148 (17.2)
> 60	58 (31.4)	48 (24.5)	75 (40.5)	60 (30.6)	26 (14.1)	27 (13.8)

*Oncology services: defined as "Inpatient and outpatient services for patients with cancer, including comprehensive care, support and guidance in addition to patient education and prevention, chemotherapy, counseling and other treatment methods."

†Chemotherapy: defined as "an organized program for the treatment of cancer by the use of drugs or chemicals."

‡Radiation therapy: defined as having any of the following capacities: image-guided radiation therapy, intensity-modulated radiation therapy, proton beam therapy, shaped beam radiation system, or stereotactic radiosurgery.

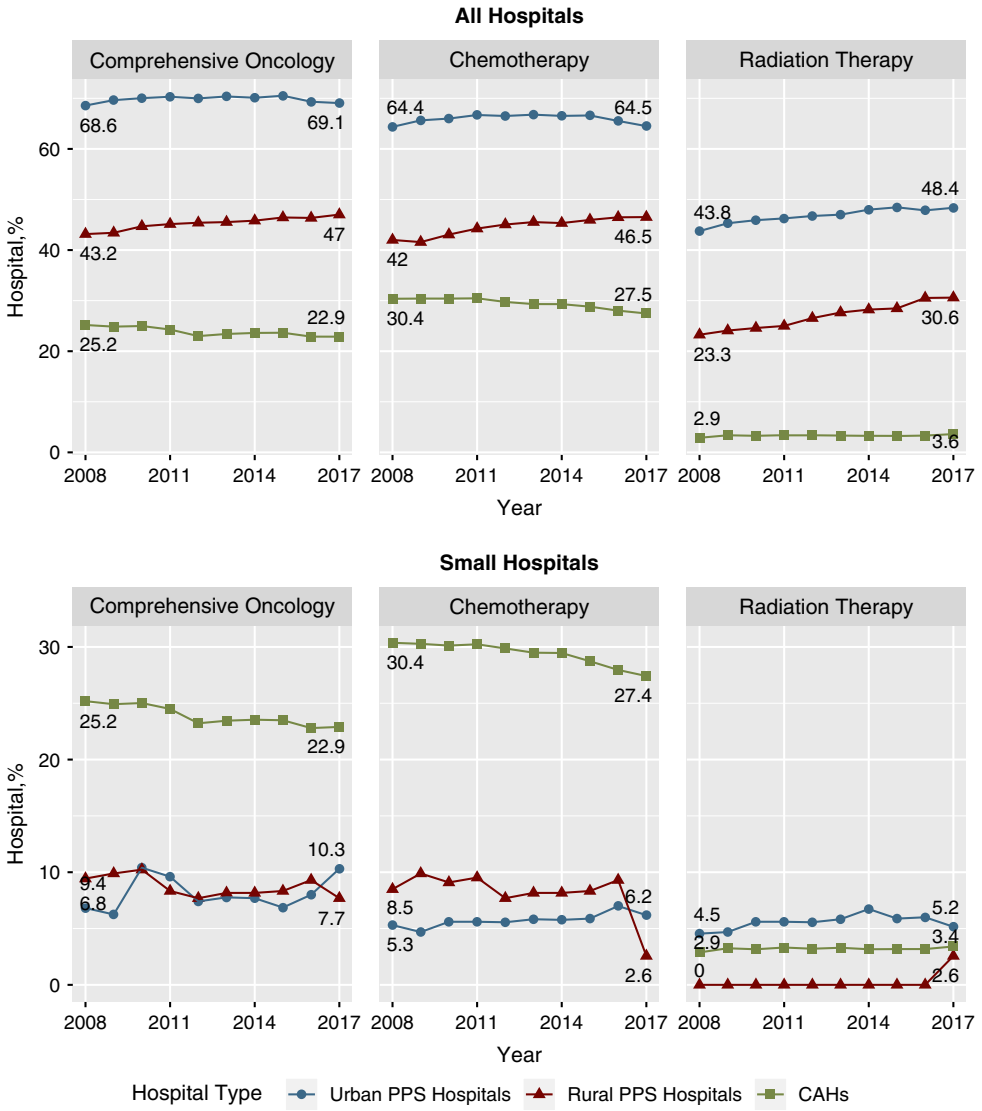

FIGURE 1. Proportion of hospitals providing cancer care services by hospital type overall and among small hospitals (hospital beds ≤25), 2008–2017. Among all nationwide hospitals, no significant different trends in proportions were observed for oncology and chemotherapy at urban PPS hospitals but rural PPS hospitals experienced increasing rates of providing all 3; CAHs had significantly decreasing trends in oncology and chemotherapy. Among small hospitals, there were no linear trends of 3 cancer services at urban and rural PPS hospitals. CAH indicates critical access hospital; PPS, Prospective Payment System.

Differential Time Trends Between Urban, Rural Prospective Payment System Hospitals, and Critical Access Hospitals

Controlling for all other hospital and county-level factors, rural PPS hospitals, and CAHs had lower odds of providing oncology services [adjusted odds ratio (AOR) = 0.49; 95% confidence interval (CI) = 0.41, 0.58 and AOR = 0.32; 95% CI = 0.27, 0.38, respectively; Table 3], compared with urban PPS hospitals in 2008. CAHs were also less likely to provide both chemotherapy and radiotherapy than rural PPS hospitals and urban hospitals in 2008. While urban and rural PPS hospitals maintained similar trends in all 3 services provision over time, CAHs experienced decreasing trends. Oncology and chemotherapy service provisions decreased more quickly among CAHs (annual AOR = 0.98; 95% CI = 0.97, 1.00) compared with urban PPS hospitals.

In the analysis restricted to hospitals with 25 beds or fewer, CAHs, compared with their urban PPS counterparts, were more likely to provide oncology and chemotherapy services in 2008, with the trends plateauing in later years. No significant differences in radiotherapy provision between small PPS hospitals and CAHs were found.

Figure 2 shows the predicted probabilities of each cancer service for an average facility by hospital type among all nationwide hospitals and small hospitals for the years 2008–2017. The predicted probabilities of providing cancer services were lower among rural PPS hospitals than urban hospitals across nearly all cancer services, with

TABLE 3. Adjusted Odds Ratios of Cancer Care Services by Hospital Characteristics Among All Hospitals and Among Small Hospitals†

	Oncology Service‡		Chemotherapy§		Radiation Therapy‖	
Characteristics	**All Hospitals**	**Small Hospitals†**	**All Hospitals**	**Small Hospitals†**	**All Hospitals**	**Small Hospitals†**
Hospital type						
Urban PPS hospitals	Reference	Reference	Reference	Reference	Reference	Reference
Rural PPS hospitals	0.49 (0.41, 0.58)***	1.12 (0.68, 1.86)	0.52 (0.44, 0.61)***	1.61 (1.01, 2.56)*	0.36 (0.29, 0.45)***	—
CAHs	0.32 (0.27, 0.38)***	1.44 (0.98, 2.13)	0.39 (0.33, 0.46)***	1.87 (1.25, 2.81)**	0.15 (0.12, 0.18)***	1.49 (0.70, 3.14)
Annual trend for urban PPS hospitals	1.01 (1.00, 1.01)	1.03 (0.96, 1.09)	1.00 (0.99, 1.01)	0.99 (0.91, 1.07)	1.03 (1.02, 1.03)***	1.06 (0.94, 1.20)
Differential annual trend by hospital type						
Rural vs. urban PPS	1.01 (0.99, 1.02)	0.93 (0.85, 1.02)	1.01 (1.00, 1.03)	0.96 (0.86, 1.06)	1.02 (1.00, 1.04)	—
CAHs vs. urban PPS	0.98 (0.97, 1.00)*	0.96 (0.90, 1.03)	0.98 (0.97, 1.00)*	1.00 (0.92, 1.09)	0.99 (0.97, 1.01)	0.96 (0.86, 1.09)
Ownership						
Public	Reference	Reference	Reference	Reference	Reference	Reference
Private nonprofit	1.12 (1.01, 1.23)*	1.14 (0.95, 1.37)	1.09 (0.98, 1.21)	1.04 (0.84, 1.30)	1.04 (0.94, 1.15)	0.95 (0.64, 1.40)
Private for-profit	0.76 (0.66, 0.88)***	0.82 (0.60, 1.12)	0.76 (0.66, 0.88)***	0.92 (0.65, 1.29)	0.79 (0.68, 0.90)***	1.03 (0.43, 2.50)
System affiliation	1.06 (1.01, 1.12)*	1.09 (0.97, 1.22)	1.04 (0.98, 1.10)	1.00 (0.89, 1.12)	1.08 (1.02, 1.14)**	1.18 (0.93, 1.50)
Accreditation¶	1.18 (1.12, 1.24)***	1.06 (0.94, 1.18)	1.18 (1.12, 1.25)***	1.10 (0.97, 1.23)	1.20 (1.14, 1.26)***	1.20 (0.92, 1.57)
% county residents in poverty						
Quartile I: 0%–11.9%	Reference	Reference	Reference	Reference	Reference	Reference
Quartile II: 12.0%–15.4%	0.99 (0.96, 1.01)	0.96 (0.91, 1.00)	0.99 (0.96, 1.03)	0.97 (0.91, 1.03)	0.99 (0.96, 1.02)	0.94 (0.82, 1.07)
Quartile III: 15.5%–18.8%	0.98 (0.94, 1.01)	0.95 (0.88, 1.02)	1.00 (0.96, 1.04)	0.97 (0.90, 1.05)	0.99 (0.95, 1.03)	0.83 (0.67, 1.05)
Quartile IV: 18.9%–55.1%	0.98 (0.94, 1.03)	0.98 (0.88, 1.08)	0.99 (0.95, 1.04)	0.91 (0.83, 1.01)	0.98 (0.93, 1.02)	0.77 (0.59, 0.99)*
Ethnicity						
% Hispanic	0.99 (0.99, 1.00)***	0.98 (0.97, 1.00)*	0.99 (0.99, 0.99)***	0.98 (0.96, 0.99)***	0.99 (0.99, 1.00)***	0.98 (0.94, 1.02)
Race						
White	Reference	Reference	Reference	Reference	Reference	Reference
Black	1.00 (1.00, 1.01)	1.00 (0.98, 1.02)	1.00 (1.00, 1.01)	0.99 (0.97, 1.01)	1.01 (1.00, 1.01)*	1.02 (1.00, 1.05)
American Indian or American Native	0.98 (0.96, 0.99)**	0.99 (0.97, 1.01)	0.99 (0.98, 1.00)	1.00 (0.98, 1.01)	1.00 (0.98, 1.01)	0.99 (0.95, 1.04)
Asian	1.02 (1.01, 1.04)**	1.01 (0.96, 1.07)	1.02 (1.01, 1.03)**	1.01 (0.96, 1.05)	1.01 (0.99, 1.02)	0.99 (0.89, 1.10)
Pacific Islander or Hawaiian	0.94 (0.88, 1.01)	0.87 (0.72, 1.05)	0.95 (0.89, 1.01)	0.87 (0.75, 0.99)*	0.97 (0.89, 1.05)	0.87 (0.60, 1.25)
% residents ≥45 y old						
Quartile I: 12.2%–36.9%	Reference	Reference	Reference	Reference	Reference	Reference
Quartile II: 37.0%–41.1%	1.00 (0.95, 1.05)	1.23 (1.03, 1.48)*	0.99 (0.94, 1.05)	1.06 (0.87, 1.28)	1.01 (0.96, 1.06)	0.98 (0.82, 1.18)
Quartile III: 41.2%–45.3%	0.96 (0.90, 1.02)	1.32 (1.08, 1.61)**	0.99 (0.93, 1.06)	1.19 (0.96, 1.49)	0.96 (0.89, 1.02)	1.00 (0.75, 1.34)
Quartile IV: 45.4%–78.1%	0.93 (0.86, 1.01)	1.27 (1.02, 1.58)*	0.98 (0.90, 1.06)	1.18 (0.94, 1.49)	0.89 (0.82, 0.97)**	0.88 (0.61, 1.27)
% females (per 10%)	1.07 (1.04, 1.09)***	1.04 (0.99, 1.10)	1.04 (1.02, 1.07)***	1.00 (0.95, 1.04)	1.06 (1.03, 1.09)***	1.13 (1.03, 1.24)*
Medicaid inpatient days ratio						
Quartile I: ≤2%	Reference	Reference	Reference	Reference	Reference	Reference
Quartile II: >2%–5%	0.96 (0.93, 0.99)**	0.90 (0.85, 0.95)***	0.95 (0.92, 0.98)**	0.90 (0.80, 1.01)	1.03 (0.99, 1.07)	0.97 (0.86, 1.10)
Quartile III: >5%–10%	0.95 (0.91, 0.99)**	0.82 (0.73, 0.92)***	0.94 (0.90, 0.98)**	1.06 (0.88, 1.28)	1.05 (1.00, 1.10)*	1.05 (0.85, 1.30)
Quartile IV: >10%	0.84 (0.80, 0.88)***	0.86 (0.77, 0.95)**	0.87 (0.83, 0.92)***	1.04 (0.79, 1.36)	1.07 (1.01, 1.13)*	0.97 (0.71, 1.31)
Medicare inpatient days ratio						
Quartile I: 12.5%	Reference	Reference	Reference	Reference	Reference	Reference
Quartile II: >12.5%–20%	0.94 (0.92, 0.97)***	0.94 (0.89, 0.99)*	0.92 (0.90, 0.95)***	0.88 (0.84, 0.93)***	0.97 (0.94, 1.01)	0.90 (0.80, 1.01)
Quartile III: >20%–30%	1.02 (0.98, 1.07)	1.06 (0.97, 1.16)	1.01 (0.97, 1.06)	1.01 (0.92, 1.11)	1.03 (0.99, 1.08)	1.05 (0.88, 1.27)
Quartile IV: >30%	1.08 (1.03, 1.14)**	1.10 (0.93, 1.29)	1.09 (1.04, 1.15)***	1.18 (1.01, 1.36)*	1.03 (0.98, 1.09)	1.03 (0.78, 1.36)
Census region						
Northeast	Reference	Reference	Reference	Reference	Reference	Reference
Midwest	0.87 (0.71, 1.07)	0.96 (0.60, 1.56)	0.93 (0.77, 1.13)	1.31 (0.81, 2.12)	0.84 (0.69, 1.02)	0.63 (0.27, 1.51)
West	0.54 (0.43, 0.68)***	0.63 (0.34, 1.16)	0.65 (0.52, 0.81)***	0.98 (0.56, 1.73)	0.69 (0.55, 0.87)**	1.51 (0.50, 4.55)
South	0.38 (0.31, 0.46)***	0.12 (0.07, 0.24)***	0.39 (0.32, 0.47)***	0.15 (0.08, 0.29)***	0.55 (0.45, 0.67)***	0.19 (0.05, 0.70)*

(*Continued*)

TABLE 3. Adjusted Odds Ratios of Cancer Care Services by Hospital Characteristics Among All Hospitals and Among Small Hospitals[†] (*continued*)

Characteristics	Oncology Service[‡]		Chemotherapy[§]		Radiation Therapy[‖]	
	All Hospitals	Small Hospitals[†]	All Hospitals	Small Hospitals[†]	All Hospitals	Small Hospitals[†]
Road miles to nearest cancer hospital						
< 15	Reference	Reference	Reference	Reference	Reference	Reference
15–30	0.66 (0.59, 0.74)***	0.63 (0.45, 0.87)**	0.74 (0.67, 0.82)***	0.79 (0.60, 1.03)	0.85 (0.77, 0.94)**	0.45 (0.30, 0.68)***
30–60	0.59 (0.52, 0.68)***	0.54 (0.37, 0.78)***	0.69 (0.61, 0.77)***	0.70 (0.53, 0.94)*	0.82 (0.72, 0.94)**	0.35 (0.22, 0.54)***
> 60	0.56 (0.44, 0.72)***	0.46 (0.26, 0.81)**	0.63 (0.53, 0.75)***	0.63 (0.44, 0.89)**	0.93 (0.76, 1.13)	0.35 (0.18, 0.68)**

Adjusted odds ratio for nationwide hospitals. Derived from logistic regressions controlling for other county characteristics, including county-level poverty rates, proportion of residents age 45 or older, proportion of residents by race/ethnicity, proportion of residents that are female, in-county population size, and census region. Odds ratios were calculated from logistic regressions with SEs clustered at the state level. Full models also controlled for state indicators. For radiation service among small hospitals, we combined urban PPS hospitals and rural PPS hospitals because of low frequency of radiation service in both categories.

PPS stands for the Prospective Payment System, as opposed to the cost-based payment system for critical access hospitals (CAHs).

[†]Adjusted odds ratio for small hospitals (beds ≤ 25).

[‡]Oncology services: defined as "Inpatient and outpatient services for patients with cancer, including comprehensive care, support and guidance in addition to patient education and prevention, chemotherapy, counseling, and other treatment methods."

[§]Chemotherapy: defined as "an organized program for the treatment of cancer by the use of drugs or chemicals."

[‖]Radiation therapy: defined as having any of the following capacities: image-guided radiation therapy, intensity-modulated radiation therapy, proton beam therapy, shaped beam radiation system, or stereotactic radiosurgery.

[¶]Hospitals accredited by Joint Commission, American Osteopathic Association, or Det Norske Veritas in a given year.

*$P < 0.05$.

**$P < 0.01$.

***$P < 0.001$.

persistent gaps over time. Compared with urban and rural PPS hospitals, rates of providing each cancer service in CAHs were consistently lower and the gaps increased over time. Among small PPS hospitals, rural PPS hospitals experienced disproportionately decreasing trends for oncology and chemotherapy service availability while small urban PPS hospitals showed increasing trends for oncology services.

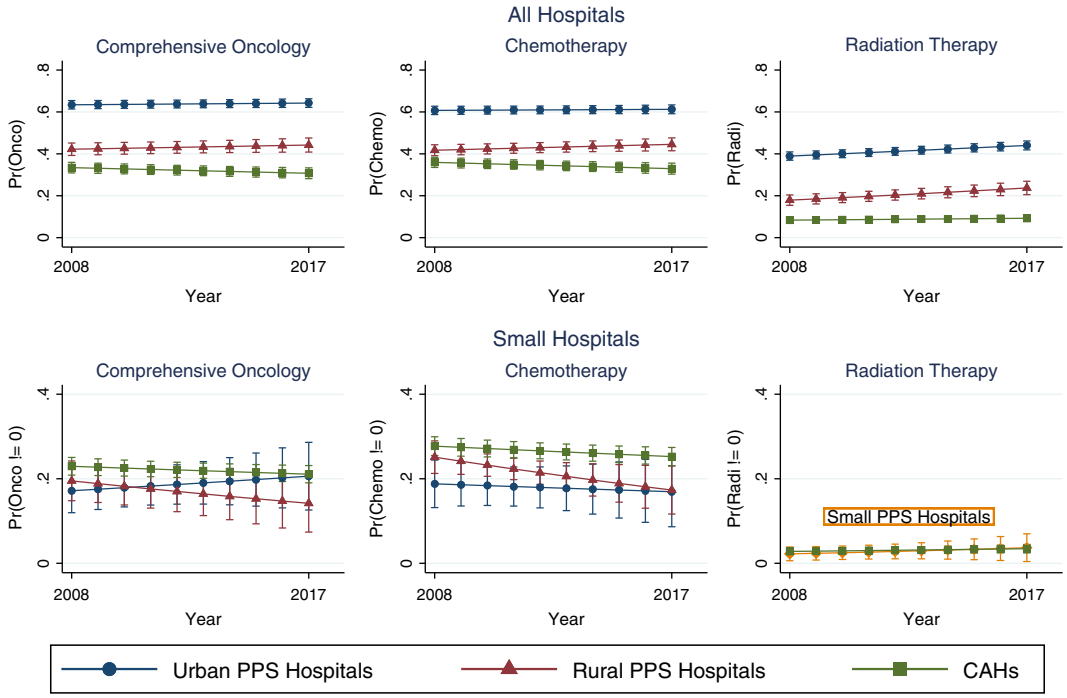

FIGURE 2. Annual predicted probabilities of cancer treatment services by hospital type. Average predicted probabilities (95% confidence interval) for each cancer service type were illustrated and calculated based on the full model presented in Table 3, adjusting for hospital ownership, system affiliation, accreditation by Joint Commission, American Osteopathic Association or Det Norske Veritas, ratios of Medicaid and Medicare inpatient days to total inpatient days, driving distances to the nearest hospital with cancer treatment services, county-level poverty rates, proportion of residents age 45 or older, proportion of residents by race/ethnicity, proportion of residents that are female, and state indicators. CAH indicates critical access hospital; PPS, Prospective Payment System.

DISCUSSION

Compared with urban PPS hospitals, rural PPS hospitals and CAHs consistently had lower rates of comprehensive oncology, chemotherapy, and radiation therapy availability over time. The gaps in cancer treatment services persisted between urban and rural PPS hospitals, but the widening gaps between urban PPS hospitals and CAHs were mostly due to hospital size. Compared with small PPS hospitals, CAHs had higher rates of oncology and chemotherapy services provision with no differences in radiation therapy provisions. Overall, communities served by small rural PPS hospitals and CAHs had reduced access to cancer treatment capacities. Whether these trends continue will depend in part on the current cancer reimbursement policies and health reform efforts for rural cancer care supply.

Between 2008 and 2017, better imaging technology for radiation therapy as well as innovative and less invasive procedures, paired with increasingly effective cancer treatments, have improved cancer morbidity and mortality nationwide.[33,34] However, we found that the availability of cancer treatment services was not equally distributed across the United States. Cancer services were consistently less available within small rural PPS hospitals and CAHs than in urban hospitals across a broad time span. This finding is critical given rural residents' persistently higher cancer incidence and mortality compared with urban residents.[1,10–12] The supply of cancer services may be inadequate to meet the need in rural communities. While cancer incidence and mortality rates in the United States are declining, improvements are slower in rural areas compared with urban areas.[5] Prior studies have found that poorer access to care among rural populations may contribute to rural cancer disparities.[11,13] We found that even with the presence of a local hospital, rural residents do not have access to necessary cancer specialty services. These access barriers may delay treatment and reduce treatment adherence among rural cancer patients.

CAHs, now comprising over half of the nation's rural hospitals, were designated to improve hospital financial viability so that access to rural health care could be maintained; yet, they rarely provide cancer treatment services in rural communities. Rural patients who have surgery at distant hospitals may subsequently have to travel further to have chemotherapy and/or radiation, which may affect adherence to the full regimen of care. This is especially concerning considering that rural patients are more likely to be diagnosed at an advanced stage and require complicated treatments.[35,36] Our findings may help explain previous literature that suggested lower likelihoods of receiving radiation therapy and/or surgery with radiation among rural residents than urban residents.[11] The scarcity of cancer treatment services in CAHs and limited availability in rural PPS hospitals might exacerbate treatment disparities between rural and urban patients. Without tailored interventions and targeted federal policies to improve the availability of cancer services in rural areas, disparities in cancer care are likely to persist.

CAHs and small rural PPS hospitals may face challenges in providing inpatient cancer treatment services due to a lack of trained cancer care workforce, financial constraints, restrictions in reimbursement policies, low patient volumes, competing priorities, and space limitations.[37] Thus, rather than incentivizing CAHs and small rural PPS hospitals to increase their capacity to provide cancer care services, there may be an opportunity to improve the regionalization of cancer care, including postdiagnosis treatments.[38,39] Providing support to CAHs and rural PPS hospitals so that they can offer outpatient cancer treatment services such as chemotherapy while allowing for comprehensive transfer and referral services for local cancer survivors is an important step in that direction. With regards to radiation therapy, which demands more advanced technology and a specialty workforce, both challenging for CAHs to maintain, further development of regional networks will be required. Further studies and operationalization of cancer care regionalization across or within health systems are warranted to ensure that large urban PPS hospitals, such as National Cancer Institute–designated or CoC-accredited cancer centers, reach rural residents, especially those in underserved communities.

The CMS OCM provides financial incentives to providers to coordinate cancer care, improve patient experience and appropriateness of care, as well as to facilitate decision-making across providers and care settings.[27,40] Unfortunately, CAHs are not eligible to participate in the OCM. This omission, practically based on the constraints of Medicare's payment infrastructure,[28] may, however, be short-sighted. From an operational perspective, CAHs are required to have patient transfer arrangements with larger facilities as part of their designation process.[22] These networks could be extended to allow coordination surrounding outpatient cancer treatment activities, given appropriate financial incentives. Further, other CMS value-based payment programs that allow CAH participation could be utilized to provide appropriate financial incentives to better coordinate cancer care, leading to improved adherence and overall outcomes.

This study was limited to hospitals responding to the AHA Annual Survey. However, with historical data, we were able to capture all community hospitals in the United States. Cancer services provided by non–hospital-affiliated outpatient treatment centers are not captured. Another limitation is that using time-variant county-level sociodemographic and socioeconomic status for each hospital location assumes that the demand of cancer services within a county were comparable to a hospital's patient structure. However, a county does not necessarily represent the patient catchment area for a given hospital. Also, we only measured 3 cancer treatment services and a hospital may provide other cancer services (eg, surgery), depending on its capacity. A final limitation is that while we included whether a hospital was located in a county designated as a health professional shortage area per year, oncology workforce supply might differ from overall health professional supply. Yet, we believe oncology workforce supply in a hospital market was stable over time; thus, the variations in oncology workforce supply across urban PPS, rural PPS, and CAHs might be controlled by the fixed-effects models.

CONCLUSIONS

On average, PPS hospitals in urban and rural America increased their service lines for cancer care during the 2008–2017 period. In contrast, cancer care capabilities in CAHs decreased over the same period. Tailored policy strategies, such as cancer care regionalization, are necessary to address disproportionate barriers faced by CAHs and their local communities for cancer treatment services.

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