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Trends in aging-related services during nephrectomy: implications for surgery in an aging population

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Dr. Saliba sits on the Editorial Board for the *Journal of the American Geriatrics Society*.
Each author has provided substantial contributions to warrant authorship. Specific contributions are as follows: HT – conceptualization, methodology, formal analysis, writing, visualization; ML – conceptualization, resources, writing, supervision; KC – methodology, formal analysis, writing; DS – conceptualization, formal analysis, writing; JH – conceptualization, resources, methodology, data curation, writing, supervision, project administration.

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Abstract

Objectives—To characterize the extent to which geriatric and related healthcare services are provided to older adults undergoing surgery for kidney cancer, a potential growth area in geriatrics and oncology.

Design—Population-based, observational study.

Setting—Surveillance, Epidemiology, and End Results cancer data linked with Medicare claims.

Participants—19,129 adults age ≥65 with kidney cancer treated surgically from 2000–2009.

Measurements—Receipt of the following services during the surgical care episode: 1) geriatric consultation; 2) medical comanagement during the surgical hospitalization; 3) inpatient physical/occupational therapy (PT/OT); and 4) post-acute PT/OT.

Methods—Multivariable, mixed-effects models to identify associated patient and hospital characteristics, examine trends over time, and characterize hospital-level variation.

Results—Geriatric consultation occurred rarely in the perioperative period (2.6%). Medical comanagement, inpatient PT/OT, and post-acute PT/OT occurred more frequently in 15.8%, 34.2%, and 15.6% of patients, respectively. In our mixed-effects models, patient age and comorbidity burden appeared to be consistent determinants of utilization across services though hospital-level variation was also noted ($p<0.001$). Use of geriatric consultation increased modestly in the latter years of the study period ($p<0.05$). In contrast, medical comanagement, inpatient PT/OT, and post-acute PT/OT increased substantially over the entire study period, by 183%, 73%, and 71%, respectively ($p<0.001$).

Conclusion—While geriatric consultation remained sparse, medical comanagement and rehabilitation services have risen considerably for older adults undergoing surgery for kidney cancer. Efforts to reorganize cancer and surgery care should explore reasons for variation and the potential for these service elements to meet the health needs of an aging population.

Keywords

aging; functional health status; nephrectomy; cancer; health services

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Introduction

Now the seventh most common malignancy in the US, kidney cancer represents an emerging focus in geriatric, cancer, and surgical care. Brought about by the widespread use of cross-sectional imaging, the diagnosis of kidney cancer has risen steadily over the past 2 decades.[1] Nearly half of newly diagnosed patients are 65 years old or older, and with the population aging at an equally precipitous rate, kidney cancer will soon rival other cancer sites among the elderly.[2] In most cases, surgery continues to be the predominant mode of treatment. While several technological advances have been developed, including organ-preserving and minimally invasive surgery, treatment-related morbidity (e.g., complications, renal dysfunction, cardiovascular events) remains sizeable,[3–5] particularly for a population predisposed to frailty, cognitive decline, malnourishment, and other syndromes of aging.

Owing to demographic projections and these aging-related health concerns, several leading organizations have advocated for greater consideration of geriatric care principles in both surgery and oncology.[6–9] Proponents contend that more proactive consideration of functional status, cognitive and mental health, medical comorbidities, polypharmacy, and social support will enhance outcomes for vulnerable elders. In the perioperative setting, several management approaches have been proffered to improve the quality of care. Team-based models involving geriatricians have been shown to enhance patient safety and shorten hospitalization for patients undergoing orthopedic and general surgeries in several small studies.[10,11] Comanagement by medicine physicians may offer similar improvements in outcomes.[12,13] Early and frequent mobilization—often facilitated through physical/occupational therapy (PT/OT)—has been endorsed programmatically by surgical care guidelines.[8] However, the extent to which these services have been activated in kidney cancer or cancer surgery more broadly remains unknown.

In this context, there is an immediate need to understand the breadth of care delivered to older adults with kidney cancer during the perioperative period. Accordingly, we examined the utilization of aging-related healthcare services—geriatric consultation, medical comanagement, and PT/OT—during the surgical care episode. In doing so, we can more effectively organize efforts to advance care for this expanding pool of surgery patients.

Methods

Data Source and Cohort Identification

To identify subjects aged 65 years or above treated surgically for kidney cancer, we used the linked SEER-Medicare dataset from 2000 through 2009. SEER is a population-based cancer registry that maintains data regarding incidence, treatment, and mortality representative of the US. SEER can be successfully linked to data from Medicare, which provides primary health insurance to 97% of adults aged ≥65 years in the US. Medicare data included inpatient, outpatient, physician/carrier, home health agency, durable medical equipment, and hospice claims.[14] Additionally, linkages to the American Medical Association physician masterfile and the National Cancer Institute (NCI) Hospital file provided information on physician specialty and hospital characteristics.

We initially identified 30,158 subjects diagnosed with primary, non-urothelial kidney cancer with continuous Medicare Part A and B enrollment (i.e., from 12 months prior to 6 months following surgery or until death) and without enrollment in a managed care plan. We restricted our sample to patients with complete cancer staging information (n=28,458) and further excluded those with either hospice care in the year preceding diagnosis (n=46) or bilateral tumors (n=86), creating a preliminary sample of 28,326 subjects. To identify and classify those undergoing surgery, we applied a validated, claims-based algorithm based on inpatient hospital and physician claims using International Classification of Diseases, 9th revision, Clinical Modification (ICD-9) and Current Procedural Terminology (CPT) codes.[15] In total, we assembled a cohort of 19,129 subjects treated surgically for kidney cancer.

Identification of Aging-related Healthcare Services

For each patient, we ascertained receipt of the following services during the surgical care episode: 1) geriatric consultation; 2) medical comanagement during the surgical hospitalization; 3) inpatient PT/OT; and 4) post-acute PT/OT. First, we identified care from a geriatrician during the 90 days before surgery, the surgical hospitalization, and within 30 days after discharge based on claims submitted with a self-designated specialty code for geriatric medicine (HCFASPEC 38) or from any provider listing geriatric medicine as a specialty in the American Medical Association physician masterfile. Second, to define medical comanagement during the surgical hospitalization, we identified all claims submitted by a general, family medicine, geriatric, or internal medicine physicians based on self-designated specialty codes. We then applied a claims threshold of ≥50% of inpatient days by provider type to qualify for our measure of medical comanagement.[16] Third, we classified the receipt of inpatient PT/OT using specific CPT or billing designation codes during the surgical hospitalization. Fourth, we created a measure for post-acute PT/OT within 30 days of discharge as provided by inpatient rehabilitation, skilled nursing facility, home health, or outpatient services.[17]

Patient and Hospital Covariates

From the SEER-Medicare dataset, we extracted information relating to age, gender, marital status, race/ethnicity, year of treatment, and tumor stage (i.e., AJCC stages I–IV). Through the above-mentioned algorithm, we classified the surgery performed as open radical nephrectomy, open partial nephrectomy, minimally invasive radical nephrectomy, and minimally invasive partial nephrectomy. We utilized census-tract level estimates of high school education and income divided into equally-sized tertiles as measures of socioeconomic status and further identified the rural/urban residential status of each subject. Comorbidity was determined using the Klabunde modification of the Charlson Comorbidity index based on inpatient and outpatient claims submitted during the 12 months prior to cancer diagnosis.[18] As a proxy for patient function, we applied a set of function-related indicators—a collection of claims indicative of reduced functional status or overall disability (e.g., mobility-assist device, previous blood transfusion, nutritional supplementation, falls, fractures, pressure ulcers, dementia).[19]

We further defined several hospital characteristics using the NCI Hospital file. We classified each hospital in terms of ownership control (i.e., non-profit vs. for-profit vs. governmental), academic affiliation, and the NCI Cancer Center designation (i.e., cancer center vs. cooperative group member vs. neither). We ascertained the total number of patient beds (i.e., 0–299, 300–500, or >500) and categorized nursing volume based on the number of nursing full-time equivalents per patient beds. Finally, we created a 3-tier categorical variable for hospital volume based on the total number of kidney cancer surgeries performed by each hospital by year.

Statistical Analysis

First, we measured the proportion of subjects to receive each type of service during the study interval. For each service, we compared patient and hospital covariates according to receipt using chi-square testing.

Given the hierarchical nature of our data, we built multivariable mixed-effects models to identify factors associated with service utilization. These models included age, gender, marital status, race/ethnicity, year of treatment, socioeconomic indicators, comorbidity, patient function, surgery type, cancer stage as well as hospital bed size, NCI designation, ownership control, nursing volume, and case volume as fixed effects and employed a hospital-level random intercept. Estimates from the multivariable mixed-effects models are reported as odds ratios (ORs) with corresponding 95% confidence intervals. Based on these models, we calculated the probability of service use for each year of study to examine trends over time.

Next, we gauged hospital-level variation in two manners. From our mixed-effects models, we calculated the probabilities and 95% confidence intervals for geriatric consultation, medical comanagement, inpatient PT/OT, and post-acute PT/OT across our included hospitals. Second, we determined the hospital component of variance using the latent variable approach: $(\sigma 2F)/(\sigma 2F + \tau 20 + \sigma 2R)$, where $\sigma 2F$ is defined as the variance of the fixed terms, $\tau 20$ is defined as the intercept (hospital level) variance, and $\sigma 2R$ is defined as the level 1 residual variance ($\pi^2/3$ in our model).[20] Given our interest in hospital-level variation, we determined the combined contribution from measured hospital covariates and unexplained hospital factors derived from the intraclass correlation coefficient of the full and null models for each service, respectively.

Lastly, we performed several sensitivity analyses to assess the robustness of our findings. Given the empiric nature of our comanagement measure, we tested a secondary measure with a higher claims threshold of ≥70%. To assess whether findings reflect worsening surgical morbidity, we repeated our analyses for patients without a perioperative complication using a previously described claims-based algorithm.[3] We also examined PT/OT use in the 3 months preceding surgery to determine whether findings could represent carryover from preoperative utilization.

All statistical testing was 2-sided, completed using computerized software (STATA version 14.1, College Station, TX), and carried out at the 5% significance level. This study was approved by the Institutional Review Board at the University of California, Los Angeles.

Results

Among 19,129 subjects, 492 (2.6%) had an encounter with a geriatrician during the surgical care episode: 269 (1.4%) preoperatively, 167 (0.9%) during the surgical hospitalization, and 245 (1.3%) in the post-acute setting. Medical comanagement and inpatient PT/OT occurred much more frequently, in 3,020 (15.8%) and 6,535 (34.2%) patients, respectively. Of those discharged alive, 2,931 of 18,827 (15.6%) patients received post-acute PT/OT in the inpatient setting, through a skilled nursing facility, at home, or as an outpatient.

Patient characteristics associated with healthcare service use are reported in Supplementary Table S1. In general, these aging-related services occurred more often for patients with greater age, comorbidity, and functional disability ($p \leq 0.004$). Geriatric consultation and PT/OT were provided more often to patients with advanced cancer ($p<0.05$) while inpatient and post-acute PT/OT appeared more common for those undergoing open surgery (p<0.001). Service use also varied with respect to gender, race/ethnicity, marital status, rural/urban residence, and socioeconomic position (p<0.05).

Among hospital characteristics detailed in Supplementary Table S2, geriatric consultation was significantly associated with greater hospital resources (i.e., bed size, nursing volume, case volume, NCI-designation, and academic status). Medical comanagement was less common in cancer centers and academic institutions (p<0.001) while inpatient PT/OT appeared more common in smaller, lower-volume hospitals with fewer nursing resources (p<0.05). Slightly more common for patients treated at academic institutions, post-acute PT/OT otherwise did not vary substantively by hospital characteristics.

The results of our multivariable mixed-effects models are reported in Tables 1 and 2. Again, these healthcare services were found to be significantly associated with patient age, comorbidity, and open surgery. Patients treated at larger hospitals more often received a geriatric consultation during the surgical care episode. Female patients and those treated at NCI-designated cancer centers had lower likelihoods of medical comanagement compared with their respective counterparts. For PT/OT, functional disability, advanced cancer, and treatment in an academic institution emerged as positive predictors whereas male gender, unmarried status, and rural residence served as negative predictors. Over time, the probability of geriatric consultation nearly doubled (2.1% in 2009 vs. 1.1% in 2000, p=0.016) but remained low. Meanwhile, the probabilities of medical comanagement, inpatient PT/OT, and post-acute PT/OT increased by 183%, 73%, and 71%, respectively (p<0.001), to more substantial levels (Figure 1).

Although delivery of these services appeared to be driven by patient-level factors, we observed significant hospital-level variation (p<0.001, Figure 2). For geriatric consultation, predicted hospital-level usage ranged from 0.4% to 32.8% (median 1.1%) with measured and unmeasured hospital factors explaining 31.2% of the variation. For medical comanagement, hospital usage ranged from 2.5% to 42.3% (median 11.3%) with hospital factors accounting for 23.4% of the variation. For inpatient PT/OT, utilization varied from 10.1% to 74.9% (median 29.5%) with hospital factors accounting for 10.3% of the variation. In contrast, post-acute PT/OT was less varied, ranging from 8.1% to 21.4% (median 12.3%) with only 3.3% of the variation attributable to the hospital. The above findings did not change substantively in our pre-specified sensitivity analyses.

Discussion

At the crossroads of two ongoing trends—an inexorable rise in incidence and an aging population, kidney cancer will become prominent among older Americans.[1,2] In turn, kidney cancer surgery will become increasingly common for this population; nephrectomy has already seen the 2nd highest growth among non-orthopedic operations over the past decade.[21] Unlike younger patients, older men and women often harbor distinct health concerns—coexisting comorbidities, functional deficits, cognitive decline, mental illness, malnutrition, and withering social support—that may manifest and intensify with surgery.

For kidney cancer surgery, more than 1 in 15 older adults experience delirium, pressure ulcers, falls/fractures, dehydration, or failure to thrive during their hospitalization.[22]

Accordingly, aging-related healthcare services may be warranted for older adults with kidney cancer. However, as identified here, patients undergoing kidney cancer surgery rarely see a geriatrician, potentially due to the shortage of specialty-trained physicians in the US.[23–25] Instead, medical comanagement, typically with an internist, has become more commonplace, nearly tripling over the study interval. This growth mirrors trends in general, vascular, and orthopedic surgery and coincides with the advent of hospitalist physcians.[16] Focused on providing inpatient medical care, hospitalists have grown their footprint dramatically and now deliver a significant proportion of hospital-based care to the elderly.[26] Perhaps in recognition of these trends, both care of the elderly and perioperative medicine are considered to be core competencies in the specialty of hospitalist medicine.[27] However, training in geriatric medicine remains quite limited during internal medicine residency.[23] Furthermore, academic institutions and cancer centers—foci of graduate medical education —utilize medical comanagement less often than other hospital types, paradoxically reducing exposure to this area. So while hospitalists offer expertise in comorbidity management and have gained familiarity with surgical issues, their capacity to provide recommended, age-appropriate care in the perioperative setting warrants further investigation.

PT/OT services may also be considered, particularly for patients with functional concerns or deficits following surgery. As highlighted in newly released guidelines on perioperative care in the elderly, early PT/OT may promote ambulation, prevent certain adverse events (e.g., delirium, falls/fractures, pressure ulcers), and enhance convalescence.[8] Though data demonstrating the utility of rehabilitation services for kidney cancer surgery is lacking, utilization has certainly become more widespread, increasing by over 70%. As nearly half of patients undergoing surgery for kidney cancer exhibit some form of disability or dysfunction at baseline, this service expansion may reflect timely and appropriate usage. At the same time, this could also be a reflection of broader healthcare trends. Both PT/OT and post-acute care have expanded in recent decades with the latter serving as a mechanism for hospitals to offload care to the outpatient setting.[17,28]

For the above-mentioned services, their application appears to be driven by both patient characteristics and hospital-level externalities. For instance, age and comorbidity—two major determinants of post-nephrectomy morbidity[29] —were found to be significant drivers of service usage even after adjusting for potential confounders. Baseline patient function, disease severity, and open surgery—indicators of preexisting or anticipated disability—also emerged as key considerations in utilizing rehabilitation services. At the same time, however, we observed significant hospital-level variation for services that occur in the inpatient setting. In the case of medical comanagement, hospitalists have increased rapidly in number but at varying rates with regional market share ranging from 10% to 80%.[26] Taken together, these patterns of care suggest that aging-related healthcare services are being delivered to patients with the greatest potential needs, subject to hospital availability.

These results should be considered in the context of several limitations. First, our findings depend on empiric, claims-based definitions for our selected services. For geriatric consultation, we used a composite measure for the entire surgical care episode due to the low number of occurrences. As such, this analysis may not capture more nuanced differences in utilization according to specific phases of care. Our definition for medical comanagement may misclassify patients should billing claims not be rigorously submitted and may potentially over-classify should patients receive an abundance of care from medicine physicians owning to a complication. Of note, we observed a significant rise in comanagement use over time when using higher thresholds for comanagement and in patients without claims suggestive of postoperative complications. PT/OT use could represent carryover from the preoperative period. However, utilization in the 3 months preceding surgery did not vary significantly over the study interval. For both geriatric consultation and post-acute PT/OT, we limited our period of interest to the 30 days after discharge. New service use after this period may occur but is likely infrequent given the anticipated recovery course after kidney cancer surgery. Second, our findings could reflect ongoing population trends regarding age, comorbidity, and functional status rather than real growth in service utilization.[2] Accordingly, we report service utilization adjusted for these variables as well as other relevant characteristics. Third, we did not examine surgeon-level variation, which could further explain practice patterns.

These limitations notwithstanding, these findings have important implications for the delivery of cancer surgery to the elderly. In recognition of the growing number of older adults in the US and the unique health needs they possess, several organizations including the National Comprehensive Cancer Network, the International Society of Geriatric Oncology, the American College of Surgeons, and the American Geriatrics Society have advocated for greater incorporation of geriatric care principles into cancer and surgical care.[6–8] While dedicated involvement from geriatricians would be ideal, our findings and others suggest limited engagement to date.[30] Instead, medical comanagement and rehabilitation services may serve as more accessible resources, at least in the near-term.

However, previous research has established shortfalls in geriatric training for internal medicine physicians not to mention surgeons for whom geriatric core competencies have yet be formalized.[23,25] As a result, best practice guidelines for the geriatric surgical patient—developed by the American College of Surgeons and the American Geriatrics Society—may help facilitate service activation and education.[8,9] Surgeons and other clinicians can apply simple tools described in the preoperative assessment guidelines to identify potential deficits (e.g., functional decline, polypharmacy) and trigger a comprehensive geriatric assessment by a trained specialist (e.g., geriatrician).[9] The surgical team or medical comanagement and rehabilitation services could then use this information in concert with perioperative care guidelines to optimize inpatient care and subsequent recovery.[8] Fortifying and coordinating these mechanisms, along with greater engagement with geriatricians, should be considered in what may become the essential framework for delivery high quality perioperative care to older patients with cancer.

Conclusions

For the growing number of older adults who undergo surgery for kidney cancer, care from a geriatrician is rare. Medical comanagement and PT/OT, however, are increasingly deployed during the course of perioperative care. Though older, sicker, and more disabled adults receive these services more commonly, utilization varies from hospital to hospital. These practice trends underscore the need to better understand the framework, function, and potential benefit of emerging team-based care models in cancer and surgery care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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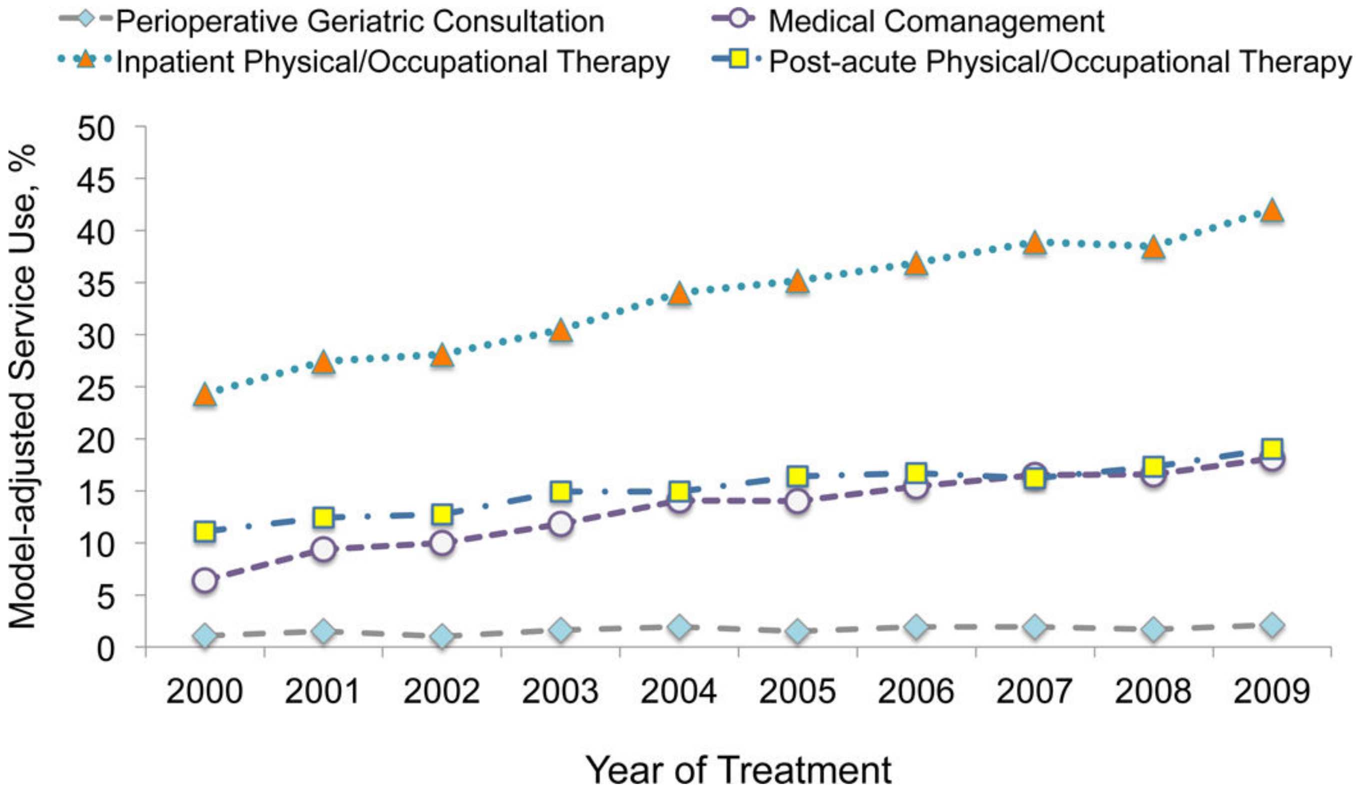

Figure 1.

Probability of geriatric consultation, medical comanagement, inpatient physical/occupational therapy, and post-acute physical/occupational therapy for older adults undergoing kidney cancer surgery from 2000–2009. Probabilities are derived from mixed-effects models adjusting for patient and hospital characteristics and a hospital-level random intercept.

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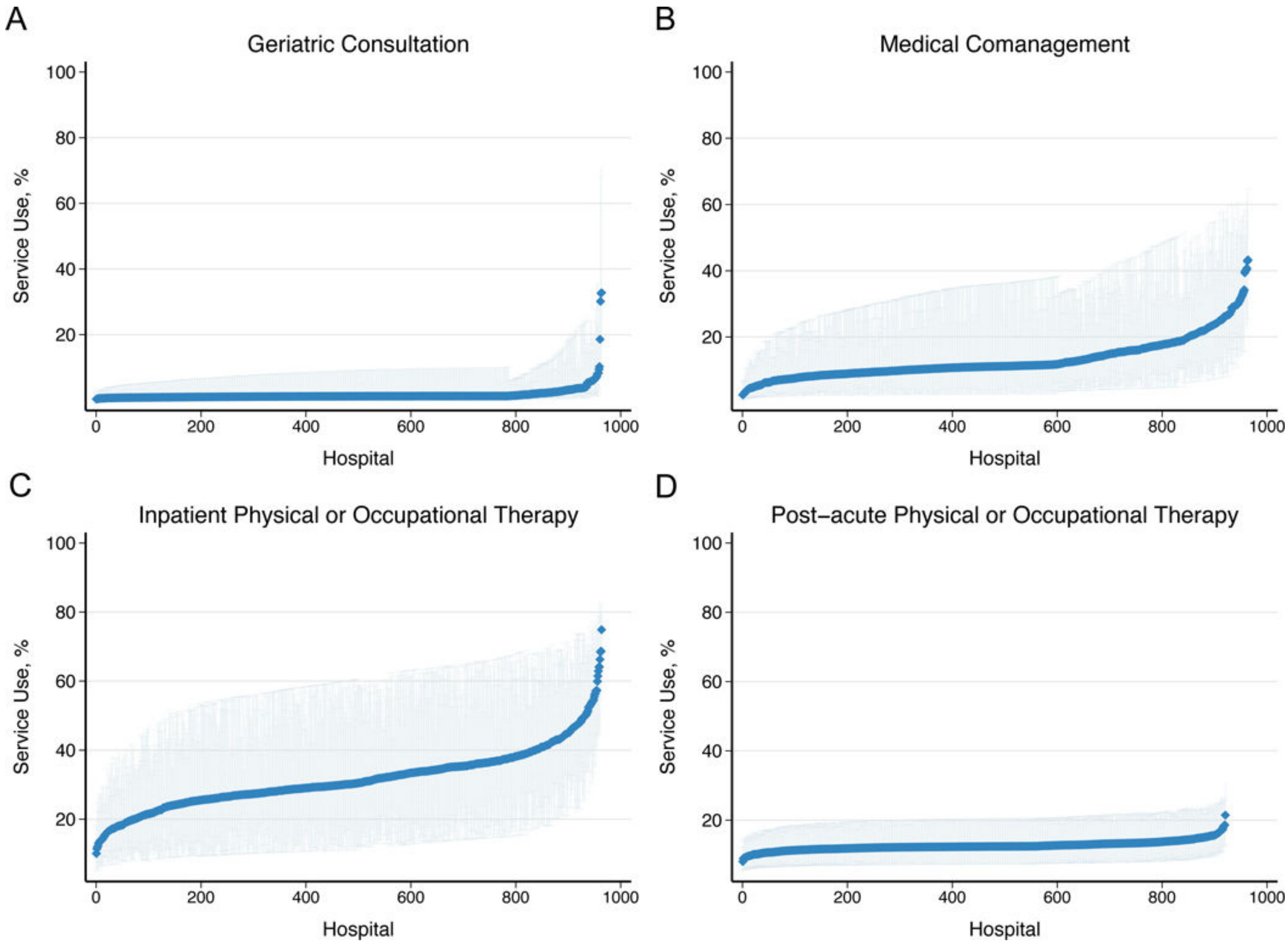

Figure 2.

Variation in hospital-level usage of (A) geriatric consultation, (B) medical comanagement, (C) inpatient physical/occupational therapy, and (D) post-acute physical/occupational therapy for older adults undergoing kidney cancer surgery. Hospitals ranked from lowest to highest probability of service use as derived from mixed-effects models adjusting for patient and hospital characteristics. Solid blue line represents adjusted probability for each hospital with 95% confidence interval depicted by gray error bars.

Table 1

Patient characteristics according to receipt of aging-related services, adjusted^

	Geriatric Consultation	Medical Comanagement	Inpatient PT/OT	Post-acute PT/OT
Age, years (Ref: 65–69)				
70–74	0.98 (0.74–1.28)	1.03 (0.91–1.15)	1.19 (1.08–1.31)	1.31 (1.14–1.49)
75–79	1.22 (0.89–1.68)	1.15 (1.02–1.31)	1.67 (1.52–1.84)	1.84 (1.63–2.08)
80–84	1.45 (1.11–1.90)	1.16 (1.01–1.34)	2.68 (2.39–3.02)	2.83 (2.46–3.26)
85+	2.29 (1.59–3.30)	1.23 (1.02–1.49)	4.20 (3.57–4.92)	4.13 (3.46–4.94)
Female	1.22 (1.00–1.49)	0.87 (0.80–0.96)	1.30 (1.21–1.39)	1.31 (1.19–1.45)
Race/Ethnicity (Ref: White)				
Black	1.47 (1.08–2.00)	1.06 (0.88–1.28)	1.15 (1.00–1.33)	1.29 (1.11–1.50)
Hispanic/Latino	1.14 (0.74–1.76)	0.77 (0.62–0.96)	0.83 (0.70–0.98)	0.85 (0.71–1.03)
Asian	1.24 (0.54–2.83)	0.86 (0.64–1.16)	0.83 (0.65–1.08)	0.73 (0.53–1.01)
Other	0.42 (0.09–1.89)	0.85 (0.49–1.48)	0.67 (0.49–0.90)	0.74 (0.45–1.23)
Married	0.84 (0.66–1.05)	1.01 (0.92–1.10)	0.76 (0.70–0.82)	0.81 (0.73–0.89)
Rural Status	0.81 (0.56–1.18)	0.72 (0.61–0.85)	0.70 (0.60–0.81)	0.72 (0.61–0.85)
Income (Ref: Bottom tertile)				
Middle tertile	1.20 (0.93–1.54)	0.97 (0.85–1.10)	0.96 (0.87–1.07)	1.03 (0.90–1.18)
Top tertile	1.05 (0.75–1.47)	1.04 (0.90–1.21)	0.88 (0.78–0.99)	1.03 (0.88–1.20)
Education (Ref: Bottom tertile)				
Middle tertile	0.94 (0.71–1.24)	1.04 (0.92–1.18)	0.93 (0.83–1.03)	0.95 (0.84–1.07)
Top tertile	1.05 (0.78–1.41)	1.00 (0.85–1.17)	0.88 (0.78–0.99)	0.94 (0.81–1.09)
Charlson Comorbidity Score (Ref: 0)				
1	0.92 (0.74–1.15)	1.36 (1.23–1.52)	1.27 (1.17–1.38)	1.31 (1.18–1.46)
2+	1.56 (1.25–1.94)	1.99 (1.75–2.26)	1.89 (1.72–2.08)	1.80 (1.62–2.01)
Function-Related Indicators (Ref: 0)				
1	0.95 (0.77–1.17)	0.97 (0.88–1.08)	1.22 (1.13–1.32)	1.44 (1.31–1.58)
2+	1.21 (0.92–1.59)	1.03 (0.91–1.17)	1.78 (1.60–1.97)	1.99 (1.77–2.23)
Tumor Stage[†] (Ref: Stage I)				
Stage II	1.38 (0.99–1.92)	0.97 (0.83–1.13)	1.13 (1.00–1.27)	1.16 (1.01–1.32)
Stage III	1.29 (1.03–1.62)	1.07 (0.96–1.20)	1.31 (1.20–1.44)	1.28 (1.14–1.43)
Stage IV	1.37 (0.97–1.93)	1.10 (0.93–1.30)	1.73 (1.50–2.00)	2.35 (2.01–2.73)
Nephrectomy (Ref: Open Radical)				
Laparoscopic Radical	0.79 (0.63–0.98)	1.18 (1.05–1.33)	0.25 (0.23–0.28)	0.44 (0.40–0.49)
Open Partial	0.98 (0.68–1.42)	0.85 (0.71–1.01)	0.89 (0.78–1.02)	0.83 (0.68–1.00)
Laparoscopic Partial	0.68 (0.49–0.95)	0.97 (0.82–1.16)	0.21 (0.18–0.26)	0.42 (0.35–0.51)

	Geriatric Consultation	Medical Comanagement	Inpatient PT/OT	Post-acute PT/OT
Year of Treatment (Ref: 2000)				
2001	1.44 (0.84–2.45)	1.52 (1.17–1.98)	1.21 (1.02–1.44)	1.14 (0.91–1.42)
2002	0.97 (0.58–1.64)	1.62 (1.27–2.07)	1.27 (1.06–1.52)	1.18 (0.95–1.46)
2003	1.52 (0.89–2.59)	1.97 (1.52–2.56)	1.46 (1.22–1.74)	1.44 (1.15–1.79)
2004	1.74 (1.05–2.88)	2.43 (1.90–3.10)	1.77 (1.48–2.12)	1.45 (1.15–1.81)
2005	1.39 (0.84–2.30)	2.40 (1.87–3.09)	1.90 (1.60–2.26)	1.63 (1.31–2.02)
2006	1.80 (1.06–3.05)	2.69 (2.07–3.49)	2.07 (1.71–2.50)	1.68 (1.35–2.10)
2007	1.81 (1.04–3.14)	2.94 (2.25–3.85)	2.30 (1.90–2.78)	1.61 (1.30–2.00)
2008	1.63 (0.97–2.75)	2.96 (2.24–3.91)	2.26 (1.86–2.73)	1.75 (1.39–2.21)
2009	1.95 (1.13–3.35)	3.31 (2.51–4.35)	2.69 (2.19–3.32)	2.00 (1.57–2.54)

^Results based on mixed-effects models adjusting for age, gender, race/ethnicity, marital status, rural/urban status, income, education, comorbidity, patient function, tumor stage, nephrectomy type, year of treatment, bed size, nursing volume, hospital volume, NCI designation, academic status, and hospital type with random intercept for hospital and presented as odds ratios with 95% confidence intervals.

†Based on the American Joint Committee on Cancer Staging Manual, 10th edition.

Abbreviation: PT/OT, physical/occupational therapy; Ref, reference group.

Table 2

Hospital characteristics according to receipt of aging-related services, adjusted^

	Geriatric Consultation	Medical Comanagement	Inpatient PT/OT	Post-acute PT/OT
Bed Size (Ref: Small)				
Medium	1.54 (1.07–2.22)	1.18 (0.99–1.41)	1.05 (0.90–1.22)	0.99 (0.87–1.12)
Large	1.77 (1.08–2.88)	1.25 (0.91–1.71)	0.79 (0.58–1.06)	0.90 (0.74–1.09)
Nursing Volume (Ref: Bottom Tertile)				
Middle Tertile	0.91 (0.66–1.25)	1.04 (0.88–1.22)	0.98 (0.85–1.13)	1.01 (0.89–1.14)
Top Tertile	1.13 (0.78–1.62)	0.98 (0.84–1.16)	1.08 (0.92–1.28)	0.98 (0.86–1.12)
Hospital Volume (Ref: 1–4 per year)				
5–10 per year	0.77 (0.58–1.01)	0.96 (0.85–1.10)	0.99 (0.90–1.10)	0.94 (0.84–1.05)
>10 per year	0.92 (0.64–1.30)	0.92 (0.75–1.13)	1.00 (0.85–1.18)	0.98 (0.83–1.16)
NCI Designation (Ref: Neither)				
Cooperative Group	0.93 (0.64–1.37)	1.06 (0.88–1.28)	0.98 (0.84–1.14)	1.01 (0.89–1.15)
Cancer Center	1.37 (0.76–2.48)	0.31 (0.19–0.50)	1.14 (0.81–1.60)	1.02 (0.79–1.31)
Academic Institution	1.35 (0.93–1.96)	0.83 (0.67–1.02)	1.19 (1.03–1.37)	1.26 (1.10–1.44)
Ownership Control (Ref: Non-profit)				
For-profit	0.89 (0.53–1.50)	0.92 (0.72–1.19)	1.23 (1.02–1.48)	1.13 (0.95–1.34)
Government	0.69 (0.40–1.19)	0.81 (0.65–1.01)	0.98 (0.81–1.18)	0.89 (0.75–1.04)

^Results based on mixed-effects models adjusting for age, gender, race/ethnicity, marital status, rural/urban status, income, education, comorbidity, patient function, tumor stage, nephrectomy type, year of treatment, bed size, nursing volume, hospital volume, NCI designation, academic status, and hospital type with random intercept for hospital and presented as odds ratios with 95% confidence intervals.

Abbreviation: PT/OT, physical/occupational therapy