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Patterns of Surveillance Imaging After Nephrectomy in the Medicare Population

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Abstract

- To characterize patterns of imaging surveillance after nephrectomy in a population-based cohort of older kidney cancer patients.
- Using the Surveillance, Epidemiology, and End Results (SEER)-Medicare database, we identified patients ≥66 years of age who had partial or radical nephrectomy for localized kidney cancer diagnosed between 2000 and 2009.
- Primary outcomes were chest (X-ray or CT) and abdominal (CT, MRI or ultrasound) imaging in Medicare claims from 4 to 36 months after surgery.
- We estimated the frequency of imaging in three time periods (post-operative months 4–12, 13–24, 25–36), stratified by tumor stage.
- Repeated-measures logistic regression was used to identify patient and disease characteristics associated with imaging.
- Rates of chest imaging were 65–80%, with chest X-ray surpassing CT in each time period.
- Rates of abdominal imaging were 58–76%, and cross-sectional imaging was more common than ultrasound in each time period.
- Use of cross-sectional chest and abdominal imaging increased over time while chest X-ray decreased ($p < 0.01$). Ultrasound use remained stable for T1 and T2 patients, but decreased in patients with T3 disease ($p < 0.05$).
- Rates of chest and abdominal imaging increased with tumor stage ($p < 0.0001$).

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Conflicts of Interest

None declared.

- Patterns of imaging suggest possible overuse in patients at low risk of recurrence and underuse in those at greater risk.
- New surveillance imaging guidelines may reduce unwarranted variability and promote risk-based, cost-effective management after nephrectomy.

Keywords

cancer; kidney; SEER program; Medicare

Introduction

In 2014 there will be more than 64,000 new kidney cancer cases and nearly 14,000 deaths attributed to kidney cancer in the United States.[1] Following radical or partial nephrectomy for localized kidney cancer, relapse rates range from 11–30%, and are closely associated with pathological tumor stage.[2–7] Although adjuvant systemic treatments are under active investigation in both the United States and Europe, post-operative surveillance remains the standard-of-care after the complete resection of tumor.[8] The rationale for surveillance imaging is to detect distant metastatic disease or local tumor recurrence before it becomes symptomatic. The presumption of surveillance imaging is that detection of an asymptomatic recurrence will be actionable and beneficial, resulting in improved outcomes for the patient.

The American Urological Association (AUA) recently released the first guidelines to provide a framework for kidney cancer surveillance for patients being managed by active surveillance, surgical resection, and thermal ablative therapies.[9] Prior to these guidelines, post-operative surveillance protocols were based on recurrence patterns reported in retrospective series.[2, 4–7] These series demonstrated a direct relationship between American Joint Commission on Cancer pathological stage (T1–T3) and risk of local and distant recurrence.[2–5, 7] Only one study, which used the University of California-Los Angeles Integrated Staging System, recommended surveillance abdominal imaging for low stage disease.[10] In contrast, all of the above series recommended at least annual chest imaging for T2 and T3 patients.

Previous studies have demonstrated inappropriate, both overuse and underuse, of imaging in staging and surveillance in other cancers, including breast, prostate and bladder.[11–13] Our objective was to describe patterns of post-operative surveillance imaging in a population-based cohort of older adults with kidney cancer. Our focus was on imaging because radiological tests have been identified as a significant, modifiable source of unnecessary costs.[14] Specifically, we assessed whether low-stage patients had routine abdominal imaging, for which there is only limited supportive data, and whether high-stage patients had routine chest imaging, where recurrences are most common.

Patients and Methods**Data Source**

The primary data source was the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER)-Medicare database, which links information from the SEER cancer

registry program with Medicare claims and enrollment records. SEER, a consortium of 17 cancer registries in selected states and geographic regions in the US, covers approximately 26% of the population.[15] For newly diagnosed cancers in their coverage area, the SEER registries collect information on site and extent of disease, first course of cancer-directed therapy and sociodemographic characteristics, with active follow-up for date and cause of death. Medicare is the primary health insurer for 97% of the US population aged 65 or older. Compared to the entire population aged 65 or older, the SEER-Medicare population has a similar age and sex distribution, but has more residents in urban and affluent areas and a smaller nonwhite population.[15] The SEER-Medicare files were used in accordance with a data use agreement from NCI.

Cohort

We identified Medicare beneficiaries age 66 years or older diagnosed with kidney cancer between 2000 and 2009 who had a claim for radical or partial nephrectomy within 6 months of diagnosis. Individuals who were diagnosed at the time of death, who were enrolled in a managed care plan, or who lacked complete Medicare coverage (parts A and B) were excluded. Patients with bilateral disease at diagnosis were excluded. Those with metastatic or lymph node-positive disease or history of another cancer were also excluded.

Outcomes

The primary outcomes were chest imaging and abdominal imaging within the first 3 years after surgery. Because we were interested in routine surveillance practices, we excluded the initial 4-month period after surgery when imaging could also be obtained for the management of post-operative complications such as pneumonia or pleural effusion[16]. CPT and ICD-9 codes used for imaging claims are provided in supporting information online (Table S1).

Outcomes were stratified by tumor stage and year of follow-up. Tumor stage was based on the SEER collaborative staging (CS) classifications for tumor extension and tumor size. Localized tumors (CS extension 10, 20 or 30) and tumors 7cm or less in size were categorized as stage 1 (T1); localized tumors greater than 7cm as stage 2 (T2), and regional tumors (CS extension 39, 40, 60 or 62) as stage 3 (T3). Surveillance years were defined as postoperative months 4–12 (surveillance year 1), months 13–24 (year 2) and months 25–36 (year 3).

Predictors of imaging included demographic characteristics, year of surveillance, tumor features and type of surgery. Demographic characteristics included age at diagnosis, gender, race, marital status, median income in the census tract of residence, geographic region and urban vs. rural residence. Comorbidity was measured using a modification of the Charlson comorbidity index based on inpatient and outpatient claims in the year before cancer diagnosis.[17] Tumor features included tumor stage, grade and size. Type of surgery was classified as radical nephrectomy or partial nephrectomy (Table S1).[18]

Statistical Analysis

The proportion of patients with a claim for chest or abdominal imaging was examined by stage and time period. Analysis of imaging in each surveillance year included only patients who survived the duration of that year. In patients with at least one imaging claim for chest or abdominal imaging, we also estimated the mean number of claims. Trends over time in imaging in the first surveillance year were examined using the Cochran-Armitage test. We used multivariable repeated-measures logistic regression to estimate the impact of disease and demographic characteristics on the likelihood of receiving chest or abdominal imaging in each surveillance year. While our primary objective was to measure the impact of stage on receipt of imaging, we were interested in these other variables as an exploratory analysis. All analyses were performed using SAS version 9.2 (SAS Institute Inc, Cary, NC).

Results

We identified 11,250 patients with non-metastatic kidney cancer who had radical (N=8,990, 80%) or partial (N=2,260, 20%) nephrectomy between 2000 and 2009 (Table 1). The majority of patients were male (55%), white (86%), married (62%) and lived in urban areas (82%). The tumor stage distribution was 70%, 11% and 19% for T1, T2 and T3 respectively, and 48% of patients had a tumor $\leq$ 4cm.

Rates of chest imaging for stage T1, T2 and T3 were 65–70%, 67–79% and 70–80%, respectively, varying by surveillance year (Table 2). Rates of abdominal imaging per surveillance year for stage T1, T2 and T3 were 61–71%, 58–70% and 64–76%, respectively, varying by surveillance year. Chest X-ray was more common than CT in each stage group and surveillance year. Abdominal CT and MRI were used more commonly than ultrasound in each stage group and surveillance year. Among patients who had at least one imaging claim in a surveillance year, the mean number of claims varied from 1.3 to 2.6, with chest X-ray being the most frequently performed imaging test.

Trends in surveillance imaging varied by disease stage and imaging modality (Figure 1). Among patients with T1 disease, the use of chest X-ray in the first surveillance year declined (67% to 59%, $p<0.0001$), chest CT increased (17% to 20%, $p<0.0001$), abdominal CT and MRI increased (54% to 61%, $p<0.0001$), and abdominal ultrasound use remained stable. For T2 patients, the use of chest X-ray decreased (70% to 64%, $p=0.0015$), chest CT increased (20% to 31%, $p=0.0047$), abdominal CT and MRI increased (49% to 66%, $p=0.0064$), and abdominal ultrasound use remained stable. For T3 patients, the rate of chest X-ray decreased (73% to 59%, $p=0.0029$), chest CT increased (26% to 42%, $p<0.0001$), abdominal CT and MRI increased (61% to 76%, $p<0.0001$), and abdominal ultrasound decreased (28% to 20%, $p=0.0128$).

Several patient and disease characteristics were associated with the likelihood of chest or abdominal imaging in multivariable analysis (Table 3). Women were more likely than men to receive each type of imaging, as were patients with more advanced tumor stage and grade. Older age at diagnosis and black race were both associated with a lower likelihood of chest and abdominal imaging. Greater comorbidity was associated with greater odds of chest imaging. Patients who had partial nephrectomy had almost double the odds of abdominal

imaging compared with those who had radical nephrectomy (adjusted odds ratio [OR] 1.93, 95% CI 1.78–2.09, $p < 0.0001$), but were less likely to receive chest imaging (adjusted OR 0.78, 95% CI 0.72–0.84, $p < 0.0001$). Compared with patients in the Northeast, those residing in the other regions were more likely to have chest imaging but less likely to have abdominal imaging.

Discussion

In this analysis of a population-based cohort of older adults with kidney cancer, we observed that rates of chest and abdominal imaging were fairly similar across stages of disease and years following surgery. Moreover, half of T1 patients had a claim for abdominal imaging in each of the first 3 years after surgery, with the majority of patients getting cross-sectional imaging. At the same time, 20–30% of T3 patients did not have a claim for chest imaging in each of the first 3 post-operative years.

This is in stark contrast to previous recommendations for surveillance imaging. During the period of our study, there was ample retrospective data supporting a direct relationship between tumor stage and risk of recurrence in kidney cancer. [2–5, 7] Recently published surveillance guidelines reinforce this principle.[9] The goals of these guidelines are to minimize the use of unnecessary tests and to detect recurrences as early as possible with the assumption that early detection of recurrence can improve patient outcomes.[19, 20] Our results suggest that clinicians did not take a risk-stratified approach to surveillance imaging, with likely overuse of imaging in patients with the lowest risk of recurrence (T1) and underuse of imaging in those with the highest risk (T3).

Even if risk-stratified approaches to post-operative disease surveillance are warranted, the evidence to support intensive imaging for high-risk kidney cancer patients is speculative. In the absence of prospective evidence, we cannot necessarily assume that earlier detection of asymptomatic recurrences portends a better outcome.[19, 20] A substantial proportion of patients will have an indolent clinical course, while a recurrence detected within the first year after surgery is a poor prognostic variable.[21, 22] Distinguishing these patients following surgery could further direct the use of imaging, as well as adjuvant and salvage therapies. Whether a thorough history and physical exam can be used to effectively guide imaging tests is controversial, as previous studies have reported that recurrences are symptomatic in 28–77% of cases.

Alternatively, intensive imaging for low-risk patients clearly represents overutilization of imaging resources with poor diagnostic yields expected in that setting. This practice has important consequences from the patient and payer perspectives. Considering the use of abdominal CT, there is a linear dose-response relationship between ionizing radiation exposure and risk of solid cancers or leukemia.[23] A recent review estimated 10-year cumulative radiation exposure of different kidney cancer surveillance protocols.[24] This study found significant variability in cumulative exposure, with some protocols exposing patients to well over 100 mSv, a level that has been associated with a 7.6% attributable risk of carcinogenesis. Considering that a large proportion of patients in our analysis received

more than one cross-sectional scan per year, it is likely that many patients were exposed to unnecessary and excessive radiation doses during this time period.

Unnecessary tests also have important cost implications. From the mid-1990s through the mid-2000s, use of advanced imaging among Medicare beneficiaries grew by more than 6 percent per year[25], and increases in imaging costs outpaced the rate of increase of all other costs in cancer care[26]. This was in part due to self-referrals among physicians who part owned advanced imaging facilities such as CT or MRI.[27] During the time period we studied, the use of cross-sectional abdominal and chest scans increased for all stages, while chest X-ray and ultrasound decreased or remained stable. During the time period of this study, only one single-center experience recommended cross-sectional chest imaging over chest X-ray in surveillance.[3] Fortunately, there are some signs that this growth in imaging costs is slowing, possibly due to efforts to reduce the use of tests with unproven medical value.[25, 28]

As would be expected, more advanced tumor stage, size and grade were independently associated with greater use of imaging. However, a number of other characteristics were associated with systematic variation in receipt of imaging. This parallels findings in other cancers, such as breast and bladder cancers, where there is wide variation in the use of surveillance testing.[13, 29, 30]

Increasing age was associated with a lower rate of chest and abdominal imaging, which may reflect the greater risk from competing causes of mortality with advancing age. Although we excluded patients with a history of another cancer, we did not examine the role of specific comorbid health conditions that could be closely associated with frequent use of abdominal or chest imaging. While we found that patients with more comorbid conditions received more frequent chest imaging, comorbidity was not associated with abdominal imaging. Therefore, we believe that comorbid conditions may have caused an overestimation of chest imaging, but not abdominal imaging, in surveillance. We also found that receipt of imaging varied by gender, race, income and geographic region. Explanations for this variation are not obvious, although similar patterns have been observed in other cancers and these findings should be explored in further studies. [13, 30]

There are several limitations to our analysis. Most importantly, in the absence of information about symptoms or laboratory findings, we could not definitively ascertain the indication for each imaging test or distinguish symptom-prompted imaging from routine surveillance in the absence of symptoms.[31] To the degree that any of the imaging use we identified was symptom-prompted, our endpoints reflect some misclassification. However, the imaging use we observed describes broad patterns of health care utilization, and even if not all imaging we identified reflected routine disease surveillance, it surely does not all represent symptom-prompted investigation. Thus, this limitation, while important, does not preclude drawing conclusions about the likely overuse and underuse of imaging in specific subgroups of patients with varying risk of recurrence. Moreover, the dataset has been used in similar ways to study post-operative imaging in other cancers. [13, 30]

We also did not have information regarding patient or physician preferences. There is evidence that physician-ownership of medical imaging technologies was associated with increased utilization during this period.[27] Finally, while our findings are representative of the Medicare population, it is not clear whether they are generalizable to younger patients.

In summary, in this population-based study of older adults with kidney cancer, rates of chest and abdominal imaging did not reflect known patterns of disease recurrence. Our findings suggest that there may be overuse of abdominal surveillance imaging in patients with low-risk disease, and considerable underuse of chest imaging in patients at greater risk of recurrence. The recently released AUA guidelines, which stratify imaging frequency and intensity by a patient's risk of disease recurrence, may help to standardize surveillance imaging after surgery for kidney cancer

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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(A)

(B)

(C)

Figure 1.

Trends in Surveillance Year 1 Imaging by T-Stage: (A) stage T1, (B) stage T2, (C) stage T3.

The x-axis represents year of diagnosis.

Table 1

Cohort characteristics

	All Patients	
Characteristic	n=11,250	
Age		
66–69	2,883	26%
70–74	3,435	31%
75–79	2,795	25%
80–84	1,590	14%
85 and older	547	5%
Sex		
Male	6,233	55%
Female	5,017	45%
Race		
White	9,633	86%
Black	900	8%
Other/unknown	717	6%
Marital status		
Married	7,019	62%
Not married/unknown	4,231	38%
Income quartile		
1 st quartile (lowest)	2,794	25%
2 nd quartile	2,786	25%
3 rd quartile	2,794	25%
4 th quartile (highest)	2,801	25%
Unknown	75	1%
Geographic region		
Northeast	2,491	22%
West	4,153	37%
Midwest	1,353	12%
South	3,253	29%
Residence		
Urban	9,263	82%
Rural	1,987	18%
Tumor stage		
Stage 1	7,857	70%
Stage 2	1,217	11%
Stage 3	2,176	19%

	All Patients	
Characteristic	n=11,250	
Tumor grade		
Low	6,338	56%
High	2,752	24%
Unknown	2,160	19%
Tumor size (cm)		
4.0	5,415	48%
4.1–7.0	3,727	33%
>7.0	2,108	19%
Comorbidity score		
0	6,171	55%
1	2,894	26%
2+	2,185	19%
Surgical approach		
Radical nephrectomy	8,990	80%
Partial nephrectomy	2,260	20%

Table 2

Frequency of chest and abdominal imaging by tumor stage and postoperative year

	Surveillance Year 1	Surveillance Year 2	Surveillance Year 3
T1			
Number at risk	N=7,857	N=7,277	N=5,969
Chest imaging	5,526 70%	5,016 69%	3,877 65%
Chest X-ray	4,981 63%	4,529 62%	3,491 58%
Chest CT scan	1,563 20%	1,502 21%	1,151 19%
Abdominal CT scan, MRI or US	5,576 71%	4,927 68%	3,644 61%
Abdominal CT scan or MRI	4,605 59%	3,895 54%	2,804 47%
Abdominal US	1,977 25%	2,056 28%	1,570 26%
T2			
Number at risk	N=1,217	N=1,099	N=908
Chest imaging	958 79%	792 72%	610 67%
Chest X-ray	834 69%	686 62%	523 58%
Chest CT scan	325 27%	286 26%	221 24%
Abdominal imaging	857 70%	743 68%	529 58%
Abdominal CT scan or MRI	735 60%	623 57%	439 48%
Abdominal US	261 21%	253 23%	188 21%
T3			
Number at risk	N=2,176	N=1,889	N=1,438
Chest imaging	1,742 80%	1,447 77%	1,003 70%
Chest X-ray	1,448 67%	1,227 65%	847 59%
Chest CT scan	751 35%	666 35%	431 30%
Abdominal imaging	1,657 76%	1,352 72%	923 64%
Abdominal CT scan or MRI	1,476 68%	1,178 62%	777 54%
Abdominal US	469 22%	444 24%	331 23%

Table 3

Impact of patient and disease characteristics on likelihood of chest and abdominal imaging

Characteristic	Chest Imaging		Abdominal Imaging	
	Odds Ratio (95% CI)	P-value	Odds Ratio (95% CI)	P-value
Surveillance year				
Year 1	Ref	<0.0001	Ref	<0.0001
Year 2	0.89 (0.85–0.94)		0.84 (0.79–0.88)	
Year 3	0.71 (0.67–0.75)		0.59 (0.56–0.62)	
Age				
66–69	Ref	<0.05	Ref	<0.0001
70–74	1.03 (0.95–1.11)		1.02 (0.94–1.11)	
75–79	1.03 (0.94–1.12)		0.90 (0.83–0.98)	
80–84	0.93 (0.84–1.03)		0.74 (0.67–0.82)	
>85	0.82 (0.70–0.95)		0.53 (0.46–0.61)	
Sex (Ref=male)	1.17 (1.10–1.25)	<0.0001	1.16 (1.09–1.24)	<0.0001
Race				
White	Ref	<0.001	Ref	<0.01
Black	0.78 (0.69–0.87)		0.80 (0.72–0.90)	
Other/Unknown	0.98 (0.86–1.10)		0.93 (0.82–1.05)	
Marital status (Ref=not married)	1.09 (1.02–1.17)	<0.01	1.17 (1.10–1.25)	<0.0001
Income quartile				
1 st quartile (lowest)	Ref	NS	Ref	<0.0001
2 nd quartile	1.00 (0.92–1.10)		1.01 (0.92–1.10)	
3 rd quartile	1.02 (0.93–1.12)		1.10 (1.01–1.21)	
4 th quartile (highest)	1.03 (0.93–1.14)		1.28 (1.16–1.41)	
Unknown	1.52 (1.02–2.26)		1.23 (0.85–1.79)	
Geographic region				
Northeast	Ref	<0.0001	Ref	<0.0001
Midwest	1.28 (1.15–1.43)		0.76 (0.68–0.85)	
West	1.12 (1.03–1.21)		0.69 (0.64–0.75)	
South	1.33 (1.22–1.46)		0.73 (0.66–0.80)	
Residence (Ref=urban)	1.06 (0.97–1.16)	NS	1.00 (0.92–1.09)	NS
Comorbidity score				
0	Ref	<0.0001	Ref	NS
1	1.14 (1.07–1.23)		1.01 (0.94–1.09)	
2+	1.39 (1.28–1.51)		0.97 (0.89–1.05)	
Tumor stage				

Characteristic	Chest Imaging		Abdominal Imaging	
	Odds Ratio (95% CI)	P-value	Odds Ratio (95% CI)	P-value
T1	Ref	<0.0001	Ref	<0.0001
T2	0.93 (0.78–1.12)		0.97 (0.82–1.16)	
T3	1.24 (1.12–1.37)		1.29 (1.17–1.43)	
Tumor size (cm)				
4	Ref	<0.0001	Ref	NS
>4–7	1.12 (1.04–1.20)		1.01 (0.94–1.08)	
>7	1.36 (1.16–1.60)		1.15 (0.99–1.34)	
Tumor grade				
Low	Ref	<0.01	Ref	NS
High	1.12 (1.04–1.21)		1.08 (1.01–1.17)	
Unknown	1.11 (1.02–1.20)		1.04 (0.96–1.12)	
Surgical approach (Ref=radical)	0.78 (0.72–0.84)	<0.0001	1.93 (1.78–2.09)	<0.0001