Original Article

Trends in Imaging After Diagnosis of Thyroid Cancer

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BACKGROUND: The largest growth noted among differentiated thyroid cancer (DTC) diagnosis is in low-risk cancers. Trends in imaging after the diagnosis of DTC are understudied. Hypothesizing a reduction in imaging use due to rising low-risk disease, the authors evaluated postdiagnosis imaging patterns over time and patient characteristics that are associated with the likelihood of imaging. **METHODS:** Using the Surveillance, Epidemiology, and End Results-Medicare database, the authors identified patients diagnosed with localized, regional, or distant DTC between 1991 and 2009. Medicare claims were reviewed for use of neck ultrasound, iodine-131 (I-131) scan, or positron emission tomography (PET) scan within 3 years after diagnosis. Trends in imaging use were evaluated using regression analyses. Multivariable logistic regression was used to estimate the likelihood of imaging based on patient characteristics. **RESULTS:** A total of 23,669 patients were included. Compared with patients diagnosed between 1991 and 2000, those diagnosed between 2001 and 2009 were more likely to have localized disease ($P<.001$) and tumors measuring <1 cm ($P<.001$). Use of neck ultrasound and I-131 scans increased in patients with localized disease ($P \leq .001$ and $P = .003$, respectively), regional disease ($P<.001$ and $P<.001$, respectively), and distant metastasis ($P = .001$ and $P = .015$, respectively). Patients diagnosed after 2000 were more likely to undergo neck ultrasound (odds ratio, 2.15; 95% confidence interval, 2.02-2.28) and I-131 scan (odds ratio, 1.44; 95% confidence interval, 1.35-1.54). Compared with 1996 through 2004, PET scan use from 2005 to 2009 increased 32.4-fold ($P \leq .001$) in patients with localized disease, 13.1-fold ($P<.001$) in patients with regional disease, and 33.4-fold ($P<.001$) in patients with distant DTC. **CONCLUSIONS:** Despite an increase in the diagnosis of low-risk disease, the use of postdiagnosis imaging increased among patients with all stages of disease. The largest growth observed was in the use of PET after 2004. ***Cancer* 2015;121:1387-94.** © *2015 American Cancer Society.*

KEYWORDS: differentiated thyroid cancer, surveillance imaging, neck ultrasound, radioiodine scan, positron emission tomography (PET) scan.

INTRODUCTION

Across a variety of payer systems, the use of advanced imaging techniques has exploded in recent years.[1,2] This contributes to both radiation exposure and increased health care costs.[3] One growing area of imaging use is posttreatment surveillance for malignancy. In the majority of cancers, increased imaging has not translated into improved survival.[4,5] In addition, studies have demonstrated poor adherence to clinical guidelines and a tendency to obtain nonindicated surveillance imaging.[6,7]

Thyroid cancer is one of the fastest-growing malignancies in the United States, with the majority of cases comprising differentiated thyroid cancer (DTC).[8,9] Small, low-risk tumors account for the majority of the increase in diagnosis, and mortality has remained relatively stable.[8] Six to 12 months after treatment of DTC, a neck ultrasound and thyroglobulin level are obtained to evaluate the presence of persistent disease. If thyroglobulin is elevated but there is no abnormality noted on neck ultrasound, a diagnostic radioiodine (iodine-131 [I-131]) scan is the preferred test; positron emission tomography (PET) can be used if the I-131 scan is negative and non–iodine-avid disease is suspected.[10-12] Although imaging has increased in the surveillance of other malignancies, to the best of our knowledge imaging trends after a diagnosis of thyroid cancer are understudied.

There remains uncertainty regarding the usefulness of imaging in thyroid cancer surveillance, especially among patients with low-risk disease.[13,14] Given the rapid growth in the incidence of DTC, it is important to understand posttreatment imaging trends, the associated costs, and potential radiation exposure. We hypothesized that, in contrast to other malignancies, the use of posttreatment imaging in patients with DTC would decrease over time, as a consequence of the rise in low-risk disease. In the current study, we examined the trends in imaging use after the diagnosis of DTC and determined the patient characteristics that increased the likelihood of undergoing an imaging study.

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MATERIALS AND METHODS

Data Source and Study Population

The Surveillance, Epidemiology, and End Results (SEER) database, a project of the National Cancer Institute since 1971, collects cancer incidence, survival, and demographic data for every cancer reported in 20 geographic areas throughout the United States. It is the largest population-based cancer database available in the United States and covers approximately 28% of the population.[15] Beginning in 1991, data from SEER was linked with Medicare reimbursement claims to create a data set that included information regarding services performed before and after a cancer diagnosis.

Data from 25,649 patients with thyroid cancer diagnosed from January 1, 1991 to December 31, 2009 were extracted from the SEER-Medicare database. Only those with DTC, including tumor histology of papillary, follicular, or Hurthle cell, were retained for the final analysis. In total, 23,669 patients were included in the final analysis.

Institutional Review Board approval was not required because this study used publically available data and could not be tracked to human subjects.

Measures

Patient age was stratified into 3 Medicare-appropriate groups: aged <65 years, 65-74 years, and ≥75 years. Patient race/ethnicity was categorized by the SEER database as white, black, Hispanic, Asian, North American Native, or other. Ethnicities of Hispanic, Asian, North American Native, and other were grouped together as "other." As measures of socioeconomic status, the median household income in the geographic region (<$35,000, $35,000-$59,999, and ≥$60,000) and the percentage of the population aged ≥25 years with only a high school diploma (<20%, 20-29.9%, and ≥30%) were collected. Geographic region was based on Census 2000 tracts, when available; otherwise, zip codes were used to prevent missing data. Tumor size was categorized as <1 cm, 1 cm to 1.9 cm, 2.0 cm to 3.9 cm, and ≥4.0 cm, according to definitions used by the American Joint Committee on Cancer.[16] Tumor histology was limited to *International Classification of Disease for Oncology* classification codes for papillary, follicular, and Hurthle cell histology.[17] Patients were stratified by their SEER stage at diagnosis as having localized disease (confined to the thyroid), regional disease (spread to regional lymph nodes), and distant disease (metastatic disease).[18] The incidence of missing data was 0.2% for race, education, and income data and 11% for tumor size. There were no missing data for age, sex, stage of disease, or histology.

Using Current Procedural Terminology (CPT) codes, we identified the percentage of patients who underwent a neck ultrasound, I-131 scan, or PET scan. The CPT code used to identify neck ultrasound was 76536. The CPT codes used to identify I-131 scans were 78015, 78016, 78017, 78018, 78020, 78800, 78801, 78802, and 78804. The CPT codes used to identify PET scans were 78810, 78811, 78812, 78813, 78814, 78815, and 78816.

To avoid overrepresenting patients who were diagnosed at an earlier time and therefore had longer follow-up, only imaging studies performed during the first 3 years after diagnosis were included. In addition, because we did not have claims data for patients diagnosed before 1991, we started our analysis with the year 1993, the first year in which there were data for patients diagnosed that year and the 2 prior years. Approximately 60% of neck ultrasounds, 74% of I-131 scans, and 46% of PET scans were performed within the 3 years after diagnosis.

Statistical Analysis

To identify changes in patient characteristics over time, demographics were analyzed in 2 cohorts: patients diagnosed from 1991 through 2000 and those diagnosed between 2001 and 2009. Tumor size and patient age were categorized using a priori established cutoffs, and all characteristics were compared across the 2 cohorts using the chi-square test.

For each year from 1993 through 2009, we calculated the percentage of patients who underwent a neck ultrasound, I-131 scan, or PET scan. To evaluate the trends in the use of neck ultrasound and I-131 scans over time, we regressed percentages of use on the year of the medical claim. Due to a large increase in use in 2005 for PET scans, we calculated the fold-increase in percent use, comparing mean use in 1996 through 2004 with that in 2005 through 2009. A permutation test was used to calculate a *P* value for the fold-increase.

To identify which patient characteristics influence the likelihood of undergoing an imaging test, we performed a multivariable logistic regression for each of the 3 imaging tests. For neck ultrasound and I-131 scans, we included all years from 1991 through 2009, but for PET scans we included only the years 2005 through 2009 due to few PET scans being performed before 2005. Covariates in the model included patient age, sex, race, geographic educational attainment, geographic median family income, SEER stage, and tumor histology. Year of diagnosis (1991-2000 or 2001-2009) was included for

TABLE 1. Differentiated Thyroid Cancer Patient and Tumor Characteristics by Decade of Diagnosis

Characteristic		Year of Diagnosis				
		1991-2000 N=7138		2001-2009 N=16,531		
		No.	(%)	No.	(%)	*P*
Age, y	<65	3915	(54.8)	6418	(38.8)	<.0001
	65-74	2000	(28.0)	6419	(38.8)	
	≥75	1223	(17.1)	3694	(22.3)	
Sex	Male	2155	(30.2)	5045	(30.5)	.6148
	Female	4983	(69.8)	11,486	(69.5)	
Race	White	5583	(78.4)	13,232	(80.3)	<.0001
	Black	475	(6.7)	1341	(8.1)	
	Other	1067	(15.0)	1914	(11.6)	
High school education only, %[a]	<20%	2306	(33.6)	4507	(27.3)	<.0001
	20-29.9%	2329	(33.9)	5572	(33.7)	
	≥30%	2227	(32.5)	6438	(39.0)	
Median household income[b]	<$35,000	1363	(19.9)	4086	(24.7)	<.0001
	$35,000-$59,999	3392	(49.4)	7655	(46.4)	
	≥$60,000	2105	(30.7)	4774	(28.9)	
Stage of disease	Localized	4063	(56.9)	10,486	(63.4)	<.0001
	Regional	2614	(36.6)	5137	(31.1)	
	Distant	461	(6.5)	908	(5.5)	
Histology	Papillary	5920	(82.9)	14,196	(85.9)	<.0001
	Hurthle cell	405	(5.7)	893	(5.4)	
	Follicular	813	(11.4)	1442	(8.7)	
Tumor size, cm	<1	1769	(29.2)	5217	(34.7)	<.0001
	1-1.9	1337	(22.1)	3660	(24.3)	
	2-3.9	1890	(31.2)	3764	(25.0)	
	≥4	1059	(17.5)	2390	(15.9)	

[a] Percentage of individuals aged ≥25 years in the geographic area with only a high school education.
[b] Median household income by geographic region.

neck ultrasound and I-131 scans, but not for PET scans. Tumor size was not included as a covariate due to its relatively high degree of missing values. We evaluated the goodness-of-fit for our models with the Hosmer-Lemeshow test at the .05 significance level; all 3 models fit the data well.

All statistical analyses were performed using SAS statistical software (version 9.3; SAS Institute Inc, Cary, NC) and R statistical software (version 3.1.1; R Foundation, Vienna, Austria).

RESULTS

The demographics of the study population are shown in Table 1. Compared with those diagnosed from 1991 through 2000, patients diagnosed with DTC after 2000 were more likely to be older ($P<.0001$) and to have localized disease ($P<.0001$) and a smaller tumor size ($P<.0001$). In addition, those diagnosed after 2000 tended to come from areas with a lower median household income ($P<.0001$) and lower educational achievement ($P<.0001$).

The use of imaging in the surveillance of DTC increased overall during the study period, as summarized in Figures 1 to 3. In linear regression analysis between 1993 and 2009, there was a significant increase in the use of ultrasound for those with localized ($P<.001$), regional ($P<.001$), and metastatic ($P = .001$) disease. The increase in I-131 scans was smaller than that for neck ultrasound, but also increased by linear regression analysis among patients with localized ($P = .003$), regional ($P<.001$), and metastatic ($P = .013$) disease.

There was a significant increase in the number of claims for PET scans after the year 2004. Compared with the period between 1996 and 2004, claims for PET scans increased 32.4-fold ($P<.001$) in those with localized DTC between 2005 and 2009. Those with regional disease had a 13.1-fold growth in the number of PET scans performed ($P<.001$). Finally, PET scan claims for patients with distant disease increased 33.4-fold ($P<.001$).

In multivariable analysis, as shown in Table 2, patients who were aged ≥65 years were more likely to undergo imaging studies than those aged <65 years. Patients aged 65 to 74 years were more likely to undergo neck ultrasound (odds ratio [OR], 2.50; 95% confidence interval [95% CI], 2.35-2.65), I-131 scan (OR, 2.81;

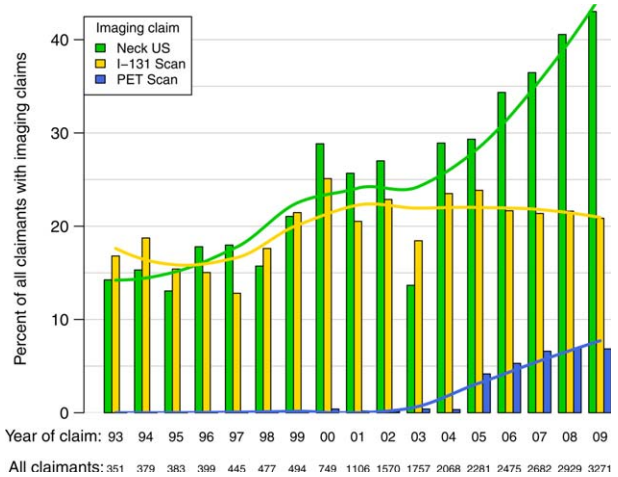

Figure 1. Imaging claims in patients with localized differentiated thyroid cancer are shown by year. US indicates ultrasound; I-131, iodine-131; PET, positron emission tomography.

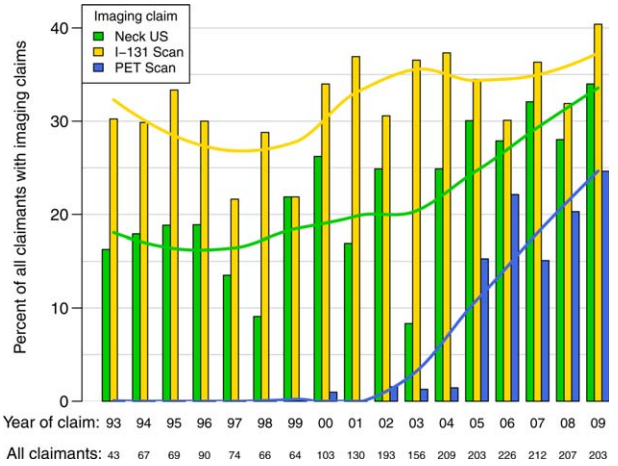

Figure 3. Imaging claims in patients with distant differentiated thyroid cancer are shown by year. US indicates ultrasound; I-131, iodine-131; PET, positron emission tomography.

95% CI, 2.64-3.00), and PET scan (OR, 1.54; 95% CI, 1.34-1.77). A similar effect was observed for those aged ≥75 years, with a higher likelihood of undergoing neck ultrasound (OR, 2.10; 95% CI, 19.6-2.26), I-131 scan (OR, 1.80; 95% CI, 1.67-1.95), and PET scan (OR, 1.80; 95% CI, 1.54-2.09). Women were more likely than men to undergo neck ultrasound (OR, 1.35; 95% CI, 1.27-1.43), but were less likely to have a PET scan (OR, 0.73; 95% CI, 0.65-0.82). Compared with white individuals, blacks were less likely to undergo a neck ultrasound (OR, 0.81; 95% CI, 0.73-0.90), I-131 scan (OR, 0.88; 95% CI, 0.79-0.99), or PET scan (OR, 0.63; 95% CI, 0.49-0.80). Other nonwhite individuals were also found to be less likely to undergo neck ultrasound (OR, 0.86; 95% CI, 0.79-0.93) and I-131 scan (OR, 0.88; 09% CI, 0.81-0.96).

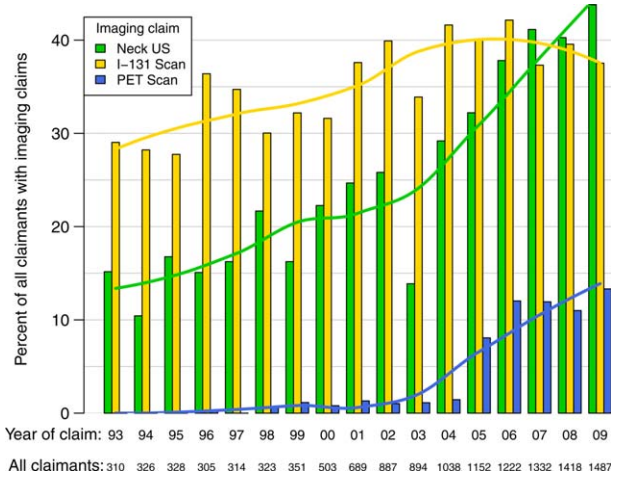

Figure 2. Imaging claims in patients with regional differentiated thyroid cancer are shown by year. US indicates ultrasound; I-131, iodine-131; PET, positron emission tomography.

SEER stage was found to be significantly associated with the likelihood of having an imaging claim. Patients with regional disease were more likely to have a claim for neck ultrasound compared with those with localized disease (OR, 1.20; 95% CI, 1.13-1.27), whereas those with distant disease were less likely (OR, 0.74; 95% CI, 0.66-0.83). Patients with both regional DTC (OR, 2.65; 95% CI, 2.50-2.82) and distant disease (OR, 2.12; 95% CI, 1.88-2.39) were more likely to undergo an I-131 scan. Again, patients with regional disease (OR, 2.05; 95% CI, 1.82-2.30) and distant DTC (OR, 3.72; 95% CI, 3.03-4.56) were also more likely to undergo a PET scan. Histology was not found to be a clinically significant factor with regard to the use of imaging, except for an increased tendency to obtain PET scans (OR, 1.54; 95% CI, 1.24-1.91) among patients with Hurthle cell carcinomas. Controlling for other patient characteristics, patients diagnosed from 2001 through 2009 were more likely to undergo a neck ultrasound than those diagnosed from 1991 through 2000 (OR, 2.15; 95% CI, 2.02-2.28). Patients diagnosed after 2000 were also more likely to undergo an I-131 scan (OR, 1.44; 95% CI, 1.35-1.54).

DISCUSSION

We hypothesized that imaging use after a diagnosis of thyroid cancer would decrease over time due to the rise in low-risk disease. Using the SEER-Medicare database, we unexpectedly found that there was a significant increase in the use of surveillance imaging studies over the past 20

TABLE 2. Association Between Patient and Tumor Characteristics and Likelihood of an Imaging Claim

Characteristic		Neck Ultrasound			I-131 Scan			PET Scan[a]		
		OR (95% CI)		*P*	OR (95% CI)		*P*	OR (95% CI)		*P*
Age, y	<65	1	[reference]		1	[reference]		1	[reference]	
	65-74	2.50	(2.35-2.65)	<.0001	2.81	(2.64-3.00)	<.0001	1.54	(1.34-1.77)	<.0001
	≥75	2.10	(1.96-2.26)	<.0001	1.80	(1.67-1.95)	<.0001	1.80	(1.54-2.09)	<.0001
Sex	Male	1	[reference]		1	[reference]		1	[reference]	
	Female	1.35	(1.27-1.43)	<.0001	1.10	(1.03-1.17)	.0028	0.73	(0.65-0.82)	<.0001
Race	White	1	[reference]		1	[reference]		1	[reference]	
	Black	0.81	(0.73-0.90)	<.0001	0.88	(0.79-0.99)	.0268	0.63	(0.49-0.80)	.0002
	Other	0.86	(0.79-0.93)	.0002	0.88	(0.81-0.96)	.0049	0.89	(0.74-1.06)	.1904
High school education only, %[b]	<20%	1	[reference]		1	[reference]		1	[reference]	
	20-29.9%	1.02	(0.95-1.10)	.5241	0.99	(0.92-1.06)	.7290	1.02	(0.88-1.18)	0.8027
	≥30%	1.11	(1.03-1.20)	.0062	1.13	(1.05-1.23)	.0019	0.97	(0.83-1.13)	0.6838
Median household income[c]	<$35,000	1	[reference]		1	[reference]		1	[reference]	
	$35,000-$59,999	0.90	(0.84-0.97)	.0041	1.03	(0.95-1.10)	.4829	0.84	(0.73-0.97)	.0161
	≥$60,000	1.16	(1.07-1.26)	.0005	1.09	(1.00-1.19)	.0419	1.02	(0.86-1.20)	.8537
Stage of disease	Localized	1	[reference]		1	[reference]		1	[reference]	
	Regional	1.20	(1.13-1.27)	<.0001	2.65	(2.50-2.82)	<.0001	2.05	(1.82-2.30)	<.0001
	Distant	0.74	(0.66-0.83)	<.0001	2.12	(1.88-2.39)	<.0001	3.72	(3.03-4.56)	<.0001
Histology	Papillary	1	[reference]		1	[reference]		1	[reference]	
	Follicular	0.89	(0.81-0.97)	.0121	1.14	(1.04-1.25)	.0070	0.84	(0.69-1.03)	.0879
	Hurthle cell	0.91	(0.81-1.03)	.1308	1.21	(1.07-1.36)	.0021	1.54	(1.24-1.91)	<.0001
Decade of diagnosis	1991-2000	1	[reference]		1	[reference]				
	2001-2009	2.15	(2.02-2.28)	<.0001	1.44	(1.35-1.54)	<.0001			

Abbreviations: 95% CI, 95% confidence interval; I-131, iodine-131; OR, odds ratio; PET, positron emission tomography.
[a] Includes patients diagnosed between 2005 and 2009.
[b] Percentage of individuals aged ≥25 years in geographic area with only a high school education.
[c] Median household income by geographic region.

years across all stages of disease. This is true for neck ultrasound, I-131 scans, and PET scans. The most dramatic increase was noted in the use of PET after 2004. SEER stage at diagnosis appears to have the largest impact on the likelihood of undergoing an imaging test. However, we still observed an increased use of imaging after controlling for other patient characteristics, including stage of disease at diagnosis.

It has become apparent that there is more reliance on advanced imaging studies in the practice of medicine. Initially, this was believed to be confined to the fee-for-service model.[2] However, an integrated health system resulted in an approximate doubling of computed tomography (CT) scans and near-tripling of magnetic resonance imaging (MRI) from 1997 through 2006.[1] Consistent with the findings of the current study, nuclear medicine studies have experienced slower growth, except for PET and PET/CT scans. A striking increase was observed in the number of PET scans performed after the year 2004 in a non-Medicare population.[1] The greatest growth in imaging use has been noted among older enrollees, but was observed in all age groups.[1]

Imaging studies in patients with malignancy are very commonly performed and are increasing. Greater than 95% of patients with advanced malignancy will undergo a high-cost diagnostic imaging procedure.[19] Studies have demonstrated a rise in imaging being performed in patients after treatment of a malignancy. A large increase in the use of MRI scans was noted among patients treated for hepatocellular carcinoma from 1998 to 2005.[5] In patients with pancreatic cancer, the number of CT, MRI, and PET scans performed in the 5 years after surgical resection more than doubled from 1991 to 2005.[20] Similar increases occurred in patients after resection of colorectal liver metastasis.[4] PET scanning is being rapidly adapted in the evaluation of malignancies; 65.3% of patients with non-small cell lung cancer underwent a PET scan from 2005 through 2007, compared with 6.3% of patients between 1998 and 2000.[21]

To the best of our knowledge, no study to date has demonstrated a clear mortality benefit for surveillance imaging. CT after surgical resection of pancreatic cancer did not appear to improve survival in patients receiving annual surveillance.[20] Similar results were noted among patients with hepatocellular carcinoma and colorectal cancer with liver metastasis.[4,5] PET was not found to be a useful tool for the detection of melanoma recurrence in patients at low risk, and did not confer any additional mortality benefit beyond yearly CT scan in patients at high risk.[22]

There is often poor adherence to recommendations for surveillance imaging. Studies in patients with early-stage breast cancer found a high incidence of nonrecommended imaging tests (such as MRI) for surveillance; however, physicians often fail to obtain recommended mammograms.[7] There has been a sharp increase in the number of nonrecommended CT and PET scans performed among patients with colorectal cancer from 2001 through 2006.[6] In men with low-risk prostate cancer, 34% reportedly underwent nonrecommended bone scans or CT scans.[23] It is interesting to note that only 60% of men with high-risk prostate cancer, for whom they are recommended, had these tests.

There is a variety of imaging modalities used for posttreatment surveillance among patients with DTC. Neck ultrasound is useful to detect recurrent disease, but does not detect distant metastasis.[24] I-131 scans can identify distant disease, but have been shown to have limited value in the setting of low thyroglobulin levels, even in high-risk patients.[13] In addition, the sensitivity of diagnostic I-131 scans in patients with mildly elevated stimulated thyroglobulin is low.[25] PET has demonstrated the ability to detect small-volume non–iodine-avid disease. A significant percentage of patients with a detectable thyroglobulin level <10 ng/mL are found to have evidence of disease on PET scan.[26]

However, the significance of the thyroid cancer detected by PET scan is debated. To our knowledge, there is a lack of evidence regarding the effect of PET scans on progression-free survival among patients with DTC.[27,28] Others have questioned whether PET provides additional information beyond neck ultrasound and CT scan.[14] Although PET-positive disease has been shown to be a poor prognostic indicator, this effect is strongest in patients with metastatic, large-volume disease.[29,30] Patients with small-volume, regional, PET-positive disease continue to have an excellent prognosis.

We found a large increase in the use of PET after the year 2004. In October 2003, Medicare approved the use of PET scans for patients treated with thyroidectomy and radioactive iodine ablation with a thyroglobulin level >10 ng/mL and a negative I-131 scan. In January 2005, Medicare expanded its coverage of PET scans under the Coverage with Evidence Development program to include indications for "diagnosis, other staging, restaging and monitoring response to treatment."[31] Part of the increase in the use of PET may be related to this expanded Medicare coverage. However, the same increase in PET scan use has been demonstrated in patients without thyroid cancer or Medicare coverage, suggesting there may be additional factors, such as improved accessibility.[2,21]

One inherent limitation of the current study is the lack of patient-level data available in large databases. There is limited information regarding cancer recurrence, iodine avidity, and patient preference, all of which influence imaging decisions. Another limitation is the restriction in the current study to 3 imaging modalities: ultrasound, I-131 scan, and PET. Billing information is not a reliable source of the indication for imaging tests. Many CT and MRI scans are also being performed in patients with DTC. However, we were concerned that these scans are more likely to be performed for indications other than thyroid cancer. Therefore, we focused on 3 imaging modalities that we believed would be most specific to DTC surveillance. A third perceived limitation would be the absence of American Joint Committee on Cancer TNM staging. We used SEER stage in the current study because TNM stage is not available for patients diagnosed before 2004. Including patients diagnosed before 2004 was essential because of our emphasis on trends in imaging use over time.

Using SEER-Medicare, the current study cohort included patients diagnosed after 1991 who were Medicare enrollees, resulting in smaller numbers compared with the SEER database alone. The cohort in the current study was primarily aged ≥ 65 years. Patients aged <65 years who are covered by Medicare are likely to have significant other comorbidities and are not generalizable to a younger DTC population. In addition, because the data are linked to Medicare billing records, there may be underreporting of imaging tests performed. For example, if physicians perform bedside ultrasound or patients have secondary insurance covering the imaging test, there would be no documentation in the Medicare database. However, with regard to capturing I-131 scans, the percentage of patients in the current study with claims for an I-131 scan was similar to prior reported rates of radioactive iodine ablation after thyroidectomy.[32-34]

Despite these limitations, there is strong evidence that SEER-Medicare is a valid tool for the evaluation of posttreatment surveillance imaging. Prior studies have confirmed the usefulness of the SEER-Medicare data to identify clinical events, such as a cancer treatment or surveillance after cancer treatment.[35,36] In fact, many studies of posttreatment surveillance in patients with other malignancies have been performed using the SEER-Medicare database.[4,5,20,21,37] The population in the SEER-Medicare data set has also been found to be generalizable to the elderly American population.[38] Although the

current study cohort was primarily aged ≥65 years, this is an important patient population to study because the fastest increase in thyroid cancer incidence has been observed in this age group.[39] In addition, the largest growth in general imaging use has occurred in older patients, although it has been demonstrated in younger patients as well.[1] This also is most likely true for thyroid-specific imaging. Therefore, we believe a similar increase in imaging would be observed in a younger thyroid cancer population.

DTC is one of the fastest growing malignancies in the United States, resulting in a variety of providers delivering posttreatment surveillance, including endocrinologists, oncologists, surgeons, nuclear medicine specialists, and primary care physicians.[9] Although there are specific guidelines and recommendations for posttreatment surveillance imaging, there is evidence that compliance with published guidelines is often low.[6,7] Work performed to evaluate surveillance imaging among patients with other malignancies has suggested small mortality benefits, if any.[4,5,20,22] We demonstrated the increased use of imaging over time despite the diagnosis of smaller, more limited, low-risk thyroid cancer. Although many of the themes presented in the current study are true for other malignancies, the overuse of imaging is highlighted by the increased use in patients with this relatively indolent malignancy. Greater imaging use clearly contributes to increased costs. Specific to thyroid cancer, increased imaging may identify low-volume recurrent disease that is unlikely to be clinically significant, leading to heightened patient anxiety and potentially unnecessary interventions. Growing health care costs underscore the importance of identifying those patients most likely to benefit from additional testing and determining when it can be avoided.

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CONFLICT OF INTEREST DISCLOSURES

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