Thoroughness of Mediastinal Staging in Stage IIIA Non-small Cell Lung Cancer

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Introduction: Guidelines recommend that patients with clinical stage IIIA non-small cell lung cancer (NSCLC) undergo histologic confirmation of pathologic lymph nodes. Studies have suggested that invasive mediastinal staging is underutilized, although practice patterns have not been rigorously evaluated.

Methods: We used the Surveillance, Epidemiology, and End Results-Medicare database to identify patients with stage IIIA NSCLC diagnosed from 1998 through 2005. Invasive staging and use of positron emission tomography (PET) scanning were assessed using Medicare claims. Multivariable logistic regression was used to identify patient characteristics associated with use of invasive staging.

Results: Of 7583 stage IIIA NSCLC patients, 1678 (22%) underwent invasive staging. Patients who received curative intent cancer treatment were more likely to undergo invasive staging than patients who did not receive cancer-specific therapy (30% versus 9.8%, adjusted odds ratio, 3.31; 95% confidence interval, 2.78–3.95). The oldest patients (age, 85–94 years) were less likely to receive invasive staging than the youngest (age, 67–69 years; 27.6% versus 11.9%; odds ratio, 0.46; 95% confidence interval, 0.34–0.61). Sex, marital status, income, and race were not associated with the use of the invasive staging. The use of invasive staging was stable throughout the study period, despite an increase in the use of PET scanning from less than 10% of patients before 2000 to almost 70% in 2005.

Conclusion: Nearly 80% of Medicare beneficiaries with stage IIIA NSCLC do not receive guideline adherent mediastinal staging; this failure cannot be entirely explained by patient factors or a reliance on PET imaging. Incentives to encourage use of invasive staging may improve care.

Key Words: Non-small cell lung cancer, Mediastinal staging, Mediastinoscopy.

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Accurate staging of lung cancer is essential to the determination of appropriate treatment. Stage IIIA non-small cell lung cancer (NSCLC) is most commonly defined by cancer spread to ipsilateral mediastinal (N2) lymph nodes. Prior studies have indicated that CT and PET scanning lack sufficient sensitivity or specificity to serve as the sole staging modality.[1–10] A 1997 statement from the American Thoracic Society/European Respiratory Society statement noted that invasive staging of enlarged lymph nodes is mandatory.[11] The American Thoracic Society, European Respiratory Society, and American College of Chest Physicians have for many years endorsed invasive sampling of mediastinal lymph nodes suspected of containing malignant cells.[1,11–13] Therefore, patients should not be given the diagnosis of clinical stage IIIA NSCLC based on PET scan findings without tissue confirmation.

Prior work has suggested that use of mediastinal staging is far lower than recommended by guidelines.[14–16] One analysis of trends in staging of Medicare patients diagnosed with NSCLC between 1998 and 2002 found that 65% of stage IIIA patients were staged with CT scan only; 30% with CT in addition to either PET or invasive biopsy; and 5% with CT, PET, and invasive biopsy.[17] This analysis also found a positive association between use of additional staging modalities and survival.

We examined the actual practice for mediastinal staging of Medicare patients with stage IIIA NSCLC to explore the reasons for its underutilization. The advantages of studying the Medicare population include ethnic, socioeconomic, and geographic diversity and a stable single payer insurance coverage for the entire period of study. We identified which staging modalities were most frequently used during the years 1998 to 2005 and examined patient factors associated with the use of invasive staging.

METHODS

Data Source and Study Sample

This study was deemed exempt by the Yale Human Investigations Committee. Data were obtained from the Surveillance, Epidemiology, and End Results (SEER)-Medicare linked database, which contains tumor registry data linked to Medicare claims for patients representing 26% of the US population.[18,19] Before 2000, only 11 of the current 16 registries participated in the SEER program; this subset of registries, which represented 14% of the population, is referred to in this study as the preexpansion registries.

We selected subjects aged 67 to 94 years who were diagnosed with stage IIIA NSCLC between 1998 and 2005. Patients were identified as IIIA using the American Joint Committee on Cancer stage variable before 2004 or collaborative stage variable after 2004 provided by SEER. The collaborative stage variable uses all data available from both clinical staging techniques and surgical resection if performed. Exclusion criteria included the following: unknown month of diagnosis, diagnosis reported on death certificate or autopsy, prior lung cancer diagnosis, or any other cancer diagnosis in the 6 months before and after the stage IIIA NSCLC diagnosis. To ensure that we had complete data for the sample, patients had to have been continuously enrolled in fee-for-service Medicare Parts A and B beginning 24 months before diagnosis through the earliest of the following events: initiation of treatment, death, or 6 months after diagnosis.

We also analyzed a subgroup of stage IIIA patients treated with both chemotherapy and radiation but not surgery within 6 months of diagnosis. This analysis allowed us to confirm our findings in a group of patients healthy enough for aggressive treatment and without the impact of unsuspected N2 disease found incidentally at the time of surgical resection.

Treatment Groups

Treatment was assessed using Medicare claims in the 6 months after diagnosis (Appendix Table A1). We divided patients into three groups: patients who did not receive chemotherapy, surgery, or radiation were classified as best supportive care; patients who received chemotherapy or radiation alone were classified as cancer-specific therapy; and patients who received combination chemotherapy and radiation therapy or any therapy that involved surgical resection were classified as curative intent therapy.

Outcome

The primary outcome was receipt of invasive mediastinal staging. We used the inpatient, outpatient, and physician Medicare claims to search for current procedural terminology (CPT) codes for PET scan, mediastinoscopy, mediastinotomy, transbronchial needle aspiration (TBNA), endoscopic ultrasound (EUS), or video-assisted thoracoscopic surgery biopsies (Appendix Table A1). For the majority of the study period, endobronchial ultrasound (EBUS)-TBNA and conventional TBNA were billed using the same CPT code, hence we could not separate these two procedures. For analytic purposes, we combined mediastinoscopy and mediastinotomy into one group. We searched for mediastinal staging procedures performed 6 months before diagnosis through the initiation of treatment or for 6 months after diagnosis in the case of patients who were not treated with any cancer-specific therapy.

As a secondary outcome, we calculated the 3-year survival of the subset of stage IIIA NSCLC patients who were diagnosed in 1998 to 2004 and received both chemotherapy and radiation within 6 months of diagnosis but did not undergo surgery.

Covariates

The following variables were selected a priori as factors that might influence whether a patient received invasive staging: age, sex, race, comorbidities, marital status, income, health care system access, treatment group as defined above, SEER registry, and year of diagnosis. Age was categorized as 67–69, 70–74, 75–79, 80–84, and 85 years and older; race as white, black, or other; and marital status as married, unmarried, or unknown. Income was defined as the median household income at the zip code level categorized into quintiles. We created a dichotomous variable indicating whether a claim had been submitted for influenza vaccination in the 18 months before the diagnosis, which has been used previously as marker for health care system access.[20]

Comorbidity was assessed by searching all Medicare claims in the 2 years before diagnosis. We used the comorbid conditions recommended by Elixhauser et al.[21] which were previously determined to be significantly associated with survival (Appendix Table A2). Only codes that appeared on at least one inpatient claim or two or more outpatient/physician claims occurring more than 30 days apart were used. We created a sum score of the number of comorbidities each patient had and then stratified patients into three groups: 0, 1 to 2, or ≥ 3 comorbidities.

Statistical Analysis

We determined the percent of patients receiving each type of invasive staging procedure for each year during the study period (1998–2005). Bivariate and multivariate logistic regression was used to identify patient factors associated with receipt of invasive staging. For the secondary analysis, we conducted a logistic regression analysis using 3-year survival as the outcome. SAS statistical software, version 9.2 (SAS Institute Inc., Cary, NC), was used for all analysis.

RESULTS

Our sample consisted of 7583 patients (Table 1). Of the 7583 patients, 1678 (22%) underwent at least one invasive staging procedure. Of these, 88% received a single invasive staging procedure such as mediastinoscopy alone, while 12% received two or more invasive staging procedure such as TBNA followed by mediastinoscopy.

As shown in Figure 1, mediastinoscopy (or mediastinotomy) was the most commonly used invasive procedure (76% of invasively staged patients) followed by TBNA with or without ultrasound guidance (26% of invasively staged patients). Video-assisted thoracoscopic surgery and EUS were rarely used.

The use of invasive staging did not change significantly during the study period. Nevertheless, the use of PET scanning increased from 2.4% in 1998 to 68.4% in 2005 (Figure 2).

In the unadjusted analysis, older age, black race, higher comorbidity, or being unmarried significantly decreased the likelihood of receiving invasive staging (Table 2). Patients who received aggressive cancer treatment were significantly more likely to have received invasive staging. Nevertheless, even among these patients, only a minority (30%) underwent invasive staging. Furthermore, even in the "high likelihood" subgroups (no comorbidities, white, and married) less than 30% underwent invasive staging.

After adjusting for all significant variables, only age, comorbidity, receipt of influenza vaccination, and treatment type remained independently associated with use of invasive staging. Patients with ≥ 3 comorbidities were less likely to have received invasive staging compared with patients with-

TABLE 1. Baseline Characteristics of Cohort and Use of Invasive Staging Techniques in Stage IIIA NSCLC, N = 7583

	n (%)
Age (yr)	
67–69	1118 (15)
70–74	2305 (30)
75–79	2197 (29)
80–84	1331 (18)
85–94	632 (8)
Sex	
Male	4308 (57)
Female	3275 (43)
Race	
White	6653 (88)
Black	635 (8)
Other	295 (4)
Marital status	
Married	3972 (52)
Unmarried	3349 (44)
Unknown	262 (4)
Income	
First quintile	1449 (19)
Second quintile	1451 (19)
Third quintile	1446 (19)
Fourth quintile	1450 (19)
Fifth quintile	1447 (19)
Unknown	340 (4)
Influenza vaccination in previous 18 mo	
No	4013 (53)
Yes	3570 (47)
Treatment group[a]	
Best supportive care	1834 (24)
Cancer-specific therapy	2051 (27)
Curative intent therapy	3698 (49)
Receipt of invasive staging	
No	1678 (22)
Yes	5905 (78)

[a] Patients classified as best supportive care did not receive any cancer-specific therapy (chemotherapy, radiation, or surgery). Patients who received chemotherapy or radiation alone were classified as cancer-specific therapy. Patients who received combination chemotherapy and radiation therapy or any therapy that involved surgical resection were classified as curative intent therapy.

NSCLC, non-small cell lung cancer.

FIGURE 1. Invasive staging techniques. In all, 1678 patients underwent invasive staging. Mediastinoscopy/mediastinotomy was used in 1270 patients (76%), transbronchial needle aspiration in 451 (26%), video-assisted thoracic surgery in 35 (2%), and esophageal ultrasound in 28 (1.6%). Because 12.5% of invasively staged patients underwent more than one procedure, the numbers sum to more than 100%.

FIGURE 2. Use of PET (positron emission tomography) scanning and invasive staging, 1998 to 2005, in preexpansion registries.

out any comorbidity (odds ratio, 0.81; 95% confidence interval [CI], 0.69–0.95), while patients who had greater health care access, as measured by receipt of influenza vaccination, were more likely to have received invasive staging compared with patients who did not receive the vaccine (odds ratio, 1.23; 95% CI, 1.09–1.39). Nevertheless, in all subgroups, the use of invasive staging was the exception rather than the rule. There was significant geographic variation in the use of invasive staging between SEER registry (Tables 2 and 3).

Receipt of cancer-specific therapy and curative intent therapy were associated with use of invasive staging. Nevertheless, even in the subset of patients who received combined radiation therapy and chemotherapy, only 30% underwent invasive staging. Only age, SEER registry, and receipt of influenza vaccination were significant covariates (Table 3).
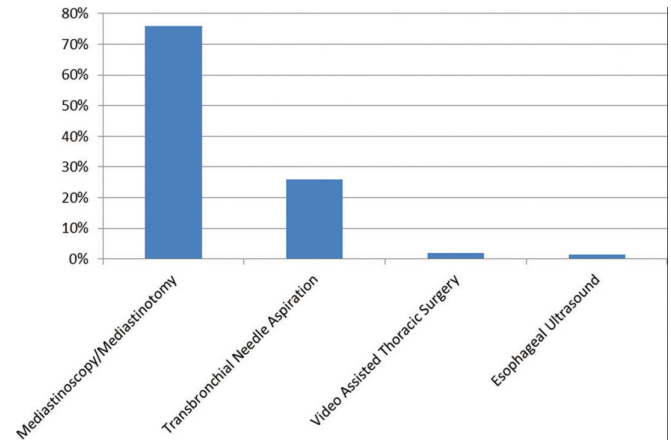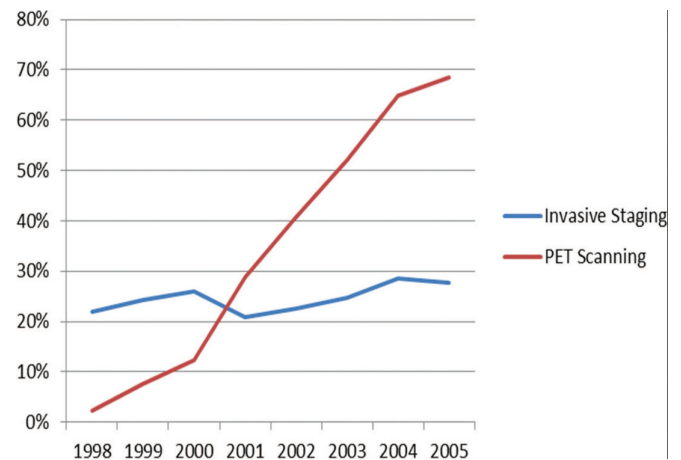
In patients treated with both chemotherapy and radiation but not surgical resection, 3-year survival was 21%. In multivariate analysis of this group, invasive staging was associated with improved 3-year survival (adjusted hazard ratio, 1.61; 95% CI, 1.21–2.12). Other factors associated positively with survival included younger age and fewer comorbidities (Table 4).

DISCUSSION

We found an underutilization of histologic confirmation in clinical staging during the years 1998 to 2005. This practice was inconsistent with evidence-based guidelines. The failure of physicians to follow clinical practice guidelines is well documented across different specialties. A review by Cabana et al.[22] described reasons that guidelines are not followed which are discussed below.

TABLE 2. Unadjusted and Adjusted Odds Ratios for Receipt of Invasive Staging

	N (% Staged)	Unadjusted		Adjusted	
		OR	95% CI	OR	95% CI
Age group					
67–69	1118 (27.6)	1.00	—	1.00	—
70–74	2305 (25.4)	0.90	0.76–1.05	0.92	0.78–1.09
75–79	2197 (22.4)	0.76	0.64–0.90	0.81	0.68–0.96
80–84	1331 (16.3)	0.51	0.42–0.62	0.57	0.46–0.70
85–94	632 (11.9)	0.35	0.27–0.47	0.46	0.34–0.61
Sex					
Male	4308 (22.1)	1.00	—	n/a	
Female	3275 (22.2)	1.01	0.91–1.13	n/a	
Race					
White	6653 (22.5)	1.00	—	1.00	—
Black	635 (17.3)	0.72	0.58–0.89	0.88	0.69–1.12
Other	295 (24.4)	1.11	0.85–1.46	1.33	0.97–1.83
Comorbidities					
0	2747 (24.1)	1.00	—	1.00	—
1–2	3169 (22.6)	0.92	0.82–1.04	0.93	0.82–1.05
≥3	1667 (18.1)	0.70	0.60–0.81	0.81	0.69–0.95
Marital status					
Married	3972 (24.3)	1.00	—	1.00	—
Unmarried	3349 (19.7)	0.82	0.72–0.92	0.93	0.83–1.05
Unknown	262 (19.9)	0.78	0.55–1.10	1.01	0.73–1.40
Income					
First quintile	1449 (17.7)	1.00	—	1.00	—
Second quintile	1451 (21.4)	1.26	1.05–1.52	1.07	0.87–1.30
Third quintile	1446 (22.4)	1.34	1.12–1.61	0.99	0.81–1.22
Fourth quintile	1450 (24.3)	1.49	1.24–1.78	1.09	0.88–1.34
Fifth quintile	1447 (24.9)	1.54	1.28–1.84	1.12	0.90–1.39
Unknown	340 (22.1)	1.31	0.98–1.75	1.13	0.83–1.54
Influenza vaccination in previous 18 mo					
No	3570 (19.7)	1.00	—	1.00	—
Yes	4013 (24.3)	1.31	1.17–1.46	1.23	1.09–1.39
Year of diagnosis					
1998	502 (22.7)	1.00	—	n/a	
1999	461 (24.3)	1.09	0.81–1.47	n/a	
2000	1033 (22.6)	0.99	0.77–1.28	n/a	
2001	983 (19.8)	0.84	0.65–1.09	n/a	
2002	1038 (8.8)	0.79	0.61–1.02	n/a	
2003	1130 (21.2)	0.92	0.71–1.18	n/a	
2004	1247 (23.7)	1.06	0.83–1.36	n/a	
2005	1189 (24.6)	1.11	0.87–1.43	n/a	
Treatment group					
Best supportive care	1834 (9.8)	1.00	—	1.00	—
Cancer-specific therapy	2051 (19.1)	2.18	1.80–2.63	2.18	1.80–2.66
Curative intent therapy	3698 (30.0)	3.96	3.34–4.69	3.31	2.78–3.95
SEER registry					
San Francisco	253 (13.8)	1.00	—	1.00	—
Connecticut	558 (26.5)	2.25	1.50–3.37	2.07	1.36–3.14
Detroit	866 (25.5)	2.13	1.45–3.15	2.04	1.36–3.06
Hawaii	131 (13.7)	0.99	0.54–1.83	0.68	0.35–1.30
Iowa	602 (24.6)	2.03	1.36–3.04	1.87	1.21–2.88
New Mexico	140 (17.1)	1.29	0.73–2.27	1.29	0.71–2.34
Seattle	486 (32.5)	3.00	2.00–4.50	3.05	1.99–4.66
Utah	94 (22.3)	1.79	0.98–3.27	1.69	0.91–3.17
Atlanta	258 (21.3)	1.69	1.06–2.69	1.55	0.96–2.50
San Jose	153 (20.3)	1.58	0.93–2.69	1.33	0.77–2.30
Los Angeles	496 (30.0)	2.68	1.78–4.01	2.48	1.63–3.78
Rural Georgia	[a]	0.86	0.29–2.59	0.91	0.29–2.80
Greater California	1181 (20.1)	1.56	1.07–2.30	1.51	1.01–2.26
Kentucky	840 (15.5)	1.14	0.76–1.71	1.05	0.69–1.63
Louisiana	562 (15.1)	1.11	0.73–1.70	1.14	0.72–1.79
New Jersey	930 (23.0)	1.86	1.26–2.75	1.70	1.13–2.54

Best supportive care, not treated with surgery, chemo, or radiation; cancer-specific therapy, treated with chemotherapy or radiation alone; curative intent therapy, treated with combination chemotherapy and radiation or any combination that included surgical resection; N, number of patients; %staged, percent of patients who underwent invasive clinical staging; Adjusted OR, adjusted odds ratio adjusted for age, race, SEER region, comorbidities, income, and access to health care services as measured by receipt of influenza vaccination.

[a] Suppressed to protect confidentiality because of cell size.

OR, odds ratio; CI, confidence interval.

Physicians might be unaware of evidence supporting recommendations for invasive staging in IIIA lung cancer patients. The extensive evidence base supporting the guidelines and the lack of an obvious change after publication of the American College of Chest Physician guidelines in 2003 suggest that this is not the case.

Clinicians might disagree with guidelines even at a population level. This seems unlikely given the lack of debate in the literature regarding the value of staging IIIA NSCLC. Nevertheless, diagnostic and therapeutic nihilism related to the perception that little can be done for patients with lung cancer may be pertinent.[23,24]

Clinicians might agree with guidelines on a population level but feel they were not relevant to an individual patient. For example, a physician might believe that the positive predictive value of CT and PET in an individual patient is sufficiently reliable to obviate the need for histologic confirmation while acknowledging that this position is not supported by evidence. Many clinicians may not feel confident in their ability to perform invasive staging techniques specified by guidelines. This may subconsciously increase the likelihood of a physician recommending guideline discordant care for a particular patient.

Limited access to invasive staging procedures may discourage adherence to guidelines. Only approximately 12% of pulmonologists perform TBNA[25–27] and less than 10% of lung cancer surgery is performed by dedicated thoracic surgeons.[28] General surgeons or cardiac surgeons performing thoracic surgery are less likely to truly be comfortable with mediastinoscopy. Nevertheless, shifting all NSCLC care to specialized expertise is anything but simple. Even if all NSCLC cancer treatment was centralized at large centers, it is not clear if there are sufficient physicians trained to meet the needs of this large group of patients. Moreover, in the United States, such centralization would require a major cultural shift and many elderly patients would likely be unwilling to travel for this care.

TABLE 3. Multivariable Analysis to Predict Use of Invasive Staging Among Subset of Stage IIIA Patients Treated with Combined Chemotherapy and Radiation

Variable	Unadjusted		Adjusted	
	Odds Ratio	95% CI	Odds Ratio	95% CI
Age				
67–69	1.00	—		
70–74	0.85	0.66–1.12	0.80	0.61–1.04
75–79	0.63	0.47–0.83	0.58	0.43–0.77
80–84	0.47	0.33–0.67	0.27	027–0.57
85–94	0.41	0.21–0.80	0.36	0.18–0.71
Sex				
Male	1.00	85–94		
Female	1.18	0.97–1.43	Not significant	Not significant
Race				
White	1.00			
Black	0.72	0.49–1.06		
Other	1.68	1.02–2.78		
Comorbidities				
0	1.00			
1–2	1.00	0.81–1.24		
≥3	0.80	0.60–1.06		
Marital status				
Married	1.00			
Unmarried	0.98	0.80–1.20	Not significant	Not significant
Unknown	1.13	0.65–1.95	Not significant	Not significant
Income				
First quintile	1.00		n/a	n/a
Second quintile	1.37	1.00–1.89	1.30	0.92–1.84
Third quintile	1.32	0.96–1.83	1.06	0.74–1.52
Fourth quintile	1.45	1.05–2.00	1.11	076–1.61
Fifth quintile	1.58	1.14–2.18	1.28	0.86–1.88
Unknown	1.14	0.67–1.94	0.86	0.49–1.52
Influenza vaccination in previous 18 mo				
No	1.00		n/a	n/a
Yes	1.28	1.05–1.56	1.31	1.06–1.61
Year of diagnosis				
1998	1.00			
1999	1.03	0.58–1.84		
2000	1.04	0.64–1.70		
2001	0.62	0.37–1.05		
2002	0.67	0.40–1.10		
2003	0.75	0.46–1.22		
2004	1.07	0.67–1.70		
2005	0.97	0.61–1.55		
SEER registry				
San Francisco	1.00			
Connecticut	3.72	1.46–9.34	4.57	1.74–12.01
Detroit	4.18	1.71–10.20	5.46	2.15–13.86
Hawaii	1.19	0.31–4.65	0.64	0.15–2.68
Iowa	3.71	1.49–9.24	4.33	1.65–11.38
New Mexico	2.63	0.88–7.88	3.31	1.05–10.40
Seattle	5.53	2.21–13.84	6.52	2.51–16.92
Utah	2.87	0.80–10.26	3.07	0.83–11.44
Atlanta	3.18	1.20–8.49	4.19	1.52–11.58
San Jose	2.24	0.74–6.80	2.51	0.81–7.80
Los Angeles	5.47	2.13–14.06	6.82	2.57–18.10
Rural Georgia	1.02	0.11–9.84	1.71	0.17–16.94
Greater California	2.26	0.93–5.51	2.71	1.07–6.86
Kentucky	2.03	0.81–5.06	2.43	0.93–6.38
Louisiana	2.14	0.84–5.42	2.78	1.04–7.43
New Jersey	2.90	1.18–7.09	3.58	1.42–9.06

OR, odds ratio; CI, confidence interval; n/a, not applicable.

TABLE 4. Results of Multivariable Analysis to Predict 3-yr Survival for Patients Treated with Chemotherapy and Radiation[a]

Variable	Unadjusted		Adjusted	
	Odds Ratio	95% CI	Odd Ratio	95% CI
Age				
67–69	1.00		n/a	n/a
70–74	0.60	0.42–0.85	0.61	0.43–0.90
75–79	0.70	0.49–0.99	0.75	0.52–1.08
80–84	0.47	0.30–0.75	0.533	0.33–0.86
85–99	0.22	0.07–0.73	0.26	0.08–0.86
Sex				
Male	1.00	85–99	n/a	n/a
Female	1.57	1.21–2.03	1.52	1.17–1.99
Race				
White	1.00		n/a	n/a
Black	0.98	0.60–1.6	1.18	0.70–2.0
Other	0.93	0.43–2.00	0.85	0.39–1.85
Comorbidities				
0	1.00		n/a	n/a
1–2	0.96	0.73–1.27	1.02	0.77–1.35
≥3	0.43	0.27–0.68	0.49	0.31–0.78
Marital status				
Married	1.00	n/a	n/a	n/a
Unmarried	0.86	0.65–1.3		
Unknown	0.75	0.33–1.68		
Income				
First quintile	1.00		n/a	n/a
Second quintile	1.21	0.72–1.74	1.11	0.71–1.75
Third quintile	1.20	0.78–1.86	1.21	0.76–1.91
Fourth quintile	1.54	1.01—2.35	1.51	0.97–2.37
Fifth quintile	1.42	0.92–2.18	1.41	0.89–2.34
Unknown	0.78	0.33–1.82	0.83	0.35–1.97
Influenza vaccination in previous 18 mo				
No	1.00			
Yes	1.21	0.86–1.46		
Year of diagnosis				
1998	1.00			
1999	1.31	0.6–2.85		
2000	1.01	0.51–2.01		
2001	1.53	0.58–2.30		
2002	1.59	0.82–3.08		
2003	1.49	0.78–2.87		
2004	1.81	0.96–3.41		
SEER registry				
San Francisco	1.00			
Connecticut	2.26	0.72–7.08		
Detroit	2.55	0.86–7.55		
Hawaii	2.00	0.45–9.00		
Iowa	2.11	0.69–6.43		
New Mexico	0.85	0.18–4.11		
Seattle	2.06	0.66–6.38		
Utah	2.27	0.50–10.29		
Atlanta	1.47	0.43–5.04		
San Jose	1.76	0.45–6.84		
Los Angeles	2.33	0.73–7.49		
Rural Georgia	1.70	0.16–18.44		
Greater California	1.52	0.51–4.54		
Kentucky	1.45	0.47–4.43		
Louisiana	1.13	0.35–3.63		
New Jersey	1.38	0.45–4.18		

OR, odds ratio; CI, confidence interval, n/a, not applicable.

These data suggest that some physicians routinely performed invasive staging and did so throughout the study period, while another larger group routinely did not. Simply publishing guidelines and evidence supporting them is not sufficient to change practice. The rate of invasive staging is likely to reflect the availability of physicians with the skills and training to routinely perform invasive mediastinal staging. To actually improve patient care, leaders need to ensure that physicians have the resources needed to provide the recommended care and that incentives are aligned to encourage best practices.

Training physicians who currently care for lung cancer patients in invasive staging techniques and providing institutional resources for them may be the key to achieving guideline adherent care. For example, both practicing pulmonologists and practicing surgeons have successfully adopted EBUS-TBNA.[29] Nevertheless, the process of becoming an expert in a new procedure is arduous and the profession's experience with the introduction of laparoscopy taught us to be cautious.[30] Medical simulation is expensive but can reduce the learning curve for a new procedure and has been used in thoracic surgery.[31] Even after use of simulation training, many physicians still want mentoring during their initial procedures. Unfortunately, there are many regulatory barriers to obtaining this mentoring including lack of reciprocity for licensing and credentialing. Addressing the need for effective continuing medical education should be a priority for medical leaders who desire to increase the rate of invasive staging of NSCLC.

Physicians and institutions also need incentives to pursue the difficult and expensive process of safely introducing invasive staging into their lung cancer practices. One policy-based approach that may be effective is using the rate of invasive staging as quality indicator for the care of lung cancer patients. The recent past has shown us examples of how selection of quality indicators can dramatically impact practice in areas such as management of myocardial infarction.

The rate of use of invasive staging was not impacted by the increased use of PET. This shows that at least in stage IIIA patients, PET was not replacing invasive staging, because this would have led to a decrease in invasive staging. Moreover, identification of PET avid lymph nodes did not prompt invasive staging for confirmation as recommended by guidelines because an increase in invasive would have accompanied this later scenario. This again suggests that guidelines alone are insufficient to change practice.

Our analysis is consistent with and expands on previous work.[17] By separating patients invasively staged from those staged with a combination of CT scan and PET, we can appreciate how actual practice is differing from guidelines and expert opinion. We noted even higher rates of utilization of PET scanning than reported by Farjah et al.[17] This may be due to our inclusion of additional CPT codes for PET scanning not used in their study and our extended study period. In addition, we did not observe the decline in utilization of invasive staging procedures that they reported. This is likely related to our inclusion of TBNA as an invasive staging procedure and our focus on patients with stage IIIA NSCLC who may be more likely to receive invasive staging than patients with either earlier or more advanced stages.

Our study has several limitations. First, data are only available on patients diagnosed through 2005. The impact of the dissemination of technologies such as EBUS and EUS over the last 5 years cannot be assessed. Second, we specifically evaluated an older Medicare population, and the results may not be generalizable to younger patients with other insurance. Nevertheless, while age and insurance status are known to impact cancer therapies, most lung cancer patients are older than 65 years. Third, the use of SEER registry to examine geographic variability does not reflect geographic distribution of health care resources. Nevertheless, our point in including this variation is only to provide additional evidence that variability in the use of staging techniques is due to factors other than patient characteristics. Furthermore, because patients may have diagnostic and treatment procedures at multiple institutions, assigning the responsibility for their care to single institution for research purposes is difficult. Therefore, we do not have data on the providers that treated any particular patient. Fourth, the SEER-Medicare database does not allow the determination of the results of an individual staging procedure in any given patient. In addition, we are subject to the limitations of using an administrative database. For example, if a TBNA were to be performed but not billed, we would classify the patient incorrectly as not having had a TBNA. Nevertheless, because this billing database is how providers are reimbursed, we are likely to capture the majority of procedures. The presence of patients in whom the absence of invasive staging would be considered medically acceptable is a potential confounder in our study.

Some patients may have been classified as IIIA in the SEER database but were only found postoperatively to have N2 involvement (incidental N2). Nevertheless, one can argue these patients should have had invasive staging to prevent this situation, and studies indicate the rate of incidental N2 should be small. Another group for whom invasive staging can be questioned is those with mediastinal infiltration of tumor to the extent that individual nodes can no longer be discerned. Nevertheless, in clinical practice, this group would clearly be a minority of patients with stage IIIA disease. Finally, comorbidities may preclude considering curative intent treatment. Data from this study suggest that more than 36% had no comorbidities.

In the end, the lack of invasive staging cannot be explained away as having been appropriate because of tumor extent or comorbidities. Even in the most favorable subgroups and youngest patients without comorbidities, the rate of invasive staging was remarkably low (<30%). Furthermore, our analyses excluding surgical patients (and thus any incidental N2 patients) did not affect the results. Although the exact rate of invasive staging that should be performed cannot be determined, there is little doubt it should be substantially higher than less than 25%.

CONCLUSION

The majority of patients with stage IIIA NSCLC did not receive invasive mediastinal staging as recommended by guidelines and associated with improved survival. This was evident for patients of all races and socioeconomic strata. Patient-related factors such as age and comorbidity do not fully explain this practice variation. This combined with the observed geographic

variation in rates of invasive staging suggest that provider, not patient, factors are responsible. Incentives to encourage use of invasive staging may be useful in improving quality of care.

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APPENDIX

TABLE A1. Codes for Identification of Staging Techniques and Treatments

HCPCS codes for invasive staging techniques	Endobronchial ultrasound	31620
	Bronchoscopy with TBNA	31629, 31633, 32605
	Thoracoscopy of mediastinal space without biopsy	32605
	VATS mediastinal biopsy	32606
	Mediastinotomy	39000, 39010
	Mediastinoscopy	39400
	Esophageal ultrasound	43231, 43242, 43259, 76975
	Esophageal ultrasound guided aspiration	43232
HCPCS codes for surgical resection	Carinal reconstruction	
	Open pneumonectomy	32440
	Removal of lung, total pneumonectomy; with resection of segment of trachea followed by bronchotracheal anastomosis (sleeve pneumonectomy)	32442
	Removal of lung, total pneumonectomy; extrapleural	32445
	Open lobectomy	32480
	Open bilobectomy	32482
	Open segmentectomy	32484
	Open sleeve lobectomy	32486
	Open completion pneumonectomy	32488
	Open apical resection	32503
	Resection of lung; with resection of chest wall	32520
	Resection of lung; with reconstruction of chest wall, without prosthesis	32522
	Resection of lung; with major reconstruction of chest wall, with prosthesis	32525
	VATS segmentectomy/lobectomy	32663

HCPCS codes for radiation treatment	Brachytherapy	77750–77799, 0182T
	Any external beam (3D conformal)	77402–416
	Any IMRT	(77301 and 77427), 77418, 0073T, G0174
	Stereotactic surgery (radiosurgery/cyberknife)	G0173, G0242, G0243, G0251, G0338, G0339, G0340, 0082T-0083T
	Any proton beam	77520–77525
	Any IGRT	77421
HCPCS codes for PET scan	G codes	G0211, G0212, G0125, G0126, G0210, G0212, G0234
	CPT codes	78811, 78812, 78813, 78815, 78816
Codes for chemotherapy treatment (any chemo drug)	HCPCS	96400–96549, Q0083-Q0085, J9000-J9999, G0355–62
	ICD9	V58.1

TBNA, transbronchial needle aspiration; VATS, video-assisted thoracoscopic surgery; IMRT, intensity-modulated radiation therapy; IGRT, image guided radiation therapy; HCPCS, Healthcare Common Procedure Coding System; PET, positron emission tomography.

TABLE A2. Comorbid Conditions

Comorbid Condition	n (%)
Chronic pulmonary disease	2401 (31.66)
Diabetes uncomplicated	1284 (16.93)
Cardiac arrhythmia	1257 (16.58)
Peripheral vascular disorders	1027 (13.54)
Congestive heart failure	978 (12.9)
Solid tumor without metastasis	827 (10.91)
Fluid and electrolyte disorders	592 (7.81)
Valvular disease	503 (6.63
Depression	433 (5.71)
Diabetes complicated	329 (4.34)
Deficiency anemia	294 (3.88)
Rheumatoid arthritis/collagen disease	241 (3.18)
Other neurological disorders	224 (2.95)
Renal failure	202 (2.66)
Weight loss	161 (2.12)
Pulmonary circulation disorders	146 (1.93)
Alcohol abuse	105 (1.38)
Coagulopathy	101 (1.33)
Liver disease	72 (0.95)
Metastatic cancer	72 (0.95)
Psychoses	71 (0.94)
Paralysis	68 (0.9)
Lymphoma	60 (0.79)
Drug abuse	33 (0.44)
AIDS/HIV	[a]

[a] Suppressed because of small cell size.

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