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Guideline-concordant Timely Lung Cancer Care and Prognosis among Elderly Patients in the United States: A Population-based Study

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Abstract

Objectives—Elderly carry a disproportionate burden of lung cancer in the US. Therefore, its important to ensure that these patients receive quality cancer care. Timeliness of care is an important dimension of cancer care quality but its impact on prognosis remains to be explored. This study evaluates the variations in guideline-concordant timely lung cancer care and prognosis among elderly in the US.

Materials and Methods—Using the Surveillance, Epidemiology, and End Results (SEER)-Medicare database (2002-2007), we identified elderly patients with lung cancer (n = 48,850) and determined time to diagnosis and treatment. We categorized patients by receipt of timely care using guidelines from the British Thoracic Society and the RAND Corporation. Hierarchical generalized logistic model was constructed to identify variables associated with receipt of timely care. Kaplan-Meier analysis and Log Rank test was used for estimation and comparison of the three-year survival. Multivariable Cox proportional hazards model was constructed to estimate lung cancer mortality risk associated with receipt of delayed care.

Results—Time to diagnosis and treatment varied significantly among the elderly. However, majority of them (77.5%) received guideline-concordant timely lung cancer care. The likelihood

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of receiving timely care significantly decreased with NSCLC disease, early stage diagnosis, increasing age, non-white race, higher comorbidity score, and lower income. Paradoxically, survival outcomes were significantly worse among patients receiving timely care. Adjusted lung cancer mortality risk was also significantly lower among patients receiving delayed care, relative to those receiving timely care (Hazard ratio (HR) = 0.68, 95% Confidence interval (CI)= (0.66 - 0.71); $p = 0.05$).

Conclusion—This study highlights the critical need to address disparities in receipt of guideline-concordant timely lung cancer care among elderly. Although timely care was not associated with better prognosis in this study, any delays in diagnosis and treatment should be avoided, as it may increase the risk of disease progression and psychological stress in patients. Furthermore, given that lung cancer diagnostic and management services are covered under the Medicare program, observed delays in care among Medicare beneficiaries is also a cause for concern.

Keywords

Lung; Cancer; Elderly; Medicare; Disparities; Guidelines; Treatment

1. Introduction

Lung cancer is the most common cause of cancer death among elderly in the United States (US).[1] Elderly also carry a disproportionate burden of lung cancer, as approximately 81% of those living with lung cancer are 60 years of age or older.[1] This pattern is expected to persist as the estimated number of elderly in the US doubles to approximately 70 million by 2030.[2] Therefore, it is important to ensure that these patients receive quality cancer care. However, research to date has shown disparities in the receipt of appropriate lung cancer care among elderly.[3]

The Institute of Medicine (IOM) recognizes timeliness of care as another important dimension of cancer care quality.[4,5] As lung cancer care requires complex coordination of services by oncology specialists, the traditional approach of referring patients for consultation with multiple specialists in a sequential fashion often results in care that is perceived slow. Therefore, standards for timely lung cancer care have been established, through clinical opinion-based guidelines, by the British Thoracic Society (BTS), the RAND Corporation, and by the American College of Chest Physicians (ACCP).[6-8] However, extensive studies in European Union countries have found delays in time to diagnosis and treatment of lung cancer than recommended in guidelines.[9] In the US, while similar delays have been reported by three studies in the Veteran Affairs setting,[10-12] one study from an military medical center reported no such delays in care.[13] Although guideline-concordant timely lung cancer care is important, its impact on survival remains unclear. While some studies from the European Union have reported poorer survival among patients with delayed care,[14-16] others have reported better survival among patients that received less timely care.[17-20] In the US, however, one study from the VA and another from an medical center reported no such association between timeliness of care and survival.[11,21] While these studies contribute valuable information to the literature, most of them have been conducted in non-US healthcare settings,[9] and of those conducted in the US have been limited to small sample sizes, included both elderly and non-elderly patients, were performed within

specific health care settings, and were primarily restricted to Non-Small Cell Lung Cancer (NSCLC) patients.[10-13,21] Therefore, a population-based analysis of patterns of guideline-concordant timely lung cancer care and associated survival among elderly patients in the US is much needed. To that end, the objectives of this study were to: (1) estimate the time intervals to lung cancer diagnosis and treatment among elderly patients; (2) estimate the receipt of and determine the predictors of guideline-concordant timely lung cancer care among elderly patients; and (3) evaluate the survival outcomes associated with receipt of guideline-concordant timely lung cancer care among elderly patients in the US.

2. Materials and Methods

2.1. Data source

This study used National Cancer Institute's (NCI) Surveillance, Epidemiology, and End Results (SEER)-Medicare linked data files from years 2002-2007. SEER is a consortium of 20 population-based cancer registries covering ~28% of the US population and its data are representative of US cancer incidence and mortality.[22] Cancer registry data files provided clinical, demographic, cause of death, and initial treatment information for elderly individuals with lung cancer in selected geographic regions. The Medicare administrative data files provided the health service claims (utilization and reimbursement) information for care provided by physicians, inpatient hospital stays, hospital outpatient clinics, home health care agencies, skilled nursing facilities, and hospice programs.

2.2. Study Cohorts

We identified Medicare beneficiaries aged 66 years and older, with incident lung cancer diagnosis (International Classification of Diseases for Oncology (ICD-O) codes: C34.0, C34.1, C34.2, C34.3, C34.8, C34.9, and C33.9; American Joint Committee on Cancer Staging (AJCC) Tumor Node Metastasis (TNM) Stages: I-IV), during the years 2003 through 2006, in the SEER-Medicare data files (Figure 1).[23] Given our intent to study timeliness of care and associated prognosis, we a priori restricted our cohort to patients with complete information on stage at diagnosis (i.e. Stage I-IV diagnosis). This resulted in exclusion of patients with missing information on stage at diagnosis (14.7%), approximately 16.6% of whom were diagnosed at death. Of the identified beneficiaries, we excluded those that were diagnosed only at death, had a prior malignancy, were enrolled in a managed care plan, or lacked Part A or B of Medicare. The resulting population cohort (Cohort A) was used to estimate time intervals to lung cancer diagnosis and treatment among beneficiaries. To estimate the receipt of and the predictors of guideline-concordant timely care among beneficiaries, we identified beneficiaries from Cohort A that received any treatment during the year following diagnosis (Cohort B). Given the limited years of follow-up data to evaluate the survival outcomes by receipt of guideline-concordant timely care, we further identified beneficiaries from Cohort B who had cancer diagnosis during the years 2003 and 2004 (Cohort C). The beneficiaries in Cohort C were then followed for three years following their cancer diagnosis to determine lung cancer specific mortality.

2.3. Assessing time to diagnosis and treatment

Figure 2 shows a pictorial depiction of our approach to assessing time to diagnosis and treatment. Specifically, time to diagnosis was determined by following the patients during the year prior to the incident lung cancer diagnosis and were categorized as 'Symptom to Chest X-Ray (CXR)' interval, 'CXR to Specialist Visit' interval, 'Specialist' interval, and 'Referral' interval.

Given the retrospective nature of our data source, we determined the occurrence of earliest lung cancer symptoms by identifying the earliest Medicare claim (date), which had an International Classification of Diseases, Clinical Modification (ICD-9-CM) code associated with either: (1) symptoms of primary tumor, (2) symptoms of intrathoracic spread, (3) symptoms of extrathoracic metastases, or (4) paraneoplastic syndromes (see Appendix A for complete list of symptoms). The comprehensive list of symptoms were derived from the ACCP guidelines for management and treatment of lung cancer.[24] The 'Symptom to CXR' interval was then defined as the time from the earliest Medicare claim date with lung cancer symptom, until the date of first Medicare claim for a CXR.

The 'CXR to Specialist Visit' interval was defined as the time from the first Medicare claim for a CXR, until the date of first Medicare claim on which the service provider was a specialist, such as respiratory/chest physician, pulmonologist, oncologist, cardiologist, or thoracic/cardiac/regular surgeon. The 'Specialist' interval was defined as the time from the Medicare claim for the first specialist appointment until the date of cancer diagnosis. Among beneficiaries that were referred to a specialist, 'Referral' interval was defined as the time from the last Medicare claim associated with services provided by the referring physician, until the date of first Medicare claim on which the service provider was the referred specialist. The overall time to diagnosis, 'Symptom to Diagnosis' interval, was defined as the time from the earliest Medicare claim date with lung cancer symptom, until the date of cancer diagnosis. Specific time intervals to diagnosis were identified only among those patients who had Medicare claims associated with events of interest.

Time to treatment was determined by following the patients for one year following incident lung cancer diagnosis. Specifically, 'Diagnosis to Treatment' interval was defined as the time from cancer diagnosis until the date of first Medicare claim for surgery, radiation, or chemotherapy. Lung cancer specific treatments and procedures were identified from the Medicare claim data files using appropriate ICD-9-CM diagnosis and procedure codes, Healthcare Common Procedure Coding System (HCPCS) codes, Current Procedural Terminology (CPT) codes and revenue center codes (see Appendix A).

2.4. Assessing receipt of guideline-concordant timely lung cancer care

Guideline-concordant timely lung cancer care was defined using clinical opinion-based guidelines published by the BTS, and the RAND Corporation.[6,7] The British Thoracic Society recommends the time interval between diagnosis and treatment to be no more than eight weeks for surgery, seven weeks for radiotherapy, and four weeks for chemotherapy.[6] On the other hand, the RAND Corporation recommends any planned treatment to be offered within six weeks of the diagnosis date.[7] To incorporate recommendations from both

sources, we defined timely care by selecting the maximum duration allowed under either source for a given type of treatment. Therefore, initial treatment was considered timely if the duration between diagnosis date and treatment date was no more than eight weeks for surgery, seven weeks for radiotherapy, and six weeks for chemotherapy.

2.5. Dependent variables

The primary outcome of interest, receipt of guideline-concordant timely lung cancer care, was categorized as 'Timely Care' or 'Delayed Care'. Survival time in days was calculated from the date of cancer diagnosis to the date of death or the three year follow-up cutoff date, which ever came first. SEER only provides the month and year of cancer diagnosis, therefore we approximated the date of cancer diagnosis by using the earliest Medicare claim date that had a lung cancer diagnosis code and which was in the SEER reported diagnosis month. This approximation is appropriate given the high level of agreement (~90%) within one month of diagnosis between the SEER diagnosis date and the first Medicare claim date with a cancer diagnosis.[25] If a patient had no Medicare claim with a lung cancer diagnosis code in the SEER reported month of diagnosis, the earliest date of any Medicare claim from that month was used. Finally, among patients with no Medicare claim in the SEER reported month of diagnosis, the date of diagnosis was approximated as the 15th day of that month. Date of death was identified from Medicare enrollment records. To estimate lung cancer specific survival, patients not found to be deceased by the cutoff date, or who died due to causes other than lung cancer were censored at that time and considered to be alive.

2.6. Covariates

Based on prognostic significance, covariates included lung cancer type and stage, age at diagnosis, gender, race, urban-rural residence, comorbidity, and measures of socio-economic status. Lung cancer type was categorized based on cell histology. Patients with ICD-O histology codes 8000-8040 or 8046-9989 were categorized as having NSCLC disease, and those with codes 8041-8045 were categorized as having Small Cell Lung Cancer (SCLC) disease. Lung cancer stage was categorized based on AJCC TNM staging system.[23] Age at diagnosis was categorized as 66-69 years, 70-74 years, 75-79 years, and 80 years and older. Race was categorized as 'White' or 'Non-white'. Urban-rural residence was categorized as 'Metro', 'Urban', or 'Rural', using the Rural-Urban Continuum codes. Comorbidity was estimated using a modified Charlson comorbidity score, based on inpatient claims from the year preceding the cancer diagnosis.[26-28] This method of creating a weighted comorbidity score has previously been reported and used for both outcomes and patterns of care analysis.[26-28] Given the lack of individual socio-economic measures in our data source, median household income and the percentage of individuals with some college education in the census tract of residence were used as markers of socio-economic status.

2.7. Data Analysis

Pearson chi-square tests were used to determine unadjusted associations between categorical variables of interest. Median time intervals (with 25% and 75% Interquartiles) to diagnosis and treatment were calculated and compared using non-parametric tests. Specifically, the Mann-Whitney test was used for pair wise comparison of time intervals and the Kruskal-

Wallis test was used for analyses involving multiple groups. Hierarchical generalized logistic model was constructed with PROC GLIMMIX procedure in SAS 9.2 to identify factors associated with receipt of guideline-concordant timely care among elderly patients. In the model, the estimated probability of a patient receiving guideline-concordant timely care conditioned on a set of predictor variables was modeled. The model treated census tract as a random effect to account for potential correlation among patients within the same county. Non-parametric estimates of the survivor function by receipt of guideline-concordant timely care were calculated using the Kaplan-Meier method. Survival differences were assessed using log-rank test. Multivariable Cox proportional hazards model was constructed to estimate lung cancer mortality risk associated with receipt of delayed care among elderly patients. To evaluate the proportional hazards assumption, we plotted smoothed Schoenfeld residuals against time and found no evidence of a systematic deviation from proportional hazards in the model. Variances in model was adjusted to account for patient clustering at the census tract level by the use of the robust inference of Lin and Wei. [29] All analysis were performed with SAS 9.2. The study was approved by the West Virginia University Institutional Review Board.

3. Results

3.1. Patient Characteristics

Based on the inclusion and exclusion criteria, we identified 48,850 patients (Cohort A) from the SEER-Medicare database. Table 1 shows the distribution of clinical and socio-demographic characteristics of these patients by type of lung cancer. Majority of the patients had NSCLC and were diagnosed with late-stage disease. Compared to SCLC patients, NSCLC patients were older, male, resided in metro areas, and had lower comorbidity scores ($p < 0.05$). However, a majority of the SCLC patients were diagnosed at late stages, as compared to NSCLC patients ($p < 0.05$).

3.2. Time to diagnosis and treatment

Table 2 shows the earliest lung cancer symptoms reported among patients. Common symptoms of primary tumor included chest pain, cough, weakness, and dyspnea. While median 'Symptom to Diagnosis' time interval was approximately six months, the median 'Diagnosis to Treatment' time interval was less than a month (Figure 2). Median 'Symptom to CXR', 'CXR to Specialist Visit', and 'Specialist' time intervals were approximately two weeks. 'Diagnosis to Treatment' intervals were shortest in patients receiving radiation and were longest in patients receiving surgery.

Table 3 shows the descriptive characteristics of patients by types of time intervals. 'Symptom to Diagnosis' time interval were longer among patients with NSCLC, early stage disease, old age, female sex, non-white race, non-rural residence, and high comorbidity score ($p < 0.05$). Similarly, 'Diagnosis to Treatment' time interval were longer among patients with NSCLC, early stage disease, old age, non-white race, and high comorbidity score ($p < 0.05$). However, gender and urban-rural residence differences in 'Diagnosis to Treatment' time interval were not observed.

3.3. Receipt of guideline-concordant timely lung cancer care

Overall, a majority of the patients (77.5%) received timely care. The proportions were highest among patients receiving radiation (80.3%), followed by surgery (76.8%) and chemotherapy (74.6%). Table 4 shows the descriptive characteristics of patients by receipt of guideline-concordant timely lung cancer care. The proportion of patients receiving timely care was higher among those with SCLC, late stage disease, young age, white race, rural residence, and low comorbidity score ($p = 0.05$). Gender differences in receipt of timely care were not observed.

3.4. Factors associated with receipt of guideline-concordant timely lung cancer care

Controlling for socio-demographic characteristics, lung cancer type and stage remained strong predictors of receipt of timely care (Table 5). Specifically, patients with SCLC or late stage disease were more likely to receive timely care. Age, race, comorbidity score, and median household income were the other significant predictors of receipt of timely care. Compared to patients aged 80 and older, those aged 66-69 years were 10% more likely to receive timely care. However, patients of non-white race were 21% less likely to receive timely care as compared to whites. Similarly, the likelihood of receipt of timely care decreased with increase in comorbidity score and decrease in median household income. Gender and urban-rural residence differences in the likelihood of receipt of timely care were not observed.

3.5. Survival outcomes associated with receipt of guideline-concordant timely lung cancer care

Table 6 shows the three year survival rates and median survival times by receipt of timely care in patients. Overall, survival outcomes were significantly worse among patients receiving timely care. Similar results were observed in stratified analysis by lung cancer type. However, in stratified analysis by lung cancer stage, better survival outcomes with timely care were observed in patients with early stage disease (Stage I/II), but the results were not significant. Among patients with late stage disease (Stage III/IV), survival outcomes were again found to be significantly worse among those receiving timely care.

3.6. Lung cancer mortality risk associated with receipt of delayed care

In the Cox proportional hazards model, the adjusted lung cancer mortality risk was significantly lower among patients receiving delayed care, relative to those receiving timely care (Hazard ratio (HR) = 0.68, 95% Confidence interval (CI) = (0.66 - 0.71); $p = 0.05$). Specifically, lung cancer mortality risk among patients receiving delayed care decreased by 32%. Other factors independently associated with lower lung cancer mortality risk included NSCLC diagnosis, early stage disease, young age, female sex, low comorbidity score, and higher median household income (Table 7). In stratified analysis by cancer type, lung cancer specific mortality risk was again found to be significantly lower among patient receiving delayed care (Table 8). However, in stratified analysis by lung cancer stage, similar results were observed only among patients with late stage disease (Stage III/IV).

4. Conclusions

In 1999, the seminal report *Ensuring Quality Cancer Care* by the IOM recommended the need for cancer disparities research so as to optimize the delivery of cancer care for all Americans.[5] Despite the fervor generated by this report, lung cancer disparities still exist in the US and may be attributed to variations in quality of cancer care. While timelines of care has been identified by the IOM as an important dimension of cancer care quality, its impact on prognosis in elderly lung cancer patients in the US remains to be fully explored. To that end, this population-based analysis studied the patterns of guideline-concordant timely lung cancer care and prognosis among elderly patients in the US.

Overall, time to lung cancer diagnosis and treatment ranged widely among elderly patients in the US. The median 'Symptom to Diagnosis' time interval of >6 months was longer than expected and could be minimized if all diagnostic investigations are planned during the initial visit to a physician. On the other hand, the median 'Diagnosis to Treatment' time interval was more or less similar to that reported in prior studies.[10-12,21] Surgically treated patients had longer delays than those treated non-surgically, a difference that is likely to reflect the extra time needed to refer patients to thoracic surgeon for additional treatment consideration. A multidisciplinary team approach involving both surgeons and oncologist in the care process may help to minimize such delay.[8]

Guideline-concordant timely lung cancer care was received by most patients and was highest among those receiving radiotherapy. Receipt of timely care also differed by patients clinical and socio-demographic characteristics. Specifically, patients with NSCLC or early stage disease were less likely to receive timely care, compared to those with SCLC or late stage disease. This finding is likely as patients with limited disease may have to wait significantly longer for treatment than those with advanced disease.[8] The finding also indicates that severity of disease at presentation may influence the speed of medical decision-making process. Contrary to results from a previous study, increasing patient age was inversely associated with receipt of timely care in this study.[30] However, these results corroborate finding by Simunovic and colleagues,[31] and may reflect less aggressive treatment approach by physicians in the elderly, given the impact on patients morbidity and quality of life. Similar to results found in prior studies, comorbidity was inversely associated with receipt of timely care.[17,31] This is expected as comorbidity is known to complicate treatment decision making in the elderly. Contrary to previous studies, household income was positively associated with the likelihood of receipt of timely care.[30-33] However, patient's gender and urban-rural residence were not associated with receipt of timely care; a finding similar to that reported in previous studies.[31,33]

This study is one of the few that have assessed the influence of guideline-concordant timely lung cancer care on survival outcomes. Contrary to our expectation, the results of this study indicate that timely care is associated with poorer prognosis in elderly lung cancer patients in the US. This result corroborate findings from previous studies,[17-20] but contradict the findings from two US studies.[11,21] The observed paradoxical results may be explained by selection bias, as symptomatic patients with advanced stage disease are more likely to receive prompt (timely) care, despite their poor prognosis to begin with. Similar to findings

from prior studies, the association between timely care and poor survival outcomes was most pronounced in patients with advanced stage disease.[19] However, we did notice a trend toward better survival outcomes with timely care among patients with early stage disease (Stage I/II), although the results were not significant. Further research is needed to explore the association between timely care and survival in patients with early stage disease, compared to those with late stage disease.

The findings from this study are subject to several limitations. Although we used cancer registry linked claims data, an inherent limitation of using administrative claims data for epidemiologic studies is the possibility of misclassification as a result of coding errors.[34] However, claims data have been evaluated for their utility as a source of epidemiologic or health services information in cancer patients.[34] Increasing the use of these types of data to assess the quality of cancer care has also been identified as a priority by the IOM. The results of this study are generalizable to the Medicare Fee-for-service (FFS) population aged 66 years and older, as data for Medicare beneficiaries enrolled in the managed care plan were not available for this study. Continuous enrollment in Medicare Part A and B was necessary for this study, therefore beneficiaries with non-continuous/intermittent enrollment were excluded. Information on care received by beneficiaries outside of the Medicare system, or through non-Medicare providers, was not available for this study.

Given the limitations in our data source, the time to diagnosis and treatment were defined using Medicare claim date and may not be exact. Furthermore, retrospective review of claims to identify earliest lung cancer symptoms was limited to the year prior to diagnosis, as findings from previous research have shown 'Symptom to Diagnosis' time intervals to be less than a year.[9] Our estimates of 'Symptom to Diagnosis' time interval may be biased as patients in whom earliest symptom date could not be identified were excluded in calculating the time interval. It is less likely that we missed any reported lung cancer symptom as we searched for a comprehensive list of symptoms, derived from the ACCP guidelines for management and treatment of lung cancer (Appendix A).[24] Overall, date of earliest lung cancer symptom was identified in 90% of the patients in this study. We recognize that the earliest symptom identified in this study may have been unrelated to lung cancer. It is for these reasons we excluded 'Symptom to Diagnosis' time interval in our analysis of guideline-concordant timely lung cancer care and prognosis. We acknowledge that our definition of timely care may be too narrow, and that given the heterogeneity of patients seen by physicians, receipt of delayed care or no care may still be considered appropriate. Furthermore, the criticality of timely care may vary by treatment intent (curative vs. palliative). This relationship, however, could not be explored in our study due to: (1) lack of information in our data source, and (2) lack of specific guidelines for timely care by treatment's intent. None the less, cancer type and stage were used as covariates in our analysis to account for the variation in disease severity and the resulting treatment variation. It should be noted that, given the intent of this study, a small proportion of patients (14.7%) with missing information on stage at diagnosis were excluded a priori from our analysis; few of these patients (16.6%) were diagnosed at death. Despite the above limitations, our definition of timely care provides a conceptual framework to assess and compare patterns of care that were prevalent during the years 2002-2007. Future studies can overcome the barriers seen in this study by collecting data on physician treatment choice, patient treatment

preferences, clinical test information, and individual-level measures of socio-economic status.

In summary, variations in lung cancer care among elderly patients continue to exist in the nation. Although clinical opinion-based guidelines for timely lung cancer care have been published by various organizations, their adoption in clinical practice remains limited. The resulting disparities in receipt of guideline-concordant timely lung cancer care may partly explain the disproportionate burden of this disease among the elderly. Although timely care was not associated with better prognosis in this study, any delays in diagnosis and treatment should be avoided, as it may increase the risk of disease progression and psychological stress in patients. Furthermore, given that lung cancer diagnostic and management services are covered under the Medicare program, observed delays in care among Medicare beneficiaries is also a cause for concern. Interventions aimed at increasing patient awareness of lung cancer symptoms and improving coordination of care among providers may help to reduce the delays in diagnosis and treatment among elderly patients in the US.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Time to lung cancer diagnosis and treatment varied significantly among elderly
- Majority of elderly patients received guideline-concordant timely lung cancer care
- Survival outcomes were significantly worse among patients receiving timely care
- Adjusted lung cancer mortality risk was lower among patients receiving delayed care

Figure 1.
Flowchart describing the steps involved in creating study cohorts using the inclusion and exclusion criteria.

Figure 2.
 Time to diagnosis and treatment among continuously enrolled Medicare Fee-for-service beneficiaries with incident lung cancer diagnosis in the United States, 2003 through 2006.

Table 1

Characteristics of continuously enrolled Medicare Fee-for-service beneficiaries with incident lung cancer diagnosis in the United States, 2003 through 2006.

Characteristics	Number (Proportion, %)	
	Non-Small Cell Lung Cancer	Small Cell Lung Cancer
Overall, n (%)	42,089 (86.2)	6,761 (13.8)
AJCC TNM stage [^]		
I	8,839 (20.8)	372 (5.5)
II	2,104 (4.6)	142 (2.1)
III	12,206 (29.3)	2,049 (30.3)
IV	18,940 (45.4)	4,198 (62.1)
Age (years) [^]		
66-69	8,039 (19.1)	1,609 (23.8)
70-74	10,901 (25.9)	1,954 (28.9)
75-79	10,985 (26.1)	1,765 (26.1)
80 or more	12,164 (28.9)	1,433 (21.2)
Gender [^]		
Male	21,928 (52.1)	3,205 (47.4)
Female	20,161 (47.9)	3,556 (52.6)
Race [^]		
Non-white	5,598 (13.3)	636 (9.4)
White	36,491 (86.7)	6,125 (90.6)
Urban-rural residence [^]		
Metro	34,976 (83.1)	5,415 (80.1)
Urban	6,271 (14.9)	1,170 (17.3)
Rural	842 (2.0)	176 (2.6)
Comorbidity, Charlson score [^]		
0	13,426 (31.9)	2,008 (29.7)
1	12,037 (28.6)	1,927 (28.5)
2	16,626 (39.5)	2,826 (41.8)

AJCC = American Joint Committee on Cancer; TNM = Tumor Node Metastasis.

Source: Surveillance, Epidemiology and End Results-Medicare linked data files, 2002-2007.

[^] Association between characteristic and cancer type among beneficiaries; Chi-square tests (p = 0.05).

Table 2

Earliest reported symptoms among continuously enrolled Medicare Fee-for-service beneficiaries with incident lung cancer diagnosis in the United States, 2003 through 2006.

Symptom [^]	United States (N = 43,833)	
	No.	%
Symptom of primary tumor		
Cough	6,143	14
Weight loss	2,087	4.8
Dyspnea	6,820	15.6
Chest pain	8,947	20.4
Hemoptysis	-	-
Bone pain	1,107	2.5
Clubbing	-	-
Fever	925	2.1
Weakness	6,519	14.9
Superior vena cava obstruction	71	0.2
Dysphagia	680	1.6
Wheezing and stridor	462	1.1
Symptoms of intrathoracic spread	1,228	2.8
Symptoms of extrathoracic metastases	6,501	14.8
Paraneoplastic syndromes	9,553	21.8

- Cell size suppressed to meet privacy guidelines.

Source: Surveillance, Epidemiology and End Results-Medicare linked data files, 2002-2007.

[^] Earliest reported symptoms among beneficiaries were identified from the earliest Medicare claim in the year prior to cancer diagnosis, which had an International Classification of Disease (ICD-9-CM) code associated with a lung cancer symptom.

Table 3

Descriptive characteristics by type of time interval among continuously enrolled Medicare Fee-for-service beneficiaries with incident lung cancer diagnosis in the United States, 2003 through 2006.

Characteristics	'Symptom to Diagnosis' interval [^]		'Diagnosis to Treatment' interval [^]	
	N	Median (IQR) days	N	Median (IQR) days
Lung cancer type ^{~†}				
NSCLC	37,792	188 (38 to 308)	27,643	27 (13 to 48)
SCLC	6,041	178 (27 to 306)	4,798	18 (8 to 31)
AJCC TNM stage ^{~†}				
I	8,428	219 (63 to 319)	6,878	34 (15 to 58)
II	1,847	188 (40 to 311)	1,682	33 (17 to 56)
III	12,916	189 (37 to 307)	9,679	26 (13 to 47)
IV	20,642	169 (28 to 302)	14,202	20 (9 to 37)
Age (years) ^{~†}				
66-69	8,441	146 (24 to 293)	7,404	24 (11 to 43)
70-74	11,487	174 (31 to 304)	9,483	25 (12 to 46)
75-79	11,477	197 (42 to 311)	8,559	25 (12 to 46)
80 or more	12,428	213 (54 to 315)	6,995	26 (12 to 48)
Gender [~]				
Male	21,904	162 (27 to 299)	16,645	25 (12 to 45)
Female	21,929	209 (49 to 315)	15,796	25 (12 to 46)
Race ^{~†}				
Non-white	5,500	191 (41 to 313)	3,846	27 (12 to 51)
White	38,333	187 (36 to 307)	28,595	25 (12 to 45)
Urban-rural residence [~]				
Metro	36,248	190 (38 to 308)	27,020	25 (12 to 46)
Urban	6,648	167 (30 to 304)	4,759	25 (12 to 43)
Rural	937	169 (27 to 299)	662	25 (12 to 44)
Comorbidity, Charlson score ^{~†}				
0	12,127	43 (11 to 222)	10,271	24 (12 to 43)
1	12,932	171 (40 to 296)	9,832	25 (12 to 45)
2	18,774	259 (122 to 331)	12,338	26 (12 to 47)

NSCLC = Non-Small Cell Lung Cancer, SCLC = Small Cell Lung Cancer, AJCC = American Joint Committee on Cancer, TNM = Tumor Node Metastasis, IQR = 25-75% Interquartile range.

Source: Surveillance, Epidemiology and End Results-Medicare linked data files, 2002-2007.

[~] Kruskal-Wallis/Mann-Whitney test (p = 0.05) comparing differences in 'Symptom to Diagnosis' time interval among beneficiaries

[†] Kruskal-Wallis/Mann-Whitney test (p = 0.05) comparing differences in 'Diagnosis to Treatment' time interval among beneficiaries

[^]'Symptom to diagnosis' interval is time from the earliest Medicare claim date, which had an International Classification of Disease (ICD-9-CM) code associated with a lung cancer symptom, until the date of cancer diagnosis. 'Diagnosis to Treatment' interval is the time from cancer diagnosis, until the date of first Medicare claim for surgery, radiation, or chemotherapy.

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Table 4

Descriptive characteristics by receipt of guideline-concordant timely lung cancer care among continuously enrolled Medicare Fee-for-service beneficiaries with incident lung cancer diagnosis in the United States, 2003 through 2006.

Characteristics	Timely Care ~		Delayed Care	
	No.	% #	No.	% #
Overall	25,139	77.5	7,302	22.5
Lung cancer type ^				
NSCLC	20,960	75.8	6,683	24.2
SCLC	4,179	87.1	619	12.9
AJCC TNM stage ^				
I	4,924	71.6	1,954	28.4
II	1,220	72.5	462	27.5
III	7,315	75.6	2,364	24.4
IV	11,680	82.2	2,522	17.8
Age (years) ^				
66-69	5,857	79.1	1,547	20.9
70-74	7,330	77.3	2,153	22.7
75-79	6,642	77.6	1,917	22.4
80 or more	5,310	75.9	1,685	24.1
Gender				
Male	12,953	77.8	3,692	22.2
Female	12,186	77.1	3,610	22.9
Race ^				
Non-white	2,818	73.3	1,028	26.7
White	22,321	78.1	6,274	21.9
Urban-rural residence ^				
Metro	20,833	77.1	6,187	22.9
Urban	3,777	79.4	982	20.6
Rural	529	79.9	133	20.1
Comorbidity, Charlson score ^				
0	8,123	79.1	2,148	20.9
1	7,638	77.7	2,194	22.3
2	9,378	76	2,960	24

NSCLC = Non-Small Cell Lung Cancer, SCLC = Small Cell Lung Cancer, AJCC = American Joint Committee on Cancer, TNM = Tumor Node Metastasis.

Source: Surveillance, Epidemiology and End Results-Medicare linked data files, 2002-2007.

~ Guideline-concordant timely lung cancer care determined using British Thoracic Society and RAND Corporation clinical opinion-based guidelines for management of lung cancer.

Row percentages

^ Association between beneficiary characteristics and receipt of guideline-concordant timely care; Chi-square test (p = 0.05)

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Table 5

Factors associated with receipt of guideline-concordant timely lung cancer care among continuously enrolled Medicare Fee-for-service beneficiaries with incident lung cancer diagnosis in the United States, 2003 through 2006.

Characteristic	Odds Ratio	95% Confidence Interval
Intercept (p-value)	0.07	-
Cancer type		
NSCLC	0.51*	0.47 to 0.56
SCLC		<i>Reference</i>
AJCC TNM stage		
I	0.59*	0.55 to 0.64
II	0.60*	0.53 to 0.68
III	0.68*	0.64 to 0.73
IV		<i>Reference</i>
Age (years)		
66-69	1.10*	1.02 to 1.20
70-74	1.02	0.94 to 1.10
75-79	1.07	1.00 to 1.16
80 or more		<i>Reference</i>
Gender		
Male	1.05	0.99 to 1.10
Female		<i>Reference</i>
Race		
Non-white	0.79*	0.73 to 0.86
White		<i>Reference</i>
Urban-rural residence		
Metro	0.89	0.72 to 1.11
Urban	1.01	0.80 to 1.26
Rural		<i>Reference</i>
Comorbidity, Charlson score		
0	1.13*	1.06 to 1.20
1	1.08*	1.01 to 1.15
2		<i>Reference</i>
Percentage with some college education (%) ^		
0.0-0.10	0.62	0.01 to 0.69
0.11-0.20	0.69	0.11 to 0.75
0.21		<i>Reference</i>
Median household income (\$) ^		
0-25,000	0.89*	0.80 to 0.98

Characteristic	Odds Ratio	95% Confidence Interval
25,001-50,000	0.93	0.84 to 1.01
50,001	<i>Reference</i>	

NSCLC = Non-Small Cell Lung Cancer, SCLC = Small Cell Lung Cancer, AJCC = American Joint Committee on Cancer, TNM = Tumor Node Metastasis.

Guideline-concordant timely lung cancer care determined using British Thoracic Society and RAND Corporation clinical opinion-based guidelines for management of lung cancer.

Model (N = 32,441), Fit Statistics: -2 restricted log pseudo-likelihood = 150424.20, Covariance parameter estimates: Intercept = county, estimate = 0.09, standard error = 0.02.

Source: Surveillance, Epidemiology and End Results-Medicare linked data files, 2002-2007.

* Statistical significance: $p < 0.05$

^ Census tract level measure

Table 6

Survival outcomes by receipt of guideline-concordant timely lung cancer care among continuously enrolled Medicare Fee-for-service beneficiaries with incident lung cancer diagnosis in the United States, 2003 through 2004.

Characteristic	N	Percent censored	Median survival time, days (95% CI) *	3-year survival rate (95% CI) *
Overall #				
Timely Care ~	13,212	25.2%	273 (266 to 282)	0.21 (0.20 to 0.22)
Delayed Care	3,535	32.8%	491 (466 to 508)	0.28 (0.27 to 0.30)
Cancer Type				
<i>NSCLC</i> #				
Timely Care ~	10,949	27.9%	281 (271 to 291)	0.24 (0.23 to 0.25)
Delayed Care	3,269	33.9%	500 (479 to 520)	0.29 (0.28 to 0.31)
<i>SCLC</i> #				
Timely Care ~	2,263	12.4%	252 (239 to 266)	0.07 (0.06 to 0.09)
Delayed Care	266	20.3%	372 (324 to 428)	0.16 (0.11 to 0.21)
AJCC TNM Stage				
<i>I</i>				
Timely Care ~	2,532	64.7%	-	0.62 (0.60 to 0.64)
Delayed Care	946	61.7%	-	0.58 (0.55 to 0.62)
<i>II</i>				
Timely Care ~	574	44.6%	745 (626 to 850)	0.40 (0.36 to 0.45)
Delayed Care	192	40.6%	618 (527 to 777)	0.37 (0.30 to 0.44)
<i>III</i> #				
Timely Care ~	4,077	22.6%	305 (291 to 317)	0.17 (0.15 to 0.18)
Delayed Care	1,214	28.2%	472 (443 to 498)	0.22 (0.19 to 0.24)
<i>IV</i> #				
Timely Care ~	6,029	8.6%	146 (140 to 152)	0.04 (0.04 to 0.05)
Delayed Care	1,183	13.3%	290 (270 to 308)	0.09 (0.07 to 0.11)

NSCLC = Non-Small Cell Lung Cancer, SCLC = Small Cell Lung Cancer, AJCC = American Joint Committee on Cancer, TNM = Tumor Node Metastasis, CI = Confidence Interval, - = median survival time not reached.

Source: Surveillance, Epidemiology and End Results-Medicare linked data files, 2002-2007.

~ Guideline-concordant timely lung cancer care determined using British Thoracic Society and RAND Corporation clinical opinion-based guidelines for management of lung cancer.

* Survival times and rates obtained from Kaplan-Meier survival estimates.

Log-rank test ($p = 0.05$) comparing differences in survival by receipt of guideline-concordant timely care

Table 7

Lung cancer mortality risk by receipt of guideline-concordant timely lung cancer care among continuously enrolled Medicare Fee-for-service beneficiaries with incident lung cancer diagnosis in the United States, 2003 through 2004.

Characteristics	Hazard Ratio (95% Confidence Interval)
Timeliness of care ~	
Delayed care	0.68* (0.66 to 0.71)
Timely care	1 (Ref)
Cancer type	
NSCLC	0.94* (0.90 to 0.98)
SCLC	1 (Ref)
AJCC TNM stage	
I	0.15* (0.14 to 0.16)
II	0.28* (0.25 to 0.31)
III	0.52* (0.50 to 0.54)
IV	1 (Ref)
Age (years)	
66-69	0.70* (0.66 to 0.75)
70-74	0.75* (0.71 to 0.79)
75-79	0.80* (0.77 to 0.84)
80 or more	1 (Ref)
Gender	
Male	1.24*** (1.20 to 1.28)
Female	1 (Ref)
Race	
Non-white	0.97 (0.90 to 1.04)
White	1 (Ref)
Urban-rural residence	
Metro	1.00 (0.88 to 1.14)
Urban	0.99 (0.87 to 1.13)
Rural	1 (Ref)
Comorbidity, Charlson score	
0	0.87* (0.83 to 0.91)
1	0.90* (0.86 to 0.94)
2	1 (Ref)
Percentage with some college education (%) ^	
0.0-0.10	1.91 (0.88 to 3.11)
0.11-0.20	1.89 (0.95 to 3.05)
0.21	1 (Ref)
Median household income (\$)	

Characteristics	Hazard Ratio (95% Confidence Interval)
0-25,000	1.22* (1.13 to 1.33)
25,001-50,000	1.10* (1.02 to 1.19)
50,001	1 (Ref)

NSCLC = Non-Small Cell Lung Cancer, SCLC = Small Cell Lung Cancer, AJCC = American Joint Committee on Cancer, TNM = Tumor Node Metastasis.

Model (N = 16,747), Fit Statistics: -2 log likelihood = 223470.70 (without covariates) and 217646.99 (with covariates), Global null hypothesis: Likelihood ratio chi-square test = 5823.7 (p = 0.05).

Source: Surveillance, Epidemiology and End Results-Medicare linked data files, 2002-2007.

* Statistical significance: p = 0.05

^ Census tract level measure

~ Guideline-concordant timely lung cancer care determined using British Thoracic Society and RAND Corporation clinical opinion-based guidelines for management of lung cancer.

Table 8

Lung cancer mortality risk by receipt of guideline-concordant timely lung cancer care and by cancer type and stage, among continuously enrolled Medicare Fee-for-service beneficiaries with incident lung cancer diagnosis in the United States, 2003 through 2004.

Characteristics	Hazard Ratio [^] (95% Confidence Interval)
Lung cancer type	
NSCLC	0.68 * (0.65 to 0.71)
SCLC	0.68 * (0.60 to 0.78)
AJCC TNM stage	
I	1.01 (0.90 to 1.13)
II	1.04 (0.82 to 1.31)
III	0.71 * (0.66 to 0.76)
IV	0.58 * (0.55 to 0.62)

NSCLC = Non-Small Cell Lung Cancer, SCLC = Small Cell Lung Cancer, AJCC = American Joint Committee on Cancer, TNM = Tumor Node Metastasis.

Guideline-concordant timely lung cancer care determined using British Thoracic Society and RAND Corporation clinical opinion-based guidelines for management of lung cancer.

Source: Surveillance, Epidemiology and End Results-Medicare linked data files, 2002-2007.

* Statistical significance: $p < 0.05$

[^] Hazard ratios associated with receipt of delayed care (Reference: Receipt of timely care), adjusted for age, gender, race, urban-rural residence, comorbidity, and census tract level measure of education and income.