The Effect of Payer Status on Survival of Patients with Stage I/II Non-small Cell Lung Cancer: NCDB 1998-2011

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Abstract. *Background: One of the challenges to improving access to care is identifying disparities in health care. To determine the influence of insurance status on outcome for patients with non-small cell lung cancer (NSCLC), we analyzed data from the National Cancer Data Base (NCDB) from 1998-2011. Materials and Methods: Data from 299,914 patients diagnosed with NSCLC registered in the NCDB were analyzed. Overall survival (OS) was the outcome variable, and payer status was the primary predictor variable. Other variables included stage, grade, lymph node status, age, race, Charlson Comorbidity Index, income, education, distance travelled, cancer program, diagnosing/treating facility, treatment delay, surgery, chemotherapy and radiation therapy. Multivariate Cox regression was used to investigate the effect of payer status on OS while adjusting for secondary predictive factors. Results: The majority of patients diagnosed at stage I-II had Medicare (61.72%), while less than one third were privately insured (29.57%). In univariate analysis, the median OS was 2.90, 3.42, 3.86, 4.19, and 6.23 years for Medicare, Medicaid, uninsured, unknown, and privately insured patients, respectively. Multivariate analysis revealed a statistically significant relationship between insurance status and OS. Interaction effects of treatment between radiation and surgery were statistically significant: patients receiving radiation in addition to surgery had a 37% increased mortality compared to patients undergoing surgery alone. Compared to receiving no treatment (radiation, surgery, chemotherapy), the 5-year direct adjusted survival probability increased by 44.70%, 40%, 3.91%, 9.42%, 31.56% and 33.20% for patients treated with surgery and chemotherapy, surgery alone, chemotherapy alone, radiation alone, radiation plus surgery, and radiation plus surgery and chemotherapy, respectively. Conclusion: Insurance status proved to be a statistically significant predictor of OS, which remained true after adjusting for all other factors. Uninsured and Medicaid patients had the highest mortality. Multivariate analysis revealed that chemotherapy in addition to surgery provided the best 5-year direct adjusted survival probability.*

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Key Words: NSCLC, survival, payer status, insurance, risk factors.

Lung cancer is responsible for more deaths than colon, breast and prostate cancer combined (1). In 2015, there will be an estimated 221,200 new cases of lung and bronchus cancer and approximately 158,040 deaths in the U.S. alone (2). In 2012, the estimated prevalence of people in the U.S. living with lung and bronchus cancer was 408,808 (2). A study demonstrated that 87% of patients diagnosed with lung cancer have non-small cell histology (3), the 5-year survival for patients with localized lung and bronchus cancer is only 54.8% (2), posing a threat to public health (4). The median age of diagnosis for non-small cell lung cancer (NSCLC) is 70 years (2, 5). The age-adjusted lung and bronchus cancer mortality rate for men and women was 47.2 per 100,000 between 2008 to 2012 (2). Men have a mortality of approximately 60 per 100,000, which is higher compared to the almost 40 per 100,000 for women. Among men, African-Americans have the highest mortality (73.1), followed by Caucasians (59.7) and Asians (34.0) per 100,000. For women, the age-adjusted mortality rates were 39.1, 35.8, 18.2 per 100,000 for Caucasian, African-American and Asian patients (6), respectively.

Some studies report no association between race and type of treatment (7, 8), while other data demonstrate that African-Americans and Hispanics are less likely to undergo lung resection or radiotherapy for inoperable early stage NSCLC (9-12). Type of treatment was associated with tumor characteristic (7). As the stage of diagnosis reflects the extent of cancer progression, lower stages are associated with better survival outcomes (2). Numerous studies have identified low socioeconomic status, especially being underinsured (uninsured, Medicaid), as a significant factor in delaying proper diagnosis and treatment (4, 13-17). Payer status may

affect access to health care and has been found to influence breast cancer stage at diagnosis and patient survival (14, 18-23). Reduced access to health care has been linked to diagnosis at more advanced stages of cancer (14, 21) and worse survival (14, 18). Lower survival rates have been found in uninsured or Medicaid patients (14, 18, 22, 24, 25). Lower education, another significant socioeconomic factor, has been associated with large tumor size and advanced-stage disease at breast cancer diagnosis (26). However, the association between education and patient survival has been conflicting (27, 28).

With the recent development of the Affordable Care Act (29), there may be a shift in health insurance coverage in the U.S. In 2013, there were 201 million people with a private insurance plan, 54.1 million people enrolled in Medicaid, 49 million with Medicare, and 42 million without healthcare insurance (30). As the type and availability of insurance changes, it will be important to assess differential effects of payer status on the outcome of patient survival. However, an MD Anderson study identified travel distance to a healthcare facility as a possible barrier to early diagnosis of colon cancer, suggesting that healthcare reforms focused on increasing insurance coverage will not address geographic barriers (31). The present study directly investigated the effect of payer status on overall survival for patients with early-stage NSCLC while adjusting for other factors.

Materials and Methods

This study examined 299,914 patients with stage I/II NSCLC who were diagnosed between 1998 and 2011 and followed up until December 31, 2012. The data were derived from a de-identified National Cancer Data Base (NCDB) file. The NCDB captures approximately 70% of all newly diagnosed cases of cancer in the U.S. at the institutional level (32). The International Classification of Disease for Oncology, third edition (ICD-O-3) codes (C340-C343, C348, and C349) associated with a diagnosis of NSCLC were used to select patients.

The survival time of patients with NSCLC was calculated from date of diagnosis to date of death, date of loss to follow-up, or date of study end (December 31, 2012). The variables investigated included payer status, sex, age, race, Charlson Comorbidity Index, income, education, distance travelled, cancer program, diagnosing/treating facility, treatment delay, grade, tumor stage, lymph node status, surgery, chemotherapy, radiation therapy.

Payer status was categorized as uninsured, private, Medicaid, Medicare (or other government insurance plan), or unknown. The American Joint Committee on Cancer stage was categorized as I-II for stage at diagnosis. Age was grouped as 18-49, 50-64, 65-74, or ≥75 years. Patient race was categorized as White, African-American, or Asian. The Charlson Comorbidity Index (33) reflects the overall health status of a patient and was categorized as 0, 1, or ≥2. Income, or median household income at zip code level, was grouped as <$30k, $30-34k, $35-45k, or ≥$46k. The percentage of adults in the patient's zip code who did not graduate from high school, as a measure of education, was grouped as ≥29%, 20-28.9%, 14-19.9%, and <14%. Education was determined using 2000 census data. Distance travelled, the distance from the patient's residential zip code to a medical center, was grouped as <33, 33-66, 66-100, or ≥100 miles. Cancer program was categorized as a community cancer program, a comprehensive cancer program, or an academic/research program; other (other services and clinics) cancer programs were excluded due to the relatively small number that fell into this category. Diagnosing/treating facility (whether the patient was diagnosed and treated at the same or different facility) was categorized as same or different. The number of days between the date of diagnosis and the date on which treatment of the patient began at any facility (i.e. treatment delay) was grouped as 0-7, 8-30, or ≥31 days. The treatment status was categorized as received and not received (no treatment at all) for surgery, chemotherapy and radiation therapy, respectively.

Kaplan–Meier methods were used to estimate survival curves. Log-rank tests were used to compare the survival distributions in univariate analysis. Šidák correction method was used for adjustment in multiple comparisons for the log-rank test where appropriate. Multivariate Cox regression was used to simultaneously estimate the hazard of death (hazard ratio) of payer status and adjusted other factors. Direct adjusted median overall survival (MOS) was calculated by using multivariate Cox regression. Statistical Software SAS 9.4 (SAS Inc. Gary, NC, USA) was used for data management, statistical analysis, and modeling. All *p*-values of less than 0.05 were considered statistically significant.

Results

Among the 299,914 patients selected, the mean age at diagnosis was 68.28 years. The mean age at diagnosis for Medicare patients was 73 years and for uninsured it was 56 years. Table I displays patient characteristics for patients with early-stage NSCLC included in this study. The percentage of patients with Medicare, private insurance, Medicaid, unknown insurance status, and no insurance was 61.72%, 29.57%, 4.06%, 2.71%, and 1.93%, respectively. A total of 15.74% of patients resided in zip codes where residents had a median income <$30,000. The large majority (81.2%) of patients travelled less than 33 miles to their healthcare facility. Approximately 26% of patients were diagnosed with disease at stage II. The leading modality of treatment for NSCLC was surgery (70.4%), followed by radiation (25.17%) and chemotherapy (22.71%).

Univariate analysis (Table II) presents MOS based on socioeconomic and treatment factors. MOS for the whole patient cohort was 3.62 years. Patients insured through Medicare demonstrated the shortest MOS (2.90 years), followed by those with Medicaid (3.42 years), uninsured (3.86 years), unknown (4.19 years), and those with private insurance (6.23 years). MOS stratified by insurance status statistically significantly differed (all *p*-values <0.05).

Our study revealed that demographic, socioeconomic, tumor characteristic, and treatment factors were statistically significant predictors of OS. Females had a longer MOS (4.56 years) than males (2.90 years). Significant racial

Table I. *Characteristics of patients with stage I/II non-small cell lung cancer: National Cancer Data Base 1998-2011.*

Factor	Level	N	%
Gender	Male	152900	50.98
	Female	147014	49.02
Age, years	18-49	15369	5.12
	50-64	84531	28.19
	65-74	108545	36.19
	75+	91469	30.5
Race	White	267602	89.23
	African-American	26974	8.99
	Asian	5338	1.78
Comorbidity	0	109367	36.47
index	1	66752	22.26
	2	28020	9.34
	Unknown	95775	31.93
Insurance	Uninsured	5796	1.93
	Private	88695	29.57
	Medicaid	12183	4.06
	Medicare	185098	61.72
	Unknown	8142	2.71
Income	<30-k	45109	15.74
	30-34k	58558	20.44
	35-45k	83082	29
	46+k	99759	34.82
Education*	≥29%	52978	18.49
	20-28.9%	73616	25.7
	14-19.9%	70606	24.65
	<14%	89278	31.16
Distance	<33	236661	81.2
travelled, miles	33-66	33339	11.44
	66-100	10427	3.58
	100+	11025	3.78
Facility type	CCP	32851	10.95
	Comprehensive CCP	172046	57.37
	Academic/ research program	95017	31.68
Diagnosing/	Same facility	223200	74.42
treating facility	Different facility	76714	25.58
Treatment	0-7	75408	28.79
delay, days	8-30	74127	28.3
	31+	112390	42.91
Tumor grade	Well-differentiated	31413	13.25
	Moderately differentiated	98062	41.36
	Poorly/undifferentiated	107602	45.39
AJCC stage	I	221496	73.85
	II	78418	26.15
Lymph node	Negative	160081	83.18
status	1-4 Positive	29751	15.46
	5+ Positive	2618	1.36
Surgery	No	88604	29.6
	Yes	210772	70.4
Radiation	No	220854	74.83
	Yes	74306	25.17
Chemotherapy	No	211741	77.29
	Yes	62200	22.71

CCP: Community Cancer Program; AJCC: .American Joint Committee on Cancer; *based on percentage of zip code residents not graduating from high school.

Table II. *Median overall survival of patients with stage I/II non-small cell lung cancer: National Cancer Data Base 1998-2011.*

			95% Confidence interval		
Factor	Level	MOS	Lower	Upper	*p*-Value
	All	3.62	3.59	3.64	
Gender	Male	2.90	2.86	2.93	<0.0001
	Female	4.56	4.50	4.61	
Age, years	18-49	10.16	9.76	10.66	<0.0001
	50-64	5.82	5.73	5.91	
	65-74	3.68	3.64	3.72	
	75+	2.19	2.17	2.22	
Race	White	3.64	3.61	3.67	<0.0001
	African-American	3.18	3.10	3.27	
	Asian	5.12	4.85	5.40	
Comorbidity	0	4.38	4.33	4.45	<0.0001
index	1	4.05	3.99	4.13	
	2	2.67	2.61	2.73	
	Unknown	2.99	2.95	3.03	
Insurance	Uninsured	3.86	3.57	4.15	<0.0001
	Private	6.23	6.12	6.32	
	Medicaid	3.42	3.27	3.54	
	Medicare	2.90	2.87	2.92	
	Unknown	4.19	3.98	4.37	
Income	<30k	2.85	2.79	2.91	<0.0001
	30-34k	3.29	3.23	3.35	
	35-45k	3.53	3.49	3.58	
	46k+	4.49	4.42	4.55	
Education*	≥29%	4.39	4.32	4.45	<0.0001
	20-28.9%	3.63	3.57	3.68	
	14-19.9%	3.34	3.29	3.39	
	<14%	3.05	2.99	3.11	
Year of	1998-2002	2.99	2.95	3.03	<0.0001
diagnosis	2003-2007	3.69	3.64	3.73	
	2008-2011	4.21	4.15	4.26	
Distance	<33	3.58	3.54	3.61	<0.0001
travelled, miles	33-66	3.76	3.67	3.84	
	66-100	4.19	3.98	4.38	
	100+	5.02	4.82	5.28	
Facility type	CCP	2.55	2.49	2.59	<0.0001
	Comprehensive CCP	3.41	3.37	3.44	
	Academic/ research program	4.58	4.52	4.64	
Diagnosing/	Same facility	3.67	3.64	3.71	<0.0001
treating facility	Different facility	3.45	3.40	3.50	
Treatment	0-7	5.79	5.70	5.87	<0.0001
delay, days	8-30	3.70	3.64	3.75	
	31+	3.55	3.51	3.59	
AJCC stage	I	4.47	4.42	4.50	<0.0001
	II	2.00	1.98	2.03	
Tumor grade	Well-differentiated	7.52	7.37	7.68	<0.0001
	Moderately differentiated	4.65	4.60	4.71	
	Poorly/undifferentiated	3.15	3.12	3.19	
Surgery	No	1.30	1.29	1.31	<0.0001
	Yes	5.75	5.71	5.80	
Radiation	No	4.76	4.72	4.81	<0.0001
	Yes	1.83	1.81	1.85	
Chemotherapy	No	4.15	4.11	4.18	<0001
	Yes	2.71	2.67	2.75	
Lymph	Negative	6.52	6.45	6.58	<0.001
node status	1-3 Positive	3.37	3.31	3.45	
	4+ Positive	2.42	2.32	2.53	

CCP: Community Cancer Program; AJCC: .American Joint Committee on Cancer; *based on percentage of zip code residents not graduating from high school.

Table III. *Hazard ratio (HR) of death in multivariate Cox regression in patients with stage I/II non-small cell lung cancer: National Cancer Data Base 1998-2011.*

Factor	Level	HR	95% Confidence interval		*p*-Value
			Lower	Upper	
Gender	Male	1.00			
	Female	0.75	0.74	0.76	<0.0001
Age, years	18-49	1.00			
	50-64	1.31	1.26	1.37	<0.0001
	65-74	1.73	1.66	1.80	<0.0001
	75+	2.51	2.40	2.62	<0.0001
Race	White	1.00			
	African-American	0.99	0.96	1.02	0.3594
	Asian	0.82	0.77	0.87	<0.0001
Comorbidity index	0	1.00			
	1	1.15	1.13	1.17	<0.0001
	2	1.42	1.38	1.46	<0.0001
	Unknown	1.33	1.30	1.35	<0.0001
Insurance	Private	1.00			
	Uninsured	1.21	1.14	1.28	<0.0001
	Medicaid	1.36	1.31	1.42	<0.0001
	Medicare	1.17	1.15	1.20	<0.0001
	Unknown	0.96	0.91	1.01	0.091
Income	46+k	1.00			
	30-k	1.16	1.13	1.20	<0.0001
	30-34k	1.09	1.06	1.12	<0.0001
	35-45k	1.07	1.05	1.09	<0.0001
Education*	≥29%	1.08	1.04	1.11	<0.0001
	20-28.9%	1.06	1.04	1.09	<0.0001
	14-19.9%	1.04	1.01	1.06	0.0016
	<14%	1.00			
Distance travelled, miles	100+	1.00			
	66-100	1.13	1.07	1.19	<0.0001
	33-66	1.12	1.08	1.17	<0.0001
	<33	1.11	1.07	1.15	<0.0001
Facility type	CCP	1.07	1.05	1.09	<0.0001
	Comprehensive CCP	1.21	1.17	1.24	<0.0001
	Academic/ research program	1.00			
Diagnosing/ treating facility	Same facility	1.00			
	Different facility	0.98	0.96	1.00	0.0529
Treatment delay, days	31+	1.00			
	8-30	0.94	0.92	0.95	<0.0001
	0-7	0.92	0.90	0.93	<0.0001
Tumor grade	Well differentiated	1.00			
	Moderately differentiated	1.44	1.40	1.48	<0.0001
	Poorly/undifferentiated	1.67	1.62	1.71	<0.0001
AJCC Stage	I	1.00			
	II	1.54	1.50	1.58	<0.0001
Lymph node status	Negative	1.00			
	1-3 Positive	1.09	1.06	1.13	<0.0001
	4+ Positive	1.47	1.40	1.53	<0.0001
Chemotherapy	No	1.00			
	Yes	0.88	0.86	0.90	<0.0001

CCP: Community Cancer Program; AJCC: .American Joint Committee on Cancer; *based on percentage of zip code residents not graduating from high school.

Table IV. *Interaction effect of surgery and radiation in patients with stage I/II non-small cell lung cancer: National Cancer Data Base 1998-2011.*

Surgery	Radiation	HR	95% Confidence interval		*p*-Value
			Lower	Upper	
No	No	1.00			
	Yes	0.70	0.61	0.80	<0.0001
Yes	No	1.00			
	Yes	1.37	1.34	1.41	<0.0001

HR: Hazard ratio.

disparity was noted between Asian (5.12 years) and Caucasian (3.64 years) patients and, to a lesser degree, between Caucasian and African-American (3.18 years) patients. Patients with well-differentiated tumor had the longest survival (7.52 years), followed by those with moderately differentiated (4.65 years), and those with poorly or undifferentiated tumor (3.15 years). Patients without lymph node involvement had a MOS of 6.52 years; MOS decreased as the number of positive lymph nodes increased.

Table III shows the hazard ratios from multivariate Cox regression analysis. Payer status was a significant predictor of OS when all other variables were held constant. Compared to patients with private insurance, those with Medicaid, no insurance, and Medicare had increased risk of dying of 36%, 21%, and 17%, respectively. Directed adjusted survival (DAS) by payer status (Figure 1) indicated that privately insured patients had a significantly better five-year survival rate of 58.4%, while Medicaid insured patients had a rate of 48.9%.

Other variables presented in Table I were also significant predictors of survival with the exception of diagnosing/ treating facility. Females were 24.4% less likely to die than their male counterparts. Asian patients were 18% less likely to die compared to their Caucasian peers. Patients diagnosed with disease at stage II were 54% more likely to die than patients diagnosed at stage I. Compared to patients with well-differentiated tumors, patients with moderately differentiated and poorly or undifferentiated tumors had an increased risk of death by 44% and 67%, respectively. Compared to patients without lymph node involvement, patients with more than four positive lymph nodes had increased risk of death by 47%.

Three-way treatment (radiotherapy, surgery, and chemotherapy) interactions were not statistically significant; however, the two-way interaction effects of surgery and radiation on patient survival were significant (Table IV). Out of the patients that did not undergo surgery, those that received radiotherapy had a 30% lower risk of death

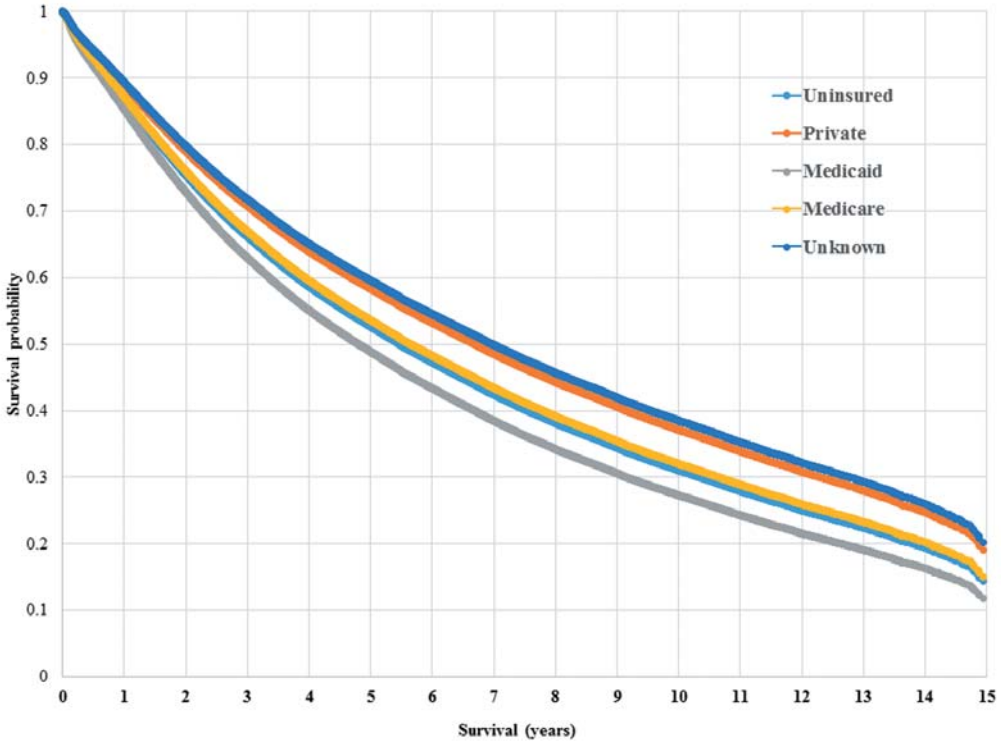

Figure 1. *Direct adjusted survival by insurance type.*

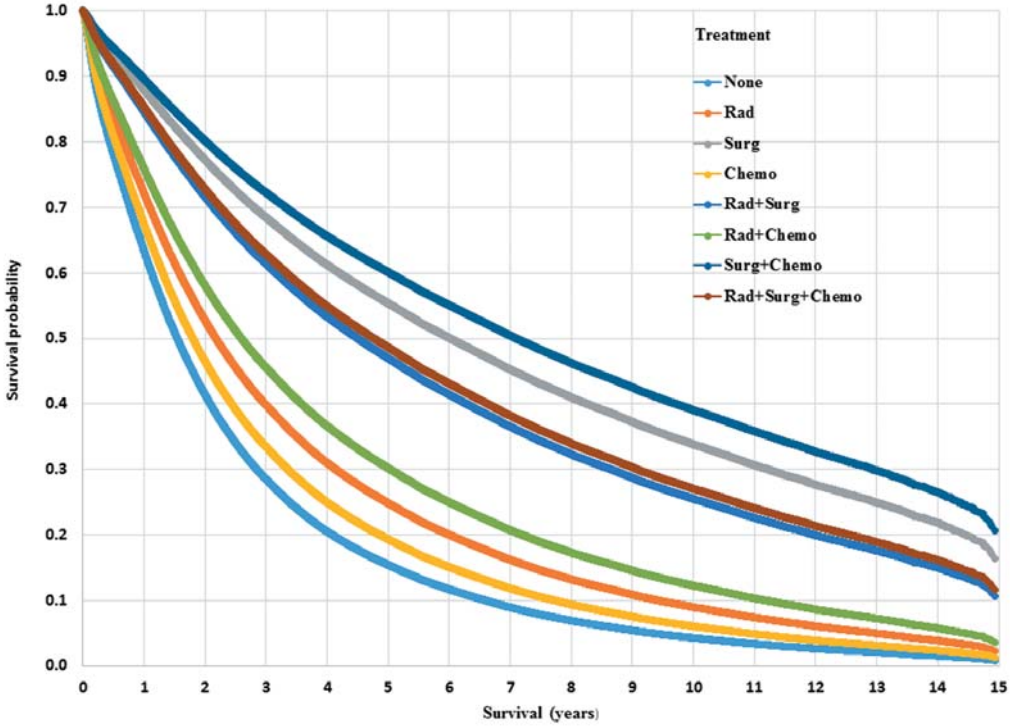

Figure 2. *Direct adjusted survival by treatment type. Rad: Radiation therapy; Surg: surgery; Chemo: chemotherapy.*

compared to patients without radiotherapy. However, out of the patients that underwent surgery, those that additionally received radiotherapy had a 37% increased risk of death compared to patients who did not receive radiotherapy.

Figure 2 presents the DAS, which evaluates patient survival based on treatment while adjusting for all other variables. For example, assessing the 5-year DAS, compared to patients who received no treatment (no radiotherapy, surgery or chemotherapy), surgery alone improved survival by 40%; radiotherapy alone and chemotherapy alone increased survival probability by 9.42% and 3.91%, respectively. Patients who received a combination of surgery and chemotherapy demonstrated the best survival, showing improvement by 44.70% compared to no treatment. The addition of radiotherapy to surgery alone or to a combination of surgery and chemotherapy reduced survival probability; the addition of radiotherapy to chemotherapy alone improved survival.

Discussion

In the present study, we investigated the effects of payer status on early-stage (I, II) NSCLC patients. After adjusting for several factors in multivariate analysis, we determined insurance status to be a significant predictor of OS. Our findings are consistent with previous studies that found Medicaid and uninsured patients to be at higher risk of death than privately insured patients (14, 22, 23, 34). This might be attributed to payer status disparities in treatment type received. In fact, several studies have indicated that the type of treatment received is indeed affected by insurance status (10, 15, 35). These studies observed that uninsured patients have lower rates of resection (35), and Medicare and Medicaid patients have lower rates of surgical intervention and higher rates of radiation therapy (35).

Our study also demonstrates that socioeconomic factors (income, education, distance traveled, treatment delay) and other factors such as sex, age, race and comorbidity affect survival. Our findings agree with previous studies that found similar survival rates for Caucasians and African-Americans (7, 8, 17). However, we found Asians had a lower risk of death (18%) compared to Caucasians. We can speculate this might be partially explained by cultural disparities in treatment selection or compliance, as our findings also indicate that treatment delay affects survival; this is implied in the 2005 Freeman et al.'s review of the determinants of cancer disparities (36).

Our findings furthermore show that certain tumor characteristics (higher grade, later stage, and increased lymph node involvement) are associated with worse survival outcomes, and this is consistent with other studies (2, 37). In contrast to a study on survival of patients with breast cancer (22), our data suggest that delaying treatment increases patients' risk of death from NSCLC. In general, the lower OS associated with lung cancer may necessitate treatment as soon as possible; delays may lead to worse treatment outcomes. On the other hand, breast cancer is in general is associated with longer OS. Immediate treatment for breast cancer may indicate worse prognoses, while treatment delays may indicate that cancer progression is slow enough to allow for the elapsed time. In addition, the breast cancer study did not adjust for treatment options. In multivariate analysis, our study demonstrated that different treatments (surgery, radiation, and chemotherapy) affect patient survival. As indicated in Figure 2, surgery alone was associated with a 5-year DAS rate of 55%. The combination of surgery and radiation increased the DAS rate to 60%, which is consistent with previous studies (16, 35).

The effect of payer status not only exists for NSCLC, but has been also reported in other cancer studies such as of breast cancer and colon cancer (14, 18, 22). The mechanism by which payer status affects OS is not clear; we extrapolate that insurance status may affect OS by changing the likelihood that patients will receive particular types of treatment (35, 38). Mediation analysis to assess the effect of payer status on survival through treatment or other factors may shed light on this proposed mechanism.

While many factors demonstrated statistical significance in multivariate analysis, the reader should differentiate clinically significant from statistically significant results upon interpretation. Two significant strengths of this study include a large sample size, which allowed for hazard ratio estimation with a narrow 95% confidence interval, and data collection by the NCDB, which covers about 70% of all cases in the U.S. However, there were also several limitations to the study. Firstly, there were over 1,500 participating Institutes involved in NCDB data collection, which may have introduced some variations in data reporting or patient selection bias. Secondly, the NCDB does not collect cause-specific death information; analysis of the effect of payer status on cause-specific survival may yield different results. Thirdly, education and income were determined based on zip code, which may not be as accurate as obtaining individual responses. In addition, the Charlson Comorbidity Index was not available until 2003; to estimate missing Charlson comorbidity data, we used the zero comorbidity of 2003 or later cohort as a reference group. Finally, the findings from this study can only be generalized to stage I/II NSCLC, and further details of treatment (type of surgical resection, dosage and exposure time of radiation, or dosage of chemotherapy) were not investigated.

Conclusion

After adjusting for all other factors that affect OS, payer status remained a significant predictor of overall survival for patients with stage I/II NSCLC. Uninsured or Medicaid

patients had a 21% and 36% increased risk of death, respectively, compared to privately insured patients. Further investigation through mediation analysis may be warranted to evaluate whether or not the effect of payer status on survival is mediated in part by treatment options available to patients with NSCLC.

Competing Interests

The Authors declare that they have no competing interests in regard to this study.

Ethics Statement

With the support from the Chair of Louisiana State University Hospital in Shreveport (currently University Health Shreveport) Cancer program, the corresponding author has applied and has been awarded the NCDB Participant Use Data File (PUF) for 1998 to 2012 from the Commission on Cancer (CoC). The PUF is a Health Insurance Portability and Accountability Act compliant data file containing cases submitted to the Commission on Cancer's (CoC) NCDB. The PUF contains de-identified patient level data that do not identify hospitals, healthcare providers, or patients as agreed to in the Business Associate Agreement that each CoC-accredited program has signed with the American College of Surgeons. The PUFs are designed to provide investigators associated with CoC-accredited cancer programs with a data resource they can use to review and advance the quality of care delivered to cancer patients through analyses of cases reported to the NCDB. NCDB PUFs are only available through an application process to investigators associated with CoC-accredited cancer programs.

Acknowledgements

The Authors wish to acknowledge the Commission on Cancer of the American College of Surgeons and the American Cancer Society for making public data available through the NCDB. The data used in this study were derived from a de-identified NCDB file. The American College of Surgeons and the Commission on Cancer have not verified and are not responsible for the analytic or statistical methodology employed or the conclusions drawn from these data by the investigator.

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Received October 6, 2015
Revised November 2, 2015
Accepted November 5, 2015