HEALTHCARE COST AND UTILIZATION DIFFERENCES AMONG AMERICAN INDIAN AND ALASKA NATIVE COMPARED WITH NON-HISPANIC WHITE PATIENTS WITH LUNG CANCER

by

Jill Jim

A dissertation submitted to the faculty of
The University of Utah
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

in

Public Health

Department of Family and Preventive Medicine

The University of Utah

August 2017

The University of Utah Graduate School

STATEMENT OF DISSERTATION APPROVAL

The dissertation of **Jill Jim**

has been approved by the following supervisory committee members:

Mia Hashibe	, Chair	**05/31/2017** Date Approved
Jaewhan Kim	, Member	**05/31/2017** Date Approved
Sara Simonsen	, Member	**05/31/2017** Date Approved
Yelena Wu	, Member	**05/31/2017** Date Approved
Heidi Hanson	, Member	**05/31/2017** Date Approved

and by **Stephen C. Alder**, Chair/Dean of

the Department/College/School of **Division of Public Health**

and by David B. Kieda, Dean of The Graduate School.

ABSTRACT

Lung cancer is the leading cause of cancer death in the United States and survival rates of American Indian and Alaska Native (AIAN) patients are worse than those of non-Hispanic White (NHW) patients. A contributing factor to the worse outcomes may be lower healthcare utilization of AIAN patients. But improving healthcare utilization of AIAN to levels used comparable to those of NHW might increase costs of their care to amounts comparable to those of NHW. **Objectives:** 1) To examine differences in total healthcare costs and healthcare utilization 12 months following lung cancer diagnosis between AIAN patients and NHW patients, 2) To examine differences in total healthcare costs and healthcare utilization during the end-of-life period (last 6 months of life) between AIAN patients and NHW patients who died from lung cancer or any cause, and 3) To compare the incidence of depression disorder 60 months after cancer diagnosis and determine depression treatment utilization among those with a depression disorder. **Methods:** The Surveillance, Epidemiology, and End Results (SEER)-Medicare dataset was used. Patients included in the study were those age 65 years and older, diagnosed with lung cancer between 2000 and 2011, Part A coverage, Part B coverage and no managed care plan before. Diagnosis and procedure codes were used to identify costs, utilization, and depression diagnoses. The propensity score matching method was used to balance groups. A generalized linear model (GLM) was used for costs analysis and the negative binomial regression model was used to analyze healthcare utilization. A Cox

proportional hazards regression model was used to identify risk factors for new diagnosis of depression. **Results:** Being AIAN was associated with lower total healthcare costs 12 months following lung cancer diagnosis. In contrast, being AIAN was not associated with total healthcare costs six months before date of death among patients diagnosed with lung cancer and ≤6 month survival time. The incidence of diagnosis of depression disorder 60 months after lung cancer diagnosis was 3.67% for AIAN patients and 6.16% for NHW patients. The mean number of depression treatment visits suggests higher utilization among AIAN patients compared with NHW patients. AIAN patients were not at increased risk for depression after cancer diagnosis. **Conclusions:** The healthcare utilization of AIAN patients with lung cancer could be improved while keeping costs of care no higher than those of NHW patients. But any improvements of health care use would need to take account of the variability among AIAN patients receiving health care 12 months following cancer diagnosis, in the last six months of life, and after depression disorder diagnosis.

Dedicated to the memories of my dad, David Harvey Jim,

my paternal grandmother, Mary Jim, and my maternal grandfather, Keith Fatt,

who died from cancer.

TABLE OF CONTENTS

LIST OF TABLES

Tables

LIST OF FIGURES

Figures

ACKNOWLEDGEMENTS

I am grateful to my dissertation advisor, Dr. Mia Hashibe, for her leadership, expertise in lung cancer research, guidance, ongoing support, and advice during my dissertation research. I am thankful to Dr. Sara Simonsen, Dr. Yelena Wu, Dr. Jaewhan Kim, Thomas K. Varghese Jr., MD, MS, and Dr. Heidi Hanson for their topic expertise guidance and support in cost analysis, research design, manuscript writing, and STATA programming. I'm grateful to many individuals and programs on this journey.

Dr. Carol Korenbrot and Dr. Alexandria Pierce for their expertise and compassion improving the lives of American Indian people through their research. It is an honor to have known these individuals and I can't thank them enough for their support, motivation, and mentorship during this process. I hope to guide other students as you had with me, you both exemplify great leadership in our Native communities.

Greggory Stoddard and Qian Ding with the University of Utah for their expertise in statistical methods. The Northwest Native American Research Center for Health with the Northwest Portland Area Indian Health Board for their support as a fellow, the Navajo Nation, and other Tribal or nonprofit organizations for their support and commitment to Native students. Lastly, my mother, siblings, extended family, and friends; most importantly, Bruce and our kids for being there for me throughout my dissertation and showing patience.

CHAPTER 1

INTRODUCTION

In the United States, lung and bronchus cancer is the leading cause of all cancer deaths and the second mostly commonly diagnosed cancer in women and men.[1,2] In 2017, an estimated 155,870 lung cancer deaths will occur in men and women, which is one lung cancer death for every four individuals.[2] Twenty-five percent (222,500 new cases) of cancer diagnoses will be new lung cancers in 2017.[2] Despite decreases in lung cancer incidence over time for American Indian and Alaska Native (AIAN) individuals, their lung cancer rates have not declined as much as non-Hispanic (NHW) individuals.[3,4] For every 100 lung cancers diagnosed, there are six more AIAN deaths than NHW deaths.[5]

Excess risk for lung cancer and cancer deaths are often attributable to behavioral risk factors such as smoking. The primary risk factor for lung cancer is smoking tobacco, as well as a person's cancer history, family history, age, smoking exposure, and occupational exposures (i.e., radon).[6] Compared to other racial/ethnicity groups, AIAN adults report a higher prevalence of daily cigarette, cigar, and smokeless tobacco use and over time their decline in smoking rates has been much slower.[5,7] Even more so, older AIAN (≥ 65 years) individuals have 10% higher odds of smoking-attributable deaths due to lung cancer compared with older NHW individuals.[8] AIAN patients with lung cancer have worse outcomes. Five-year survival rates for AIAN patients for any cancer are much

lower (53.9%) than other racial/ethnicity groups (67.6% for NHW patients, 57.0% for Blacks).[9] Most AIAN patients, once diagnosed with lung cancer, live with cancer fewer years than NHW patients.

A smaller proportion of AIAN patients with lung cancer have surgery after cancer diagnosis.[10-12] There are standard treatment guidelines for lung cancer patients developed by the National Comprehensive Cancer Network.[13] Cancer-related therapy consists of surgery, radiation, chemotherapy, and combination treatments. Appropriate therapy depends on the type of lung cancer, and may differ depending on the stage at which it is diagnosed. For example, initial therapy for non-small cell lung cancer patients depend on the stage of the disease, if the tumor is small then surgery is recommended;
a larger tumor it may require surgery followed by radiation treatment, and in some cases additional chemotherapy.[13] Although guidelines are in place, fewer AIAN cancer patients than NHW cancer patients received guideline-concordant treatment after cancer diagnosis.[10] More often these patients are diagnosed with lung cancer at stage III or IV of the disease, which is considered late stage.[10] Lung cancer patients with a late-stage diagnosis are given different treatment options than those at an earlier stage (stage I or II diseases).

Racial differences in health care costs and utilization of lung cancer patients have not been widely studied. The publications that do exist focus on either cancer-treatment and/or racial/ethnicity groups. In 2008, two studies using SEER-Medicare datasets reported trends in the cost of initial cancer treatment and costs of care for elderly patients in the United States. In 2002, one study showed that the total healthcare costs (cancer-treatment and other hospitalizations) for lung cancer patients was $39,891.[14] In

2004, researchers defined three phases of care to describe cost implications for cancer patients: 1) initial phase (less than 12 months after diagnosis), 2) continuing phase (more than 12 months after cancer diagnosis), and 3) end-of-life phase (last 12 months of life).[15] The mean net costs of cancer care (e.g., the difference between cancer patients and control subjects without cancer) for lung cancer patients with a distant stage at diagnosis was $42,833, while patients in the last year of life was $66,969.[15] Because racial differences were not addressed in these publications, our research will add to their findings.

Cancer patients diagnosed at a late stage (distant) for lung cancer may experience psychological distress leading to a depression disorder diagnosis. As worse cancer survival outcomes are seen in lung cancer patients with a depression disorder, more research was recognized by several researchers to identify incidence and prevalence rates for depression in cancer patients, especially in the United States.[16-18]

In the United States, there are 566 federally recognized tribes. Many of those receive health services (including mental health services) through Indian Health Service (IHS) under the Indian Health Care Improvement Act in 1976 as modified and amended in succeeding years.[19,20] Patient care provided through the IHS for the AIAN population is not an entitlement program like Medicare, Medicaid, or Social Security with a budget proportional to the population that is entitled to the benefits. Instead, the IHS has a budget that changes little from year to year as the AIAN population grows. There are limits on the amount of health care that can be provided to the AIAN population, though since 1976 the AIAN population may apply for Medicaid or Medicare like other US citizens. The IHS has a limited number of health care providers located on or near tribal

lands that provide mainly primary care. In the 2010 census, there was an estimated 76% of AIAN individuals residing off a Tribal Reservation.[21] In order to maintain eligibility for IHS, a patient has to reside within the IHS boundaries and if a patient relocates eligibility is loss after three months.[22] Figure 1.1 shows the IHS boundaries by Contract Health Service Delivery Areas.[23] Although the IHS receives federal funding to give tribes for medical services not provided by IHS health care facilities, there is never enough to cover the needs of all patients. IHS health care facilities encourage Medicare enrollment of eligible AIAN so facilities can be reimbursed for treatment they provide.

AIAN cancer patients with Medicare or other health care coverage receive health services on and off the tribal reservations and they often require cancer-treatment at non-IHS facilities. The Centers for Medicare and Medicaid Services (CMS) is an agency committed to providing a health insurance program for people older than 65 years old, people under age 65 with certain disabilities, and those with End-Stage Renal Disease at any age. CMS works with tribes through meaningful consultation and a Tribal Advisory Group to assure access to care for AIAN elders and to increase capacity of Indian Health Service to deliver integrated and comprehensive programs.[24] Effective policies are extremely important regarding enrollment, access to care, coordinated care, integrated services, coverage, and benefits for AIAN elderly patients with lung cancer, since their health needs differ from other Medicare enrollees.

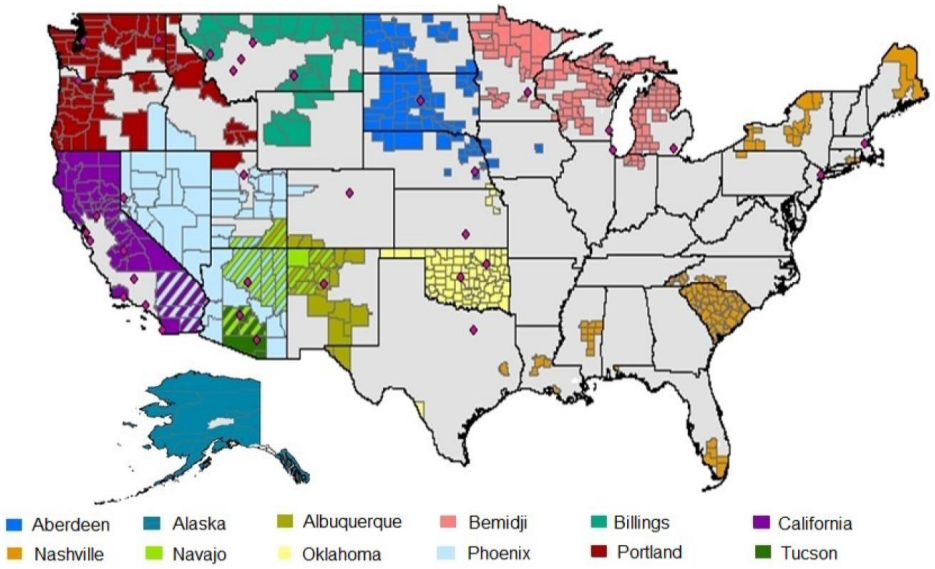
Investigating healthcare costs and utilization differences among AIAN and NHW patients with lung cancer could determine whether an AIAN individual get less treatment at lower costs. Understanding healthcare costs and utilization differences among AIAN and NHW patients with lung cancer will provide a foundation for further research and an

evaluation of cancer care disparities. This dissertation focused on three specific aims.

In the first specific aim, we will examine whether there are differences in total healthcare costs and healthcare utilization 12 months following lung cancer diagnosis between AIAN and NHW patients. The hypotheses are that total healthcare costs and healthcare utilization are higher for NHW patients compared with AIAN patients with lung cancer.

In the second specific aim, we will examine differences of total healthcare costs and healthcare utilization during the end-of-life period (last six months of life) between AIAN and NHW patients who died from lung cancer or any cause. The hypotheses are that total healthcare costs and healthcare utilization are higher for NHW patients during the end-of-life period compared with AIAN patients with lung cancer.

The third specific aim is to compare the incidence of depression disorder 60 months after cancer diagnosis and to determine depression treatment utilization among those with depression disorder. We will further determine the risk factors for depression disorder among lung cancer patients. The hypotheses are that incidence of depression disorder is higher in AIAN patients and that there is less depression treatment utilization for AIAN patients compared with NHW patients with lung cancer.



[a] The map is based on CHSDA designations in 2006. Since that time, the CHSDA county designations have had minor changes, with counties being added to or removed from CHSDAs. These changes impacted Albuquerque, Nashville, and Phoenix areas.

Figure 1.1 Indian Health Service Areas by Contract Health Service Delivery Areas (CHSDA).

CHAPTER 2

DIFFERENCES IN HEALTHCARE COST AND UTILIZATION BETWEEN AMERICAN INDIAN AND ALASKA NATIVE COMPARED WITH NON-HISPANIC WHITE PATIENTS FOLLOWING 12 MONTHS AFTER LUNG CANCER DIAGNOSIS

2.1 Abstract

While disparities in lung cancer survival outcomes of American Indian and Alaska Native (AIAN) patients compared to non-Hispanic White (NHW) patients are documented, little is known of disparities in health care among AIAN and NHW patients with lung cancer that could contribute to these disparities in outcome, nor what the costs might be of reducing any disparities in health care. **Objective:** We examined total healthcare cost and utilization (for cancer- and noncancer-treatment) differences among AIAN patients and NHW patients 12 months after lung cancer diagnosis. **Methods:** We used the Surveillance, Epidemiology, and End Results (SEER)-Medicare dataset and identified 126,725 patients diagnosed from January 1, 2000 to December 31, 2011. There were 1,254 patients matched on patient characteristics and cancer prognosis. To identify total healthcare costs and total healthcare utilization based on cancer and noncancer-treatment, we used diagnosis and procedure codes. To examine total healthcare costs between American Indian and Alaska Native patients and non-Hispanic White patients,

we used a generalized linear model with gamma distribution and log link. To examine healthcare utilization, we used a negative binomial regression Model. **Results:** American Indian and Alaska Native patients used significantly less health care ($p < 0.01$) compared with non-Hispanic White patients. Being an American Indian and Alaska Native patient was also associated with lower total healthcare costs ($p = 0.01$) adjusting for patient characteristics and cancer prognosis. An analysis of cancer-treatment and noncancer-treatment costs showed that being an American Indian and Alaska Native patient was associated with lower cancer-treatment costs, but not noncancer-treatment costs. **Conclusion:** Healthcare disparities exist between AIAN and NHW lung cancer patients, with lower costs of cancer care among the AIAN patients indicating that increased costs of reducing the healthcare disparities need not increase costs of care relative to NHW patients.

2.2 Introduction

In the United States, cancer costs continue to increase annually in part due to new treatments, an aging population, and longer survival among those with cancer.[14,25] Cancer care expenditures from 1998 to 2000 was $94.6 billion and by 2010 it was $133.7 billion.[25] In 2014, across several payment sources for cancer care, 38% of costs were covered by Medicare and 44% of costs by private payers.[25] Payment sources for health services often entail private insurance, patients and their families (out-of-pocket), and public plans such as Medicare and Medicaid.

Among Medicare patients, the average cost of lung cancer treatments was greater than those of breast and prostate cancer treatments.[14] Yabroff and researchers[15] reported that lung cancer patients with Medicare coverage and late-stage diagnosis have higher net

costs of lung cancer care in the initial phase (12 months following cancer diagnosis). Additionally, Warren and researchers[14] reported that an increase in cancer-treatment costs during the initial phase are related to surgery and adjuvant therapy ($12,712 for cancer-related surgery and $23,026 for chemotherapy vs. $12,712 for surgery).

In 2017, an estimated 155,870 lung cancer deaths will occur in men and women, which is the equivalent of one cancer death for every four individuals.[2] Twenty-five percent (222,500 new cases) of cancer diagnoses will be new lung cancers in 2017. Over the course of a decade (1999 to 2009), 8,118 AIAN persons died from lung cancer in the United States.[5] Most important, in Indian Health Service areas cancer deaths vary. AIAN patients have higher lung cancer deaths compared with NHW persons across several areas throughout the nation, such as Northern Plains, Alaska, Southern Plains, and the Pacific Coast.[5]

Little is known about differences in total healthcare cost and utilization for AIAN patients and NHW patients after diagnosis with lung cancer. This study contributes to recent broader studies of healthcare cost and healthcare utilization by focusing on AIAN and NHW lung cancer patient costs reflecting cancer and noncancer-treatment care.[14,15] Specifically, we examined healthcare cost and utilization 12 months after cancer diagnosis date for AIAN and NHW patients diagnosed with lung cancer between 2000 and 2011. The hypotheses in this study were that NHW patients would have higher levels of healthcare utilization and therefore accrue higher healthcare costs compared with AIAN lung patients.

2.3 Methods

2.3.1 Study Design and Data Source

This study was a cohort design using the Surveillance, Epidemiology, and End Results (SEER)-Medicare dataset from 2000 to 2012. SEER-Medicare is a population-based resource often used cancer epidemiology and health services research. The SEER-Medicare database represents 26% of the United States population and 42% of the AIAN population aged 65 and older based on SEER registry locations.[10] This study utilized data from SEER registries in Connecticut, Detroit, Greater California, Greater Georgia, Hawaii, Iowa, Kentucky, Louisiana, Los Angeles, Michigan, New Jersey, New Mexico, Rural Georgia, San Francisco-Oakland, San Jose-Monterey, Seattle-Puget Sound, and Utah. The SEER-Medicare dataset was a linked dataset by using a unique patient identification number in the SEER Registry and Medicare claims. Several files from SEER-Medicare were used in this study: Durable Medical Equipment (DME), Home Health (HHA), Medicare Provider Analysis and Review (MEDPAR), National Claims History (NCH, previously known as Physician/Supplier), Outpatient (OUTSAF), and Patient Entitlement and Diagnosis File (PEDSF).

2.3.2 Study Population

Non-Hispanic White and AIAN Medicare enrollees aged 65 years or older with a first primary cancer date of diagnosis between January 1, 2000 and December 31, 2011 of lung and bronchus cancer (e.g., ICD-O codes C34.0-C34.3, C34.8, C34.9) and stages IA to IV (as defined by the American Joint Committee on Cancer) were included. Further inclusion criteria were patients with continuous enrollment in Part A and Part B six months prior to cancer diagnosis date and from the cancer diagnosis date to 12 months

after cancer diagnosis. If the patient died within those timeframes, they were still included in the study.

The following are exclusions of patients based on Medicare enrollment, histology and date of cancer diagnosis. Patients were excluded based on Medicare eligibility status as a managed care plan and/or absence of any Part A (inpatient claims) and Part B (outpatient claims) coverage six months prior to and 12 months following cancer diagnosis. Patients with the following lung cancer histology codes were excluded due to location of tumor on skin or gastrointestinal tract: 8585/3 Thymoma, malignant; 8720/3 Malignant melanoma; 8770/3 Mixed epithelial and spindle cell melanoma; 9650/3 Hodgkin lymphoma; 9680/3 Diffuse large B cell; and 9699/3 Marginal zone B-cell lymphoma. Patients with a diagnosis date at death or autopsy, a cancer diagnosis date after date of death, or a cancer diagnosis date prior to age 65 years were excluded. Prescription drugs claims were not included in this study. The resulting sample size for this study was 443,691 patients and 316,964 patients were excluded for the reasons above. The sample for this study was 126,725 (434 AIAN patients and 126,291 NHW patients) (see Figure 2.1). The final sample after matching was 418 AIAN patients and 836 NHW patients.

2.3.3 Propensity Score Method

We used the propensity score methodology developed by Rosenbaum and Rubin who described propensity scores as the probability of treatment assignment conditional on observed baseline covariates.[26] The propensity scores were applied to improve adjustment of confounders, such as marital status and disease attributes, and to establish similar matched controls (matching NHW patients to the AIAN patients). Although it is

important to note that hidden bias (unmeasured confounders) cannot easily be detected using this method.[27,28]

In this study, logistic regression was used to estimate propensity scores for each patient. The covariates were age at diagnosis, sex, year of diagnosis, stage of disease, grade, histology, Charlson Comorbidity Index, SEER registry, and marital status. The dependent variable was outpatient and inpatient costs. The Charlson Comorbidity Index was derived from physician claims of comorbid conditions.[29-31] The focus of the study consists of lung cancer patients; therefore, cancer diagnosis was excluded from the Charlson Comorbidity Index.[32] The PSMATCH2 in STATA was used for propensity scoring matching of 1:2 ratio without replacement.[28,33,34] To determine similarities, we assessed the balance of covariates, the continuous and categorical covariates means and proportions were compared using the Harder, Stuart, and Anthony method along with the standardized bias cutoff of 0.10.[28]

2.3.4 Definition of Total Healthcare Cost

Total healthcare costs were examined for the 12-month period after cancer diagnosis. To identify total healthcare costs the Current Procedural Terminology (CPT); Healthcare Common Procedure Coding System (HCPCS); International Classification of Diseases; Ninth Revision (ICD-9); and revenue codes were used (see Table 2.1). The DME, HHA, MEDPAR, NCH, and OUTSAF files were used to estimate total healthcare costs. All healthcare costs for each outpatient and inpatient visit were assessed from the patient's admission date. Total healthcare cost consists of cancer-treatment and noncancer-treatment costs that are defined as payments and not charges.

The three payment sources used to identify total healthcare costs in the SEER-Medicare files are Medicare, coinsurance, and patient responsibility. Medicare costs are reimbursed amounts. Coinsurance consists of payments by a primary payer other than Medicare. Patient responsibility was defined as the beneficiary's liability for payment.

Total healthcare cost was defined as the sum of cancer-treatment and noncancer-treatment costs. Inpatient, outpatient, and emergency department costs were identified from the NCH file. Part A claims using the Centers for Medicare and Medicaid Services (CMS) Inpatient Hospital Index and Part B claims were adjusted using the Medicare Economic Index.[35] All costs were reported in 2012 dollars as this was the most recent diagnosis year in the SEER-Medicare dataset.

2.3.5 Definition of Total Healthcare Utilization

Total healthcare utilization was examined for the 12-month period after the cancer diagnosis. Total healthcare utilization is defined as the sum of cancer-treatment encounters and noncancer-treatment encounters. The NCH file was used to identify patient encounters. Encounters were comprised of inpatient (Part A), outpatient (Part B), and emergency department visits (Part B). To identify encounters, the ICD-9, revenue, HCPCS, and CPT codes were used. Total healthcare visits were based on a patient's admission date in an inpatient and outpatient setting.

2.3.6 Covariates

The PEDSF file was used to identify the patient's age at diagnosis, year of diagnosis, sex, stage of disease, grade, histology, SEER registry at diagnosis, and marital status. The NCH file was used to identify Charlson Comorbidity Index scores.

2.3.7 Statistical Analysis

To describe patient characteristics, the chi-square test was used to determine NHW versus AIAN cohort differences for binary and categorical variables. The independent *t* test was used to examine the differences of continuous variables between the cohort groups. Statistical significance was defined as $p < 0.05$. STATA version 14.0 (*Stata Statistical Software: Release 14*. College Station, TX: StataCorp LP) was used for all analyses. To examine the possible associations between total healthcare costs and other variables, the generalized linear model (GLM) with log link and gamma distribution was applied due to positive skewness of cost data. To examine the associations of healthcare utilization with other variables and due to the over-dispersion (if the variance is larger than the mean of a Poisson distribution) of total healthcare utilization, a negative binomial regression model (NBRM) was used in the unadjusted and adjusted models.

2.4 Results

A total of 126,725 of first primary lung cancer patients 65+ years of age were included in the cohort study: 434 cases were AIAN patients and 126,291 were NHW patients (see Table 2.2). Before patients were matched, age at lung cancer diagnosis ($p = 0.01$), stage of disease ($p = 0.02$), histology ($p = 0.02$), marital status ($p < 0.01$), and SEER registry residence ($p < 0.01$) differed between AIAN patients and NHW patients, such that AIAN patients had more adenocarcinoma cancer (28%), were not married (47%), and resided mainly in the West US census region (79%). Grade ($p = 0.10$), gender ($p = 0.87$), Charlson Comorbidity Index ($p = 0.35$), and census metro residence ($p < 0.01$) did not differ between AIAN and NHW patients. Among NHW and AIAN patients, there

were more patients between age 65 and 70 years (32% AIAN, 29% NHW) with stage IV disease (47% AIAN vs. 36% NHW), and who resided in metro areas (78% AIAN versus 80% NHW).

Once patients were matched, the propensity scores for all covariates met the 10% standardized bias criteria between AIAN and NHW patients (see Figures 2.2 and 2.3).[27,28] In the matched sample, 418 AIAN patients were matched to 833 NHW patients (see Table 2.2). As a result, the unadjusted difference in mean total healthcare costs after matching was -$4,784 ($39,371 versus $44,155 for AIAN and NHW, respectively) (see Table 2.3). In Table 2.4 the unadjusted difference in mean total healthcare utilization after matching was -4 visits (40 versus 44 visits for AIAN and NHW, respectively).

2.4.1 Unadjusted Total Healthcare Costs

In the matched sample, the unadjusted log coefficients show that being an AIAN was associated with lower total healthcare costs (coefficient = -0.13, $p = 0.02$).

2.4.2 Adjusted Total Healthcare Costs

In the adjusted GLM, being an AIAN patient was associated with a 13% decrease in average healthcare costs (coefficient=-0.13, $p = 0.02$) and a 20% decrease in average cancer-treatment costs (coefficient=-0.20, $p = 0.05$) after adjusting for demographics, survival time, cancer prognosis, and comorbidities (see Table 2.5 and Table 2.6). In contrast, being an AIAN was a not associated with total noncancer-treatment costs (coefficient=-0.10, $p = 0.06$) after adjusting for demographics, survival time, cancer prognosis, and comorbidities (see Table 2.7).

2.4.3 Unadjusted and Adjusted Healthcare Utilization

In the unadjusted model, AIAN patients had a 12% lower healthcare use compared with NHW patients (coefficient = -0.11, $p = 0.02$). In the adjusted model, AIAN patients used significantly less healthcare compared with NHW patients (coefficient = -0.12, $p = 0.01$). Patients with stage II disease compared with stage III and IV disease, while holding other variables constant, had a rate 1.30 times greater healthcare visits for patients. Divorced, separated, and widowed patients compared with single and married patients, while holding other variables constant, had a rate of 0.81 times less healthcare visits (see Table 2.8).

2.4.4 Cancer- and Noncancer-Treatment Care

In this study, more than half of total healthcare costs for AIAN (54%) and NHW patients (52%) with lung cancer were for noncancer-treatment in inpatient care. While most (more than 90%) cancer-treatment costs from AIAN and NHW patients were for outpatient care. Sixty-five percent of cancer-treatment costs by AIAN patients were from chemotherapy, as well, 3% from surgery and 40% from radiation therapy. For NHW patients, 72% of cancer-treatment costs were from chemotherapy, as well, 4% from surgery and 29% from radiation therapy.

2.5 Discussion

AIAN patients had lower total healthcare costs within the 12-month period after cancer diagnosis. In addition, being AIAN was associated with lower cancer-treatment costs, while being AIAN were not associated with total noncancer-treatment costs. As far as healthcare utilization, AIAN lung cancer patients was associated with lower

healthcare utilization. To our knowledge, this is the first study to examine patterns of healthcare costs and healthcare utilization among older AIAN patients with lung cancer.

2.5.1 Total Healthcare Costs

The overall mean total healthcare cost in this study was lower than those reported in other SEER-Medicare studies that investigated the costs of cancer or costs of care (i.e., the difference in costs between cancer and noncancer patients).[14,15] The mean total healthcare costs were lower in our study compared with lung cancer patients investigated by Yabroff and researchers[15] 12 months following cancer diagnosis ($39,180 for AIAN and $43,844 for NHW lung cancer patients in our study compared to $45,524 in the Yabroff study,[15] adjusted to 2012 dollars). Yabroff and colleagues[15] included hospice estimates (i.e., 12 months following cancer diagnosis) that may suggest higher costs compared to this study. They were able to identify costs of care, but didn't control for confounders or addressed racial/ethnic differences. We evaluated differences in costs among AIAN and NHW lung cancer patients and within these differences the proportion of higher noncancer-treatment costs compared to cancer-treatment costs were known; however, the proportion of patients with cancer-treatment costs was not tested for statistical significance in this study.

Warren and researchers examined the costs of cancer-treatment 12 months following lung cancer diagnosis using SEER-Medicare and reported fewer than 50% of patients received cancer-treatment.[14] Although we did not examine differences in proportion of patients who used services, we are able to report cancer-treatment costs in relation to total healthcare costs. In contrary, the percent of total healthcare costs suggest that less than 72% of chemotherapy spending were from AIAN lung cancer patients in

the matched sample. As well, close to half of the total healthcare spending was from inpatient care for noncancer-treatment by AIAN lung cancer patients. These results illustrate a shift in costs of noncancer-treatment costs in inpatient care than cancer-treatment costs.

2.5.2 Total Healthcare Utilization

AIAN patients received fewer health services (i.e., inpatient and outpatient care) than NHW lung cancer patients 12 months following cancer diagnosis. Due to the limited studies of healthcare utilization for lung cancer patients following cancer diagnosis, comparability to other studies is not addressed, rather the need for further research is strongly recommended. In this study, the results suggest higher inpatient care spending from noncancer-treatment care. On average, aging adults with cancer accrue more costs and patient time for hospitalizations, emergency room visits, ambulatory surgeries, and physician visits than patients without cancer.[36] Although we are capturing comorbidities six months before cancer diagnosis, this time period may not detect long-term chronic health conditions that may suggest higher noncancer-treatment costs after cancer diagnosis. Our findings provide healthcare utilization in conjunction with healthcare costs for lung cancer patients in one cohort.

A strength of this study is consideration of both cancer-treatment and noncancer-treatment care for AIAN and NHW lung cancer patients. Most importantly, patterns suggest that healthcare costs and utilization are lower for AIAN patients. Both cohort groups portrayed similar trends, the results suggest higher health spending from noncancer-treatment than cancer-treatment care. In prior cost studies using SEER-Medicare, racial/ethnic differences were not well represented and an inclusion of

noncancer-treatment costs that augments complete patient care 12 months following cancer diagnosis. Significant differences in healthcare costs and utilization among AIAN patients is concerning in this study. One study reported that AIAN cancer patients (including lung cancer) who trust their provider adhered to guideline-concordant treatment more often.[40] Other research in understanding access to and use of treatment by AIAN is positive and indicates progress toward improving treatment, and thus potentially survival outcomes, for AIAN patients with cancer.

There are several limitations of this study. Retrospective studies like this study rely on detailed data on patients, but use of claims data does not include provider notes on treatment intentions or other information regarding patient care. Additional provider information may support assumptions about access to care issues, such as refusals or provider-patient decision making. Out-of-pocket expenses were captured as part of total healthcare costs in this study, but information about receipt of payment is not reported. Most AIAN patients in this study are from lower income census regions. However, it's not known if other financial support assistance existed that contributed to their out-of-pocket expenses. For AIAN patients on Medicare, more than 28% have no supplemental coverage and are at risk for out-of-pocket sharing requirements.[41] Also, payments made by the Indian Health Service for cancer-treatment and noncancer-treatment are not linked to SEER-Medicare, thus Medicare cost estimates may not reflect all sources of payments. Geographically, representation of AIAN patients who utilize IHS facilities is limited since IHS Contract Health Service Delivery Areas are not aligned with SEER registry locations. Race misclassification is possible, since Medicare uses self-reported information, while SEER registries obtain race information from providers.

In summary, the results in this study suggest that AIAN patients with lung cancer use less care resulting in fewer costs for overall healthcare services. Since survival rates of AIAN patients with lung cancer are lower than other racial and ethnic groups, there should be further research of cancer-treatment utilization among AIAN patients with lung cancer. The possibility remains that increased resources applied to the care of AIAN patients with lung cancer could potentially reduce disparities between AIAN and White patients with lung cancer not only in use of care, but survival as well. The mix of resources from Medicare, Indian Health Service, State, Federal, and Tribal agencies for tribal AIAN needs to be better understood since tribal and nontribal AIAN patients are part of a unique health care delivery system.

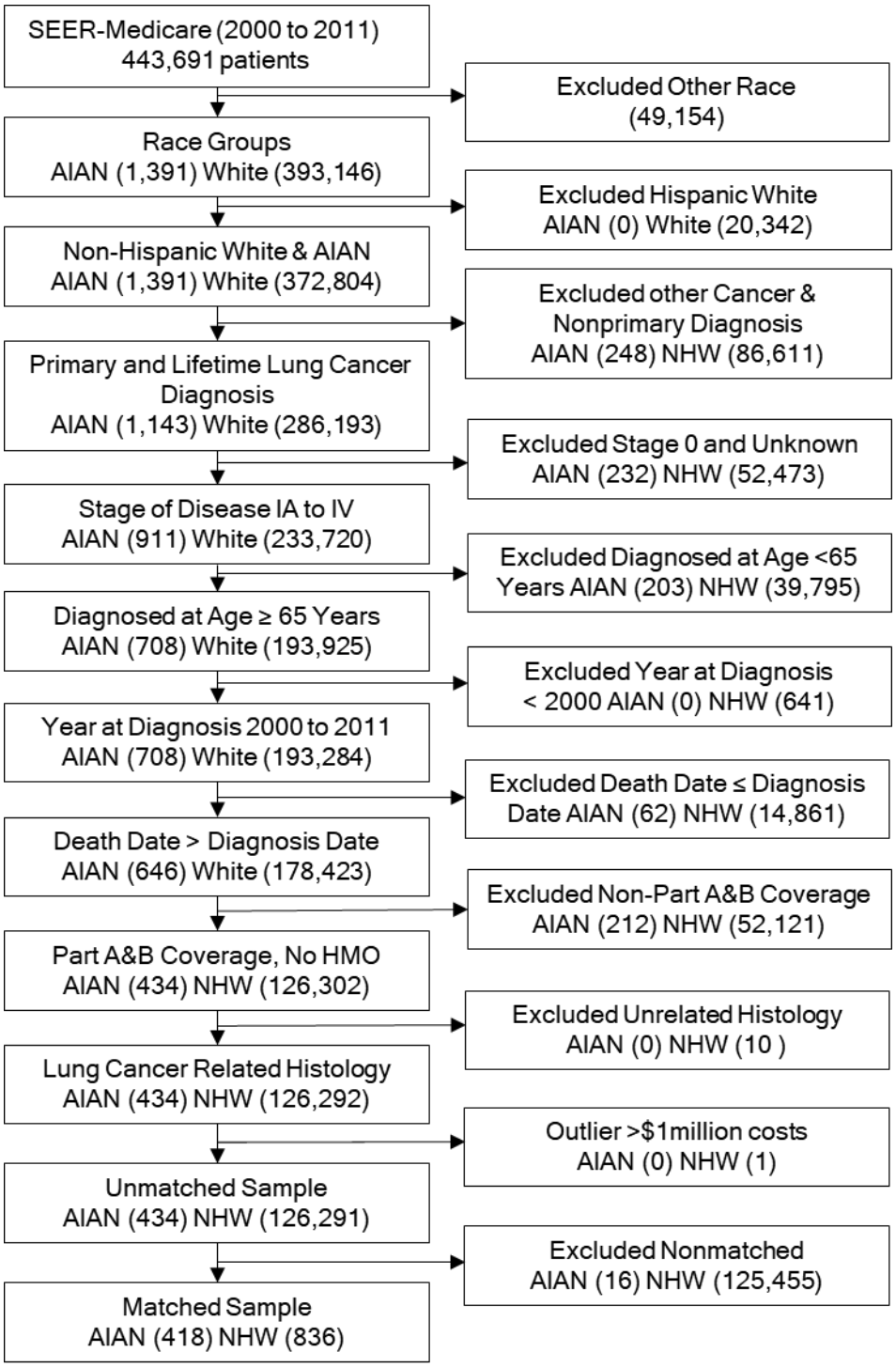


Figure 2.1 Inclusion and Exclusions Diagram

Note. AIAN = American Indian and Alaska Native; NHW = Non-Hispanic White

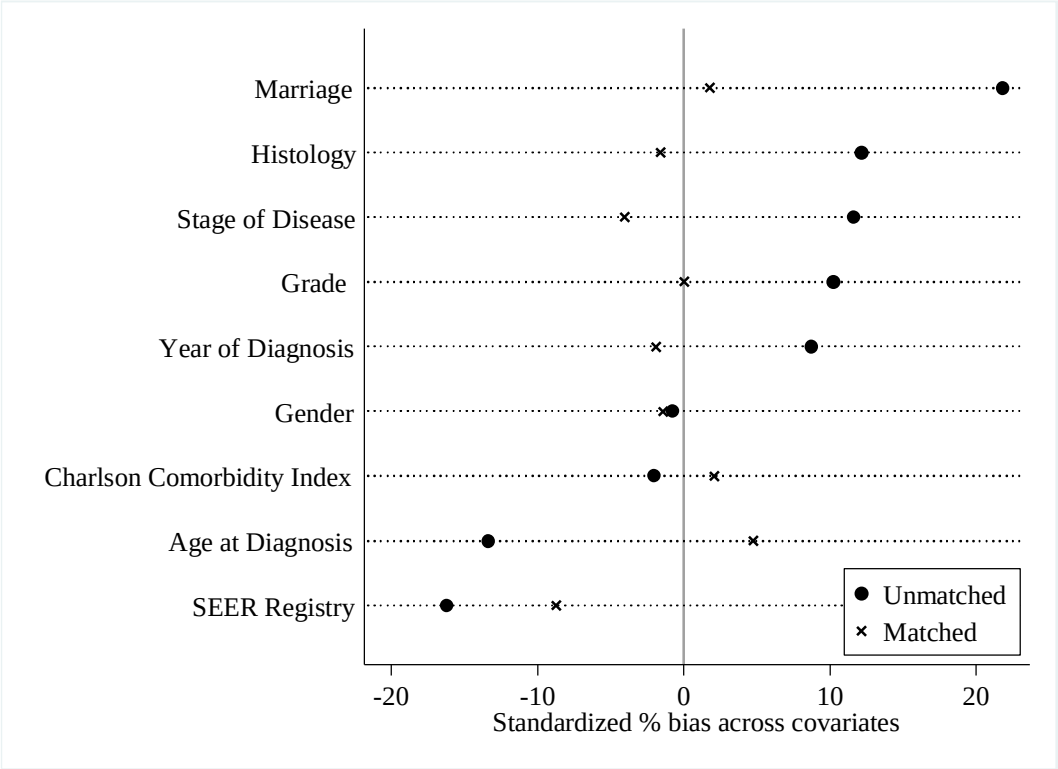


Figure 2.2 Percent of Standardized Bias Differences for Propensity Score Matching in Group One.

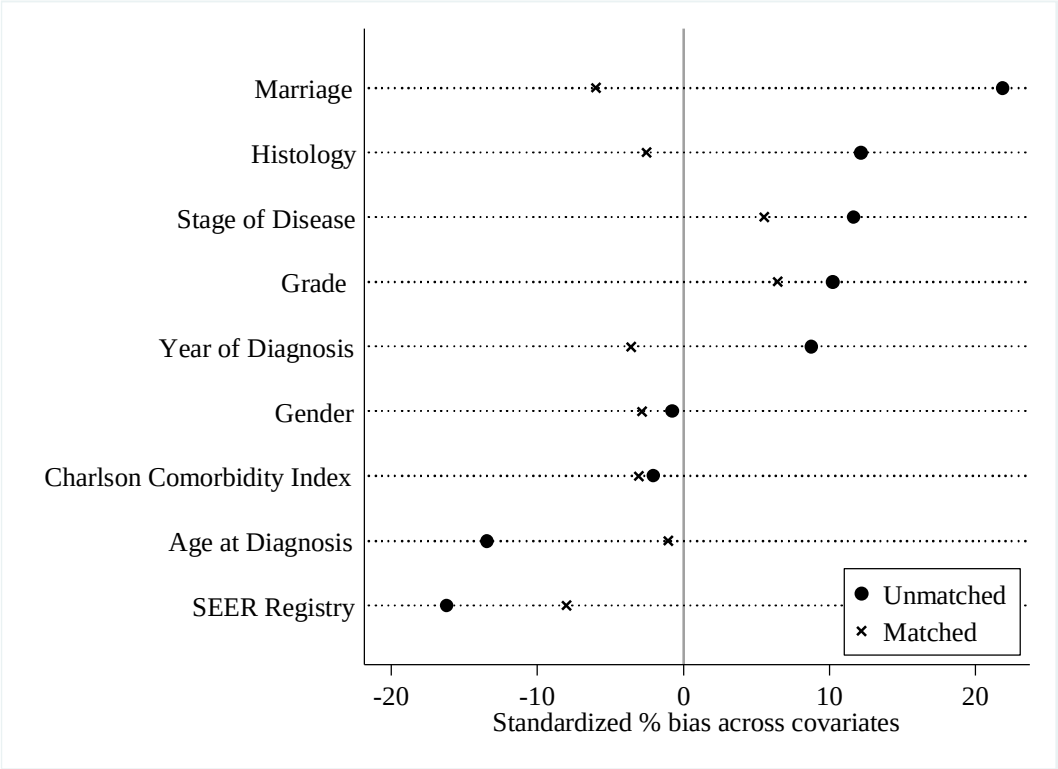


Figure 2.3 Percent of Standardized Bias Differences for Propensity Score Matching in Group Two.

Table 2.1

Diagnostic and Procedure Codes

Items	Diagnostic and Procedure Codes
Radiation Therapy	
ICD-9	9221 9222 9223 9224 9225 9226 9227 9228 9229 923 9231 9232 9233 9239
CPT	V580 V661 V671 7637 76370 77014 76950 7695 77261 77280 7728 77285 77290 7729 77295 77299 7730 77300 77301 77305 77310 7731 77315 77321 77326 77327 77328 77331 77332 7333 77334 77336 77370 77371 7737 77372 77373 77399 77401 77402 77403 77404 77406 77407 77408 77409 77411 77412 77413 77414 77416 77417 77418 7742-77425 77427 77431 77432 77435 77469 77470 77499 77520 77522 7752 77523 77525 77615 77750 77761 77762 77763 77770 77771 77772 77776 77777 77778 77781-77787 77789 77799
HCPCS	G0173 G0251 G0339 G0340 G034 G0256 G0261 G6015 C1717 C1719 C2638 C2640 C2641
Revenue	330 333
Surgery	
ICD-9	3201 3209 321 322 3223 3224 3225 3226 3228 3229 323 324 325 3259 329 344
CPT	19260 19271 19272 31640 31641 31643 32100 32440 32442 32445 32480 32482 32484 32486 32488 32500 32520 32522 32525 32657
Chemotherapy	
ICD-9	3492 9925 V581 v5810 v5811 v662 v6620 v672 v6720
CPT	36260 3626 95990 9599 95991 96400 964 9640 96405 96406 96408 96410 9641 96412 96414 96420 9642 96422 96423 96425 96440 9644 96445 96450 96520 9652 96530 96542 96545 96549
HCPCS	A4301 C9411 C9414 E0782 E0783 E0784 E0785 E0786 E0873 E0874 G0355 G0356 G0357 G0358 G0359 G0360 G0361 G0362 G0363 J0207 J0640 J0880 J1190 J1440 J1950 J2405 J2430 J2505 J2820 J3487 J8520 J8521 J8530 J8560 J8565 J8600 J8610 J8700 J8999 J9000 – J9999 K0415 K0416 Q0083 Q0084 Q0085 Q0136 Q0137 Q0179 S0177 S0181
Revenue	331 332 335

Note. ICD = International Classification of Disease, 9th Edition; HCPCS = Healthcare Common Procedure Coding System; CPT = Current Procedural Terminology.

Table 2.2

Baseline Patient Characteristics

Variables	Unmatched					Matched				
	AIAN *N* = 434	%	NHW *N* = 126,291	%	*p* Value	AIAN *N* = 418	%	NHW *N* = 836	%	*p* Value
Age at Diagnosis (mean)	74		75		0.01	74		74		0.75
65-70	141	32.49	36,071	28.56		136	32.54	284	34.09	
71-75	124	28.57	33,402	26.45		117	27.99	233	27.97	
76-80	93	21.43	29,363	23.25		90	21.53	181	21.73	
81+	76	17.51	27,455	21.74	0.06	75	17.94	135	16.21	0.87
Year of Diagnosis										
2000 – 2005	200	46.08	62,047	49.13		194	46.41	376	44.98	
2006 – 2011	234	53.92	64,244	50.87	0.21	224	53.59	460	55.02	0.63
AJCC 6th Stage of Disease										
Stage I	69	15.90	27,743	21.97		64	15.31	148	17.70	
Stage II	24	5.53	5,496	4.35		23	5.50	35	4.19	
Stage III	137	31.57	36,322	28.76		133	31.82	235	28.11	
Stage IV	204	47.00	56,730	44.92	0.02	198	47.37	418	50.00	0.30
Histology Type										
Adenocarcinoma	122	28.11	44,982	35.62		117	27.99	240	28.71	
Large Cell	15	3.46	4,675	3.70		15	3.59	37	4.43	
Non-Small Cell	74	17.05	17,305	13.70		70	16.75	113	13.52	
Small Cell	72	16.59	18,522	14.67		71	16.99	140	16.75	
Squamous Cell	109	25.12	28,159	22.30		106	25.36	208	24.88	
Other Type	42	9.68	12,648	10.01	0.02	39	9.33	98	11.72	0.55
Grade										
Well Differentiated	12	2.76	5,298	4.20		12	2.87	27	3.23	

Table 2.2 Continued

Variables	Unmatched					Matched				
	AIAN *N* = 434	%	NHW *N* = 126,291	%	*p* Value	AIAN *N* = 418	%	NHW *N* = 836	%	*p* Value
Moderately Differentiated	52	11.98	19,109	15.13		50	11.96	98	11.72	
Poorly Differentiated	104	23.96	31,371	24.84		104	24.88	219	26.20	
Undifferentiated	32	7.37	7,742	6.13		30	7.18	62	7.42	
Cell Type Unknown	234	53.92	62,771	49.70	0.10	222	53.11	430	51.44	0.98
Baseline Charlson Comorbidity Index (Mean)	0.02		0.03		0.35	0.02		0.02		0.93
Gender										
Male	227	52.30	65,568	51.92		220	52.63	431	51.56	
Female	207	47.70	60,723	48.08	0.87	198	47.37	405	48.44	0.72
Census Tract Metro Residence										
Metro	337	77.65	100,458	79.54		323	77.27	654	77.27	
Nonmetro	97	22.35	25,826	20.45		95	22.73	182	21.77	
Missing	0	0.00	7	0.01	0.61	0	0.00	0	0.00	0.70
Marital Status										
Married	176	40.55	65,452	51.83		176	42.11	346	41.54	
Single	38	8.76	8,165	6.47		38	9.09	69	8.28	
Divorced	204	47.00	48,244	38.20		204	48.80	418	50.18	
Missing	16	3.69	4,430	3.51	<0.01	0	0.00	0	0.00	0.84
US Census Region										
Northwest	29	6.68	25,873	20.49		29	6.94	147	17.58	

Table 2.2 Continued

Variables	Unmatched					Matched				
	AIAN *N* = 434	%	NHW *N* = 126,291	%	*p* Value	AIAN *N* = 418	%	NHW *N* = 836	%	*p* Value
Midwest	35	8.06	18,008	14.26		34	8.13	130	15.55	
South	26	5.99	39,780	31.50$6		26	6.22	199	23.80	
West	344	79.26	42,630	33.76	<0.01	329	78.71	360	43.06	<0.01

Note. AJCC = American Joint Committee on Cancer.

Table 2.3

Description of Healthcare Costs

Variables	American Indian and Alaska Native			Non-Hispanic White		
	Mean $	Median $	Range $ (min–max)	Mean $	Median $	Range $ (min–max)
Unmatched (AIAN = 434, NHW = 126,291)						
Cancer-Treatment						
Inpatient	568	0	0-15,795	674	0	0-182,457
Outpatient	9,071	1,166	0-115,601	9,885	1,977	0-477,047
Emergency Room - Hospital	8	0	0-336	6	0	0-5,557
Surgery	288	0	5,029	463	0	0-182,457
Radiation Therapy	3,850	0	0-49,090	3,482	0	0-159,478
Chemotherapy	6,331	0	0-107,491	7,265	0	0-477,047
Total Cancer-treatment	9,713	2,720	0-116,184	10,668	3,302	0-477,047
Noncancer-Treatment						
Inpatient	21,234	16,205	0-293,821	21,827	15,567	0-664,007
Outpatient	6,322	4,474	0-85,210	7,072	4,920	0-247,303
Emergency Room - Hospital	272	179	0-3,670	221	144	0-7,082
Total Noncancer-Treatment	29,382	22,508	0-321,104	30,905	23,467	0-665,432
Total Healthcare Treatment Cost	39,095	31,188	0-344,978	41,573	32,610	0-665,432
Matched (AIAN = 418, NHW = 836)						
Cancer-Treatment						
Inpatient	573	0	0-15,795	761	0	0-62,039
Outpatient	9,134	1,599	0-115,601	10,901	2,333	0-202,374
Emergency Room – Hospital	7	0	0-336	8	0	0-549
Surgery	286	0	0-5,029	433	0	0-15,426
Radiation Therapy	3,897	0	0-49,090	3,472	0	0-36,107

Table 2.3 Continued

Variables	American Indian and Alaska Native			Non-Hispanic White		
	Mean $	Median $	Range $ (min–max)	Mean $	Median $	Range $ (min–max)
Chemotherapy	6,366	0	0-107,491	8,484	0	0-202374
Total Cancer-Treatment	9,782	2,990	0-116,184	11,789	3,763	0-202,374
Noncancer-Treatment						
Inpatient	21,333	16,250	0-293,821	22,983	17,046	0-237,912
Outpatient	6,445	4,570	0-85,210	7,358	5,244	0-77,596
Emergency Room – Hospital	271	178	0-3,670	242	161	0-1,546
Total Noncancer-Treatment	29,589	22,570	0-321,104	32,482	26,032	0-262,697
Total Healthcare Treatment Cost	39,371	31,281	0-344,978	44,271	36,135	0-307,217

Table 2.4

Description of Healthcare Utilization (Visits)

Variables	American Indian and Alaska Native			Non-Hispanic Whites		
	Mean Number of Visits	Median Number of Visits	Range (min-max)	Mean Number of Visits	Median Number of Visits	Range (min-max)
Unmatched (AIAN = 434, NHW = 126,291)						
Cancer-Treatment						
Inpatient	0.48	0	0-31	0.62	0	0-82
Outpatient	8	1	0-90	8	1	0-253
Emergency Room - Hospital	0.03	0	0-2	0.02	0	0-12
Total Cancer-Treatment Visits	8	2	0-91	8	2	0-269
Noncancer-Treatment						
Inpatient	11	8	0-164	12	8	0-350
Outpatient	16	12	0-79	19	16	0-198
Emergency Room - Hospital	1	1	0-11	2	1	0-36
Total Noncancer-Treatment Visits	31	28	0-227	36	31	0-359
Total Healthcare Visits	40	35	0-271	44	38	0-361
Matched (AIAN = 418, NHW = 836)						
Cancer-Treatment						
Inpatient	0.48	0	0-31	0.66	0	0-22
Outpatient	8	1	0-90	8	1	0-98
Emergency Room - Hospital	0.03	0	0-2	0.03	0	0-4

Table 2.4 Continued

Variables	American Indian and Alaska Native			Non-Hispanic White		
	Mean Number of Visits	Median Number of Visits	Range (min‑man)	Mean Number of Visits	Median Number of Visits	Range (min–max)
Total Cancer-Treatment Visits	8	2	0-91	9	2	0-107
Noncancer-Treatment						
Inpatient	11	8	0-164	12	9	0-127
Outpatient	17	12	0-79	19	17	0-90
Emergency Room - Hospital	1	1	0-11	1	1	0-8
Total Noncancer-Treatment Visits	32	29	0-227	36	31	0-183
Total Healthcare Visits	40	35	0-271	44	38	0-197

Table 2.5

Adjusted Generalized Linear Model of Total Healthcare Costs

Covariates (N = 1,254)	Coefficient(β)	exp(β) 95% CI	p Value
American Indian and Alaska Native Race	-0.12	0.80-0.98	0.02
Age at Diagnosis			
65-70	Reference		
71-75	-0.08	0.83-1.04	0.20
76-80	-0.22	0.71-0.91	<0.01
81+	-0.35	0.61-0.81	<0.01
Female	0.06	0.96-1.17	0.24
Grade			
Well Differentiated	Reference		
Moderately Differentiated	0.09	0.82-1.46	0.55
Poorly Differentiated	0.08	0.82-1.43	0.57
Undifferentiated	-0.07	0.68-1.30	0.68
Cell Type Unknown	0.05	0.81-1.40	0.66
AJCC 6th Stage of Disease			
Stage I	Reference		
Stage II	0.34	1.11-1.79	0.01
Stage III	0.23	1.08-1.46	<0.01
Stage IV	0.12	0.97-1.30	0.12
Histology Group			
Adenocarcinoma	Reference		
Large Cell	-0.12	0.70-1.13	0.34
Non-Small Cell	-0.04	0.83-1.12	0.61
Small Cell	-0.09	0.78-1.06	0.24
Squamous Cell	-0.03	0.85-1.11	0.67
Other Type	-0.54	0.49-0.69	<0.01
Charlson Comorbidity Index	-0.04	0.79-1.16	0.66

Table 2.5 Continued

Covariates (*N* = 1,254)	Coefficient(β)	(β) 95% CI	*p* Value
Marital Status			
Married, Domestic Partner	Reference	0.84-1.19	0.98
Divorced, Widowed, Separated	-0.14	0.78-0.97	0.01
Survival Time	0.00	0.99-1.00	0.16
Constant	10.70		

Note. Statistically significant at alpha level of 0.05; exp(β) = exponent of log coefficient; AJCC = American Joint Committee on Cancer.

Table 2.6

Adjusted Generalized Linear Model of Total Cancer-Treatment Costs

Covariates (N = 1,254)	Coefficient(β)	exp(β) 95% CI	p Value
American Indian and Alaska Native Race	-0.20	0.66-1.00	0.05
Age at Diagnosis			
65-70	Reference		
71-75	-0.20	0.64-1.04	0.10
76-80	-0.35	0.54-0.92	0.01
81+	-0.69	0.37-0.67	<0.01
Female	0.10	0.89-1.36	0.37
Grade			
Well Differentiated	Reference		
Moderately Differentiated	0.49	0.89-2.98	0.11
Poorly Differentiated	0.42	0.86-2.70	0.15
Undifferentiated	0.46	0.80-3.12	0.19
Unknown	0.39	0.83-2.61	0.19
AJCC 6th Stage of Disease			
Stage I	Reference		
Stage II	0.70	1.21-3.32	0.01
Stage III	0.77	1.60-2.93	<0.01
Stage IV	0.57	1.32-2.39	<0.01
Histology Group			
Adenocarcinoma	Reference		
Large Cell	0.07	0.65-1.76	0.80
Non-Small Cell	0.09	0.79-1.50	0.58
Small Cell	0.27	0.95-1.79	0.10
Squamous Cell	0.04	0.80-1.36	0.75
Other Type	-1.05	0.25-0.50	<0.01
Charlson Comorbidity Index	0.13	0.77-1.69	0.51

Table 2.6 Continued

Covariates (N = 1,254)	Coefficient(β)	(β) 95% CI	p Value
Marital Status			
Married, Domestic, Partner	Reference		
Single	-0.44	0.45-0.92	0.02
Divorced, Widowed, Separated	-0.36	0.56-0.87	<0.01
Survival Time	0.00	1.00-1.01	<0.01
Constant	8.60		

Note. Statistically significant at alpha level of 0.05; exp(β) = exponent of log coefficient; AJCC = American Joint Committee on Cancer.

Table 2.7

Adjusted Generalized Linear Model of Total Noncancer-Treatment Costs

Covariates (N = 1,254)	Coefficient(β)	exp(β) 95% CI	p Value
American Indian and Alaska Native Race	-0.10	0.82-1.01	0.06
Age at Diagnosis			
65-70	Reference		
71-75	-0.05	0.84-1.08	0.43
76-80	-0.16	0.75-0.98	0.02
81+	-0.26	0.67-0.90	<0.01
Female	0.05	0.94-1.17	0.38
Grade			
Well Differentiated	Reference		
Moderately Differentiated	-0.04	0.71-1.32	0.82
Poorly Differentiated	0.00	0.74-1.34	0.99
Undifferentiated	-0.20	0.58-1.16	0.26
Unknown	-0.04	0.71-1.29	0.78
AJCC 6th Stage of Disease			
Stage I	Reference		
Stage II	0.23	0.97-1.63	0.08
Stage III	0.01	0.86-1.18	0.91
Stage IV	-0.06	0.80-1.10	0.43
Histology Group			
Adenocarcinoma	Reference		
Large Cell	-0.23	0.61-1.03	0.08
Non-Small Cell	-0.07	0.79-1.10	0.42
Small Cell	-0.21	0.69-0.96	0.02
Squamous Cell	-0.04	0.84-1.10	0.59
Other Type	-0.47	0.52-0.76	<0.01
Charlson Comorbidity Index	-0.12	0.72-1.09	0.26
Marital Status			
Married, Domestic Partner	Reference		
Single	0.12	0.93-1.35	0.22
Divorced, Widowed, Separated	-0.07	0.84-1.05	0.25
Survival Time	0.00	1.00-1.00	0.35

Table 2.7 Continued

Covariates (N = 1,254)	Coefficient(β)	(β) 95% CI	p Value
Marital Status			
Married, Domestic Partner	Reference		
Single	0.12	0.93-1.35	0.22
Divorced, Widowed, Separated	-0.07	0.84-1.05	0.25
Survival Time	0.00	1.00-1.00	0.35

Note. Statistically significant at alpha level of 0.05; exp(β) = exponent of log coefficient; AJCC = American Joint Committee on Cancer.

Table 2.8

Adjusted Negative Binomial Regression Model of Total Healthcare Utilization

Covariates (N = 1,254)	Coefficient(β)	(β) 95% CI	p Value
American Indian and Alaska Native Race	-0.12	0.81-0.97	0.01
Age at Diagnosis			
65-70	Reference		
71-75	-0.04	0.86-1.07	0.42
76-80	-0.14	0.77-0.98	0.02
81+	-0.23	0.70-0.91	<0.01
Female	-0.06	0.86-1.04	0.22
Grade			
Well Differentiated	Reference		
Moderately Differentiated	0.04	0.80-1.37	0.76
Poorly Differentiated	-0.02	0.75-1.26	0.86
Undifferentiated	-0.07	0.69-1.27	0.66
Unknown	-0.05	0.73-1.23	0.69
AJCC 6th Stage of Disease			
Stage I	Reference		
Stage II	0.30	1.08-1.69	0.01
Stage III	0.26	1.13-1.49	<0.01
Stage IV	0.04	0.90-1.19	0.60
Histology Group			
Adenocarcinoma	Reference		
Large Cell	0.01	0.80-1.26	0.96
Non-Small Cell	0.01	0.88-1.16	0.90
Small Cell	0.07	0.93-1.23	0.36
Squamous Cell	0.01	0.89-1.13	0.93
Other Type	-0.51	0.51-0.71	<0.01
Charlson Comorbidity Index	0.09	0.91-1.31	0.36
Marital Status			
Married, Domestic Partner	Reference		
Single	-0.13	0.75-1.03	0.11
Divorced, Widowed, Separated	-0.19	0.75-0.91	<0.01
Survival Time	0.00	1.00-1.00	<0.01

Table 2.8 Continued

Covariates (N = 1,254)	Coefficient(β)	(β) 95% CI	p Value
Marital Status			
Married, Domestic Partner	Reference		
Single	-0.13	0.75-1.03	0.11
Divorced, Widowed, Separated	-0.19	0.75-0.91	<0.01
Survival Time	0.00	1.00-1.00	<0.01

Note. Statistically significant at alpha level of 0.05; AJCC = American Joint Committee on Cancer.

CHAPTER 3

HEALTHCARE COSTS AND UTILIZATION DIFFERENCES BETWEEN AMERICAN INDIANS AND ALASKA NATIVES COMPARED WITH NON-HISPANIC WHITES WITH LUNG CANCER DURING THE END-OF-LIFE PERIOD

3.1 Abstract

Lung cancer is the leading cause of cancer deaths in the US. **Objective:** We examined total healthcare cost and utilization differences among American Indian and Alaska Native patients and non-Hispanic patients in the last six months of life, as well as among patients who died and with ≤6 month survival. **Methods:** We used the Surveillance, Epidemiology, and End Results (SEER)-Medicare dataset and identified 55,386 patients and of those 627 were matched patients diagnosed from January 1, 2000 to December 31, 2011. Patients were matched on demographics and cancer prognosis. To identify total healthcare costs and total healthcare utilization based on cancer and noncancer-treatment, we used diagnosis and procedure codes. To examine total healthcare costs between American Indian and Alaska Native patients and non-Hispanic White patients, we used a generalized linear model with gamma distribution and log link. To examine healthcare utilization, we used a negative binomial regression model. Healthcare costs and utilization were analyzed separately by any cause and lung cancer

mortality. **Results:** Being an American Indian and Alaska Native patient was not associated with total healthcare costs among any cause and lung cancer mortality ($p = 0.92$, $p = 0.97$, respectively) after adjusting for patient characteristics, survival time, and cancer prognosis. Being an American Indian and Alaska Native patient was not associated with healthcare utilization among those who died of any reasons (any cause) and those who died of lung cancer (95% CI: 0.85-1.07, 95% CI: 0.81-1.05, respectively) compared with non-Hispanic White patients. **Conclusion:** We conclude there are no significant differences in costs or use of care in the last six months of life for AIAN patients with short-term lung cancer survival.

3.2 Introduction

Lung cancer is the leading cause of cancer deaths among American Indian and Alaska Native (AIAN) patients.[42] AIAN patients with cancer have lower 5-year survival rates than other racial/ethnic groups.[9] AIAN patients more commonly diagnosed with lung cancer at late stage (III and IV) compared to other race/ethnicity groups.[10] A patient's duration in the terminal illness phase can vary from a few days to a few months of life. Patients in the terminal illness or end-of-life phase are those with a poor prognosis showing advanced stage of disease when death is likely imminent.

For patients with advanced lung cancer, end-of-life care helps with the management of pain, symptoms, and other psychological, social, spiritual, and practical support. It is essential for cancer patients to obtain supportive care while experiencing physical and emotional alterations in their remaining days. Cancer patients often experience challenges financially, spiritually, and with decisions on proper care.[43,44] Perspectives on end-of-life care among AIAN patients with cancer differ by tribe and

cultural influences in the United States.[45] AIAN patients experience challenges during the end-of-life care due to the idea that talking about death is a taboo, absence of autonomous treatment decision making, and existence of medical mistrust and dissatisfaction.[46,47] Once end-of-life care is determined for AIAN elders with lung cancer, little is documented on the patterns of healthcare utilization (e.g., inpatient, outpatient, hospice) and costs for this population group. Shiovitz and researchers studied cancer-directed treatment and hospice care services among lung cancer patients and concluded that disparities in hospice utilization are accounted for by socioeconomic status.[11]

For many cancer patients, the cost of cancer care is the highest during the end-of-life period.[15] On average, a patient with lung cancer at age 72 in 2000 incurred costs of $14,987 in the last month of life.[44] In another study, Chastek and researchers reported that cancer-related costs in the last six months were $74,212, with rapid increases in inpatient costs ($1,785 to $20,559) and hospice services (0.7% to 35.6%).[45] In the same study, lung cancer patients had an average of $25,529 in inpatient costs and $7,714 in outpatient procedures. It is uncertain if older AIAN patients experience lower expenditures in the terminal phase compared with non-Hispanic White (NHW) patients.

Availability of end-of-life care services and use of services among AIAN cancer patients are limited. In one study, Kitzes and researchers examined end-of-life and palliative care issues at one federally directed Indian Health Service area in the Southwest and concluded that there were few formal palliative services available to AIAN cancer patients in the mid-1990s.[45] Another option for cancer patients in the end-of-life phase is hospice services that provide support to improve the quality of care in their remaining days. Shivotz and researchers reported significant differences in fewer

hospice utilization among AIAN elders compared with NHW elders.[11]

Healthcare cost and utilization in the last six months of life for AIAN elders with early lung cancer stage (stage I and II) to metastatic lung cancer has not been extensively researched. The study will examine differences of total healthcare cost and utilization during the end-of-life period (i.e., last 6 months of life) between AIAN patients and NHW lung cancer patients who died from their lung cancer or any cause.

3.3 Methods

3.3.1 Study Design and Data Source

This study was a cohort design using the Surveillance, Epidemiology, and End Results (SEER)-Medicare dataset from 2000 to 2012. SEER-Medicare is a population-based resource often used cancer epidemiology and health services research. The SEER-Medicare database represents 26% of the United States population and 42% of the AIAN population aged 65 and older based on SEER registry locations.[10] This study utilized data from SEER registries in Connecticut, Detroit, Greater California, Greater Georgia, Hawaii, Iowa, Kentucky, Louisiana, Los Angeles, Michigan, New Jersey, New Mexico, Rural Georgia, San Francisco-Oakland, San Jose-Monterey, Seattle-Puget Sound, and Utah. The SEER-Medicare dataset was a linked dataset by using a unique patient identification number in the SEER Registry and Medicare claims. Several files from SEER-Medicare were used in this study: Durable Medical Equipment (DME), Home Health (HHA), Hospice (HOSP), Medicare Provider Analysis and Review (MEDPAR), National Claims History (NCH, previously known as Physician/Supplier), Outpatient (OUTSAF), and Patient Entitlement and Diagnosis File (PEDSF).

3.3.2 Study Population

Non-Hispanic White and AIAN Medicare enrollees aged 65 years or older with a first primary cancer date of diagnosis between January 1, 2000 and December 31, 2011 of lung and bronchus cancer (e.g., ICD-O codes C34.0-C34.3, C34.8, C34.9) and stages IA to IV (as defined by the American Joint Committee on Cancer) were included. Further inclusion were patients with continuous enrollment in Part A and Part B six months prior to cancer diagnosis date and six months prior to date of death date. If the patient died within those timeframes, they were still included in the study. Patients with a Medicare date of death were included in the study.

The following are exclusions of patients based on Medicare enrollment, histology of disease and date of cancer diagnosis. Patients were excluded based on Medicare eligibility status as a managed care plan and/or absence of any Part A and Part B coverage six months prior and after cancer diagnosis. Patients with the following lung cancer histology codes were excluded due location of tumor on skin or gastrointestinal tract: 8585/3 Thymoma, malignant; 8720/3 Malignant melanoma; 8770/3 Mixed epithelial and spindle cell melanoma; 9650/3 Hodgkin lymphoma; 9680/3 Diffuse large B cell; and 9699/3 Marginal zone B-cell lymphoma. Patients with a diagnosis date at death or autopsy, a cancer diagnosis date after date of death, or a cancer diagnosis date prior to age 65 were excluded due to absence of claims data. The resulting sample for this study was 443,691 patients and 55,386 patients had a survival time of ≤6 months after cancer diagnosis (see Figure 3.1). The matched sample was 209 AIAN patients and 418 patients with a ≤6 month survival time. The healthcare utilization and costs differed for patients who survived more than six months; this patient group will be explored in a separate

analysis and was considered to be beyond the scope of the current study.

3.3.3 Propensity Score Method

We used the propensity score methodology developed by Rosenbaum and Rubin who described propensity scores as the probability of treatment assignment conditional on observed baseline covariates.[26] The propensity scores were applied to improve adjustment of confounders, such as marital status and disease attributes, and to establish similar matched controls (matching NHW patients to the AIAN patients). Although it is important to note that hidden bias (unmeasured confounders) cannot easily be detected using this method.[27,28]

In this study, logistic regression was used to estimate propensity scores for each patient. The covariates were age at diagnosis, sex, year of diagnosis, stage of disease, grade, histology, Charlson Comorbidity Index, SEER registry, and marital status. The Charlson Comorbidity Index was derived from physician claims of comorbid conditions.[29-31] The focus of the study consists of stages III to IV lung cancer patients; therefore, cancer diagnosis was excluded in the Charlson Comorbidity Index.[32] The PSMATCH2 in STATA was used for propensity scoring matching of 1:2 ratio without replacement.[28,33,34] To analyze the propensity scores and to determine similarities, we first assessed the balance of covariates, the continuous and categorical covariates means and proportions were compared using the Harder, Stuart, and Anthony method along with the standardized bias cutoff of 0.10.[28]

3.3.4 Definition of Total Healthcare Cost

Total healthcare costs were examined for no more than six months, in addition, costs were analyzed separately depending on whether the cause of death was lung cancer or any cause. To identify total healthcare costs the Current Procedural Terminology (CPT), Healthcare Common Procedure Coding System (HCPCS), International Classification of Diseases, Ninth Revision (ICD-9), and revenue codes were used (see Table 3.1). The DME, HHA, HOSP, MEDPAR, NCH, and OUTSAF files were used to estimate total healthcare costs. All healthcare costs for each outpatient and inpatient visit were assessed from the patient's admission date. Total healthcare cost consists of cancer-treatment and noncancer-treatment costs that are defined as payments and not charges.

The three payment sources used to identify total healthcare costs in the SEER-Medicare files are Medicare, coinsurance, and patient responsibility. Medicare costs are reimbursed amounts. Coinsurance is payments by a primary payer other than Medicare. Patient responsibility is defined as the beneficiary's liability for payment.

Total healthcare cost was defined as the sum of cancer-treatment and noncancer-treatment costs from the SEER-Medicare files. Inpatient, outpatient, and emergency department costs were identified from the NCH file. Part A claims using the Centers for Medicare and Medicaid Services (CMS) Inpatient Hospital Index and Part B claims were adjusted using the Medicare Economic Index.[34] All costs were reported in 2012 dollars as this was the most recent diagnosis year in the SEER-Medicare dataset.

3.3.5 Definition of Healthcare Utilization

Total healthcare utilization was examined from six months up to date of death among those who died of any cause or lung cancer. Healthcare utilization is defined as the sum of cancer-treatment encounters and noncancer-treatment encounters. The NCH file was used to identify patient encounters. Encounters were comprised of inpatient (Part A), outpatient (Part B), and emergency department (Part B). To identify encounters, the ICD-9, revenue, HCPCS, and CPT codes were used. Total healthcare visits were based on a patient's admission date in an inpatient or outpatient setting.

3.3.6 Covariates

The PEDSF file was used to identify the patient's age at diagnosis, year of diagnosis, sex, stage of disease, histology, SEER registry at diagnosis, and marital status. The NCH file was used to identify Charlson Comorbidity Index scores.

3.3.7 Statistical Analysis

To describe patient characteristics, the chi-square test was used to determine NHW versus AIAN cohort differences for binary and categorical variables. The independent *t* test was used to examine the differences of continuous variables between the cohort groups. Statistical significance was defined as $p < 0.05$. STATA version 14.0 (*Stata Statistical Software: Release 14*. College Station, TX: StataCorp LP) was used for all analyses. Healthcare costs and utilization analyses were separated by mortality (any cause and lung cancer). To examine total healthcare costs, an estimated generalized linear model (GLM) with log link and gamma distribution was applied. To examine the associations of healthcare utilization with other variables and due to the over-dispersion

(if the variance is larger than the mean of a Poisson distribution) of total healthcare utilization, a negative binomial regression model (NBRM) was used in the unadjusted and adjusted models.

3.4 Results

A total of 55,386 AIAN patients and NHW patients were included in the study. Of those, a total of 619 patients were in the matched cohort (209 AIAN patients and 410 NHW patients).

3.4.1 Patient Characteristics

A total of 55,379 patients were available for selection into the study, 216 AIAN patients and 55,170 NHW patients (see Table 3.1). Before matching, age at diagnosis ($p = 0.01$), stage of disease ($p = 0.04$), marital status ($p < 0.01$), and US census region residence ($p < 0.01$) differed between AIAN patients and NHW patients. There were more AIAN patients compared with NHW patients between ages 71 to 75 (30% versus 25%), had stage IV disease (63% versus 65%), were either divorced/separated/widowed (51% versus 41%), and resided in the West US census region (78% versus 34%). Year of diagnosis after 2005 (54% versus 49%), adenocarcinoma lung cancer type (27% versus 30%), lung cancer death (81% versus 85%), grade undetermined (60% versus 61%), Charlson Comorbidity Index scores (0.02 versus 0.03), males (51% versus 55%), and census metro residence in the west region (78% versus 34%) were similar between AIAN patients and NHW patients.

After patients were propensity score matched, there were 209 AIAN patients and 418 NHW patients (see Table 3.1). All covariates met the 10% standardized bias criteria

between AIAN patients and NHW patients in the propensity score matching method (see Figures 3.2 and 3.3). Therefore, no differences were shown for age at diagnosis (p = 0.33), year of diagnosis (p = 0.78), cause of death (p = 0.10), grade (p = 0.37), baseline Charlson Comorbidity Index (p = 0.46), gender (p = 0.46), census tract metro residence (p = 0.05), marital status (p = 0.41), while differences existed for stage of disease (p = 0.02) and US census region ($p < 0.001$) between AIAN patients and NHW patients.

The unadjusted differences in mean total healthcare costs after matching was $601 ($32,139 versus $31,538 for AIAN and NHW, respectively) (see Table 3.2). In Table 3.3, the unadjusted difference in mean total healthcare utilization after matching was one visit (26 versus 27 visits for AIAN and NHW, respectively). The mean monthly trend for cancer- and noncancer-treatment costs increased up to two months before date of death (see Figure 3.4).

3.4.2 Unadjusted Total Healthcare Costs by Cause of Mortality

The generalized linear regression model was used to identify differences in the unadjusted mean total healthcare costs between AIAN and NHW lung cancer patients. In the unadjusted model for any cause mortality, being AIAN was not associated with higher total end-of-life healthcare costs (coefficient = 0.19, p = 0.77). Similarly, for lung cancer mortality, being AIAN was not associated with total end-of-life healthcare costs (coefficient = 0.04, p = 0.61).

3.4.3 Adjusted Total Healthcare Costs by Cause of Mortality

In the adjusted GLM for any cause mortality, being AIAN was not associated with total healthcare costs (coefficient = 0.01, p = 0.92), while holding patient

characteristics, cancer prognosis, and comorbidities constant (see Table 3.4). Equally for lung cancer mortality, being AIAN was not associated with total healthcare costs (coefficient = -0.003, $p = 0.97$), while holding patient characteristics, survival time, cancer prognosis, and comorbidities constant.

3.4.4 Adjusted Total Healthcare Costs by Stage of Disease and Any Cause Mortality

When adjustment variables were added to the GLM for patients who died of any cause, being AIAN was not associated with total healthcare costs for stage I, II, and III of the disease (stage I/II: $p = 0.35$, stage III: $p = 0.45$) (see Table 3.5). Likewise, among patients who died of lung cancer, being AIAN was not associated with total healthcare costs for stage I, II, and III disease (stage I/II: $p = 0.29$, stage III: $p = 0.33$). For patients with stage IV disease, among those with any cause and lung cancer mortality, being AIAN was not associated with total healthcare costs (Any Cause: $p = 0.53$, Lung cancer: $p = 0.53$).

3.4.5 Adjusted Total Healthcare Utilization

In the adjusted model for any cause mortality, being AIAN was not associated with healthcare utilization compared with NHW patients (coefficient = -0.04, 95% CI: 0.81-1.05) (see Table 3.6). Patients over the age of 81 years have a 17% decrease in the number of healthcare visits relative to younger individuals. Single patients compared with divorced, separated, or widowed cancer patients have 4% decrease in the number of healthcare visits.

In the adjusted model for lung cancer mortality, being AIAN was not associated with healthcare utilization compared with NHW patients (coefficient = -0.08, 95% CI:

0.81-1.05) (see Table 3.6). Patients age 81 years and older have a 18% decrease in the number of healthcare visits than younger patients. Patients with other types of histology have a 35% decrease in total healthcare visits than other types of lung cancer.

3.4.6 Cancer- and Noncancer-Treatment Care

Overall costs showed that more than half of total healthcare costs for AIAN (67%) and NHW (66%) patients with lung cancer were from noncancer-treatment in inpatient care, while outpatient care costs from cancer-treatment were 87% for AIAN and 91% for NHW lung cancer patients. Of the total cancer-treatment costs, 43% was from chemotherapy and 61% from radiation therapy for AIAN lung cancer patients (53% from chemotherapy and 50% from radiation for NHW patients). Chemotherapy and radiation are offered in outpatient care.

Patient noncancer-treatment visits were 83% of the total healthcare visits in the last six months of life for AIAN lung cancer patients in this study. Sixty-percent of noncancer-treatment visits by AIAN lung cancer patients were in inpatient settings and it suggests higher inpatient costs from noncancer-treatment care.

3.5 Discussion

The study sought to compare healthcare costs and healthcare utilization in the last six months of life between AIAN patients and NHW patients diagnosed with lung cancer who survived up to six months before date of death. AIAN lung cancer patients was not associated to healthcare costs or utilization in the last six months of life.

3.5.1 Total Healthcare Costs

The mean total healthcare costs in the last six months of life were lower overall in our study compared to other studies.[49,50] In most cases, patients with advanced lung cancer spend more on end-of-life care and initial care after cancer diagnosis.[15] Studies similar to our study defined costs differently and may limit our comparability. Total healthcare costs are higher in our study compared to Bremner and colleagues, since we included stages I to IV disease, patients who received/did not receive health services, all lung cancer types, and our definitions of costs differed (e.g., short- and long-term inpatient stays were included, and clear distinction of cancer and noncancer-treatment costs). However, monthly trends for short-term survival are consistent with our findings, noncancer-treatment costs increased from month six up to month two ($1,483 to $11,495 for AIAN patients, $1,101 to $10,440 for NHW patients) and decreased in the last 30 days of life. The decrease in the last 30 days of life represent partial costs of patients who died after the first day of the month, these are due to SEER releasing only cancer diagnosis month and year date, but not diagnosis day.

In comparison to a study that ended in 2009 by Chastek and colleagues, we reported similar monthly trends in the last six months of life for inpatient care, chemotherapy and radiation therapy. Their total cancer costs were $58,818, (commercial insurance was the primary payer) while our study reported total healthcare costs of $32,139 for AIAN and $31,538 for NHW lung cancer patients.[49] Although Chastek and colleagues[49] indicated their results are similar to Medicare costs, the estimates in this study of cancer-treatment and noncancer-treatment are not close to their total cancer costs of $58,818. Our study was able to separate treatments (cancer and noncancer) and overall

health services during the six-month period, whereas prior studies provided estimates of cancer costs or specific health services.

3.5.2 Total Healthcare Utilization

Comparability to other studies is limited since prior studies focused on costs in the last six months or last year of life and hospice care utilization.[49] In our study, a mean of one hospice visit for noncancer-treatment was observed in both AIAN and NHW lung cancer patients. In contrast, a study by Guadagnolo and researchers[51] investigated disparities among AIAN patients on Medicare dying from cancer and they reported AIAN patients used fewer hospice services compared with NHW patients. Hospice visits often decrease hospital days and spending, though, for patients with disenrollment in hospice spend more without extending survival time.[52-54] Although hospice care is crucial during the end-of-life care, 50% of total healthcare visits by AIAN patients and 54% of total healthcare visits by NHW patients were from noncancer-treatment care in an inpatient setting during the last six months of life in our study.

Although there are several strengths in this study, some limitations must be explained. We used claims data that focus on payments of health services rather than clinical reasons. For example, individual medical history and treatment regimen are not documented well in claims data. Also, use of claims data introduces coding errors. Since patients may or may not use Indian Health Service, our understanding of healthcare utilization on and off the Tribal reservations is limited. Payments made by Indian Health Service for cancer- and noncancer-treatment are not linked to SEER-Medicare, thus Medicare cost estimates are limited and may be underestimated. Out-of-pocket expenses were captured as part of total healthcare costs in this study, but information about receipt

of payment is not reported in SEER-Medicare. Most AIAN patients in this study are from lower income census regions, however, it's not known if other financial support assistance existed that contributed to their out-of-pocket expenses. For AIAN patients on Medicare, more than 28% have no supplemental coverage and are at risk for out-of-pocket sharing requirements.[41] The results in this study may not be generalizable to individuals in the general population, since most patients resided in the Western region of the United States. Race misclassification is possible, since Medicare uses self-reported information, while SEER registries obtain race information from providers.

In summary, the results in this study verified that despite insignificant differences in healthcare costs and utilization between AIAN patients and NHW patients in the last six months of life, hospitalizations remain a cost driver in costs. Future research should collect data on health costs and utilization to examine specific health services (e.g., hospice care use, palliative care access) and socioeconomic factors contributing to worse lung cancer survival outcomes for AIAN lung cancer patients. Medicare, Indian Health Service, Federal, Tribal, and Private health entities must provide opportunities to increase cultural competency of providers to understand end-of-life care resources for AIAN elderly cancer patients.

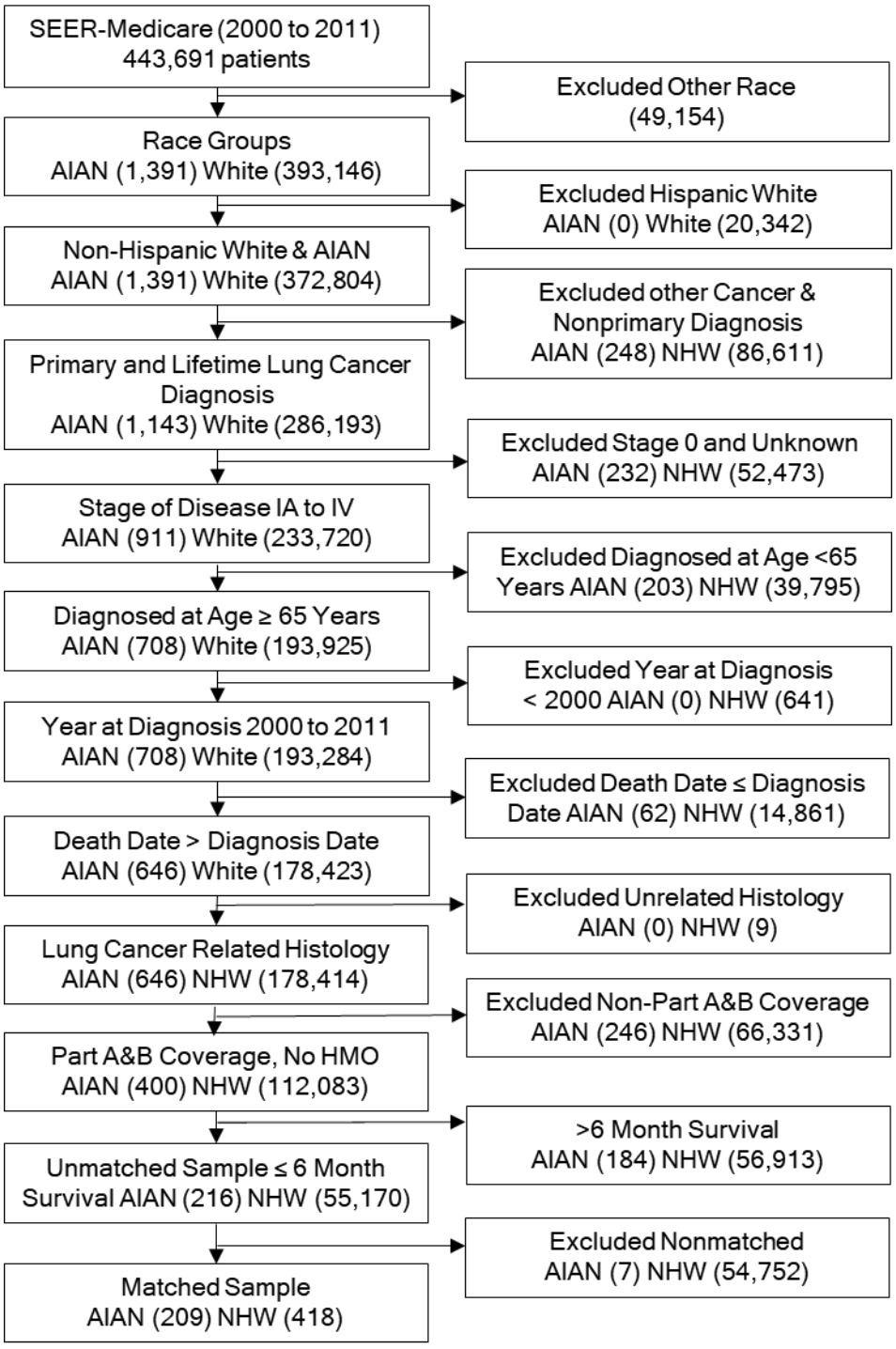


Figure 3.1 Inclusion and Exclusions Diagram.

Note. AIAN = American Indian and Alaska Native; NHW = Non-Hispanic White.

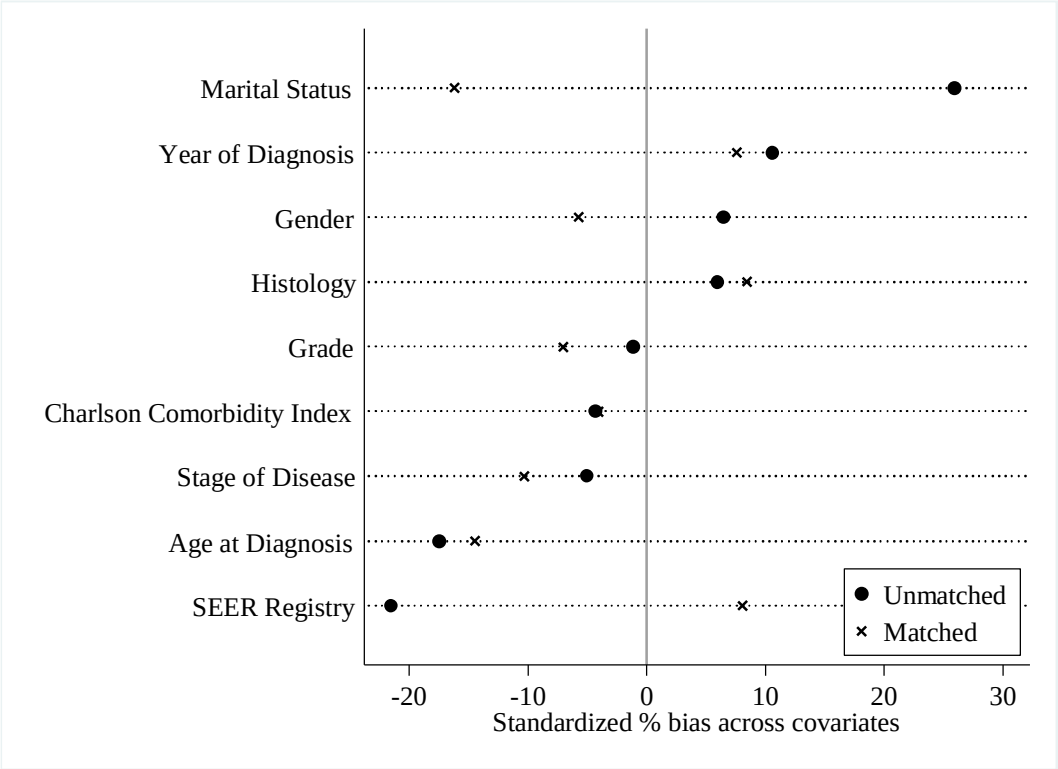


Figure 3.2 Percent of Standardized Bias Differences for Propensity Score Matching in Group One.

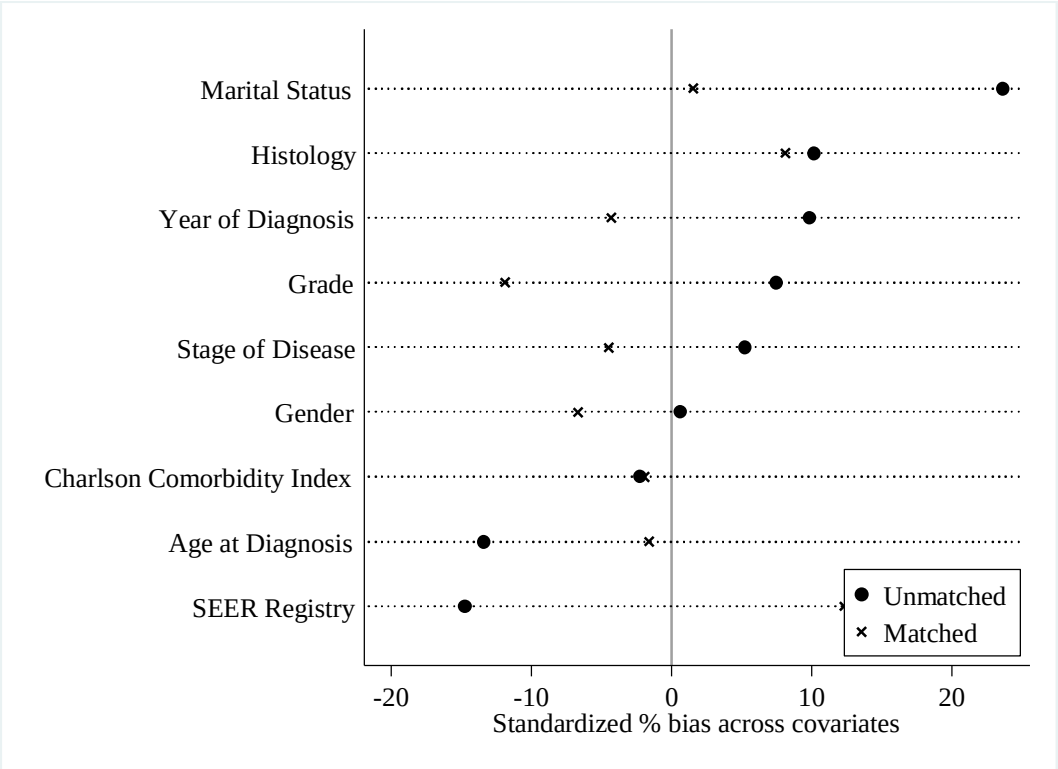
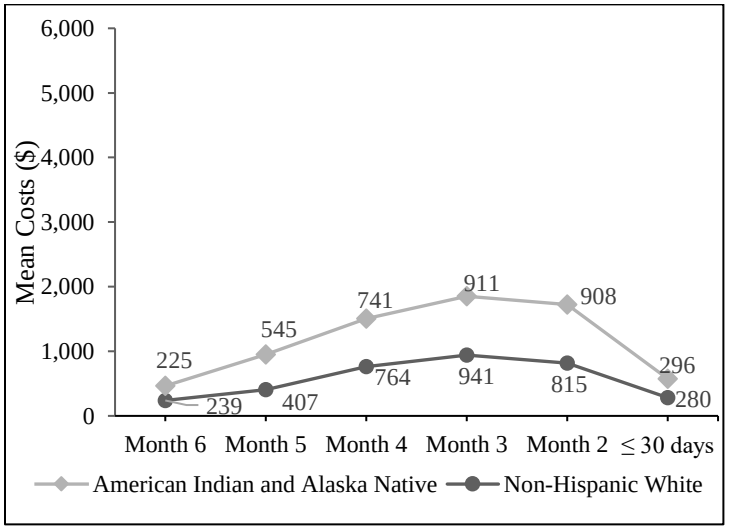


Figure 3.3 Percent of Standardized Bias Differences for Propensity Score Matching in Group Two.

a) Cancer-Treatment Mean Monthly Costs



b) Noncancer-Treatment Mean Monthly Costs

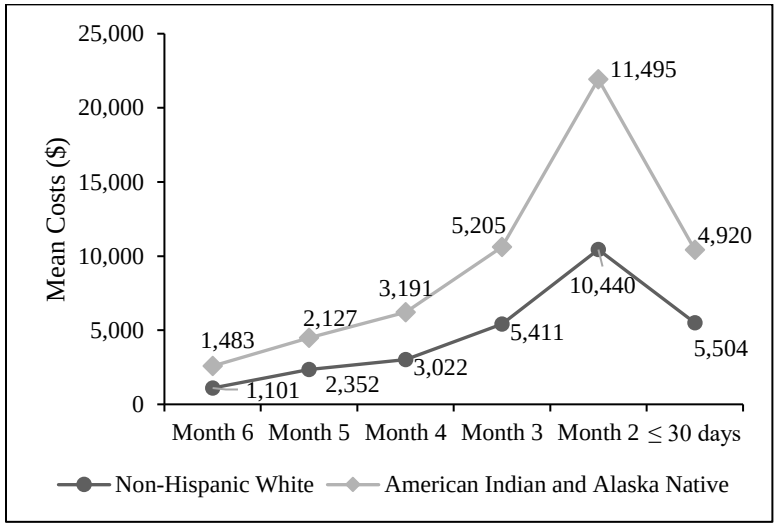


Figure 3.4 Mean Monthly Healthcare Costs

Table 3.1

Patient Characteristics of Lung Cancer Patients in the Last 6 Months of Life

Variables	Unmatched					Matched				
	AIAN *N* = 216	%	NHW *N* = 55,170	%	*p* Value	AIAN *N* = 209	%	NHW *N* = 418	%	*p* Value
Age at Diagnosis (mean)			76		0.01	75		76		0.33
65-70	75	28.70	13,315	24.13		61	29.19	103	24.64	
71-75	62	29.63	13,609	24.67		60	28.71	123	29.43	
76-80	64	19.44	13,313	24.13		41	19.62	87	20.81	
81+	42	22.22	14,933	27.07	0.05	47	22.49	105	25.12	0.66
Year of Diagnosis										
2000-2005	99	45.83	2,866	51.23		98	46.89	201	48.09	
2006-2011	117	54.17	26,904	48.77	0.11	111	53.11	217	51.91	0.78
AJCC 6th Stage of Disease										
Stage I	13	6.02	3,578	6.49		12	5.74	27	6.46	
Stage II	10	4.63	1,068	1.94		10	4.78	4	0.96	
Stage III	58	26.85	14,706	26.66		56	26.79	107	26.79	
Stage IV	135	62.50	35,818	64.92	0.04	131	62.68	280	62.68	0.02
Histology Type										
Adenocarcinoma	58	26.85	16,672	30.22		55	26.32	127	30.38	
Large Cell	10	4.63	2,243	4.07		10	4.78	9	2.15	
Non-Small Cell	32	14.81	8,677	15.73		30	14.35	75	17.95	
Small Cell	36	16.67	9,070	16.44		36	17.22	78	18.66	
Squamous Cell	53	24.54	10,207	18.50		52	24.88	68	16.27	
Other Type	27	12.50	8,301	15.05	0.28	26	12.44	61	14.59	0.05
Cause of Death										
Lung Cancer	175	81.02	46,769	84.77		170	81.34	361	86.36	

Table 3.1 Continued

Variables	Unmatched					Matched				
	AIAN *N* = 216	%	NHW *N* = 55,170	%	*p* Value	AIAN N = 209	%	NHW *N* = 418	%	*p* Value
Other	41	18.98	8,401	15.23	0.13	39	18.66	57	13.64	0.10
Grade										
Well Differentiated	5	2.31	947	1.72		5	2.39	3	0.72	
Moderately Differentiated	18	8.33	4,651	8.43		17	8.13	32	7.66	
Poorly Differentiated	49	22.69	12,507	22.67		49	23.44	95	22.73	
Undifferentiated	14	6.48	3,653	6.62		14	6.70	21	5.02	
Cell Type Unknown	130	60.19	33,412	60.56	0.98	124	59.33	267	63.88	0.37
Baseline Charlson Comorbidity Index (Mean)	0.02		0.03		0.58	0.02		0.03		0.67
Gender										
Female	105	48.61	25,036	45.38		101	48.33	215	51.67	
Male	111	51.39	30,134	54.63	0.34	108	51.67	203	48.33	0.46
Census Tract Residence										
Metro	163	75.46	43,553	78.94		157	75.12	342	81.82	
Nonmetro	53	24.54	11,614	21.05		52	24.88	76	18.18	
Missing	0	0.00	3	0.01	0.45	0	0.00	0	0.00	0.05
Marital Status										
Married	75	34.72	26,525	48.08		75	35.89	141	33.73	
Single	23	10.65	3,917	7.10		23	11.00	35	8.37	
Divorced	111	51.39	22,668	41.09		111	53.11	242	57.89	
Missing	7	3.24	2,060	3.73	0.001	0	0.00	0	0.00	0.41

Table 3.1 Continued

Variables	Unmatched					Matched				
	AIAN *N* = 216	%	NHW *N* = 55,170	%	*p* Value	AIAN *N* = 209	%	NHW *N* = 418	%	*p* Value
US Census Region										
Northwest	13	6.02	10,941	19.83		13	6.22	74	17.70	
Midwest	21	9.72	7,844	14.22		21	10.05	88	21.05	
South	13	6.02	17,730	32.14		13	6.22	88	21.05	
West	169	78.24	18,655	33.81	<0.01	162	77.51	168	40.19	<0.01

Note. AIAN = American Indian and Alaska Native; NHW = Non-Hispanic White; AJCC = American Joint Committee on Cancer.

Table 3.2

Description of Healthcare Costs

Variables	American Indian and Alaska Native			Non-Hispanic White		
	Mean $	Median $	Range, $	Mean $	Median $	Range, $
Unmatched Cohort (AIAN = 216; NHW = 55,170)						
Cancer-Treatment						
Inpatient	401	0	0-13,624	351	0	0-182,457
Outpatient	3,192	0	0-47,164	3,551	0	0-283,146
Hospice	18	0	0-3,982	15	0	0-14,559
Surgery	143	0	0-5,030	135	0	0-182,457
Radiation	1,647	0	0-33,657	1,767	0	0-61,880
Chemotherapy	2,139	0	0-29,743	2,298	0	0-283,146
Total Cancer-Treatment	3,644	0	0-47,309	3,963	412	4-283,146
Noncancer-Treatment						
Inpatient	21,552	18,637	0-112,359	20,926	14,535	0-664,511
Outpatient	3,384	2,146	0-23,812	3,229	2,004	0-97,195
Hospice	1,868	148	0-25,197	2,057	462	0-90,716
Total Noncancer Treatment	28,448	23,712	0-121,680	27,909	21,285	0-665,748
Total Healthcare Costs	32,091	26,568	0-126,710	31,873	24,776	0-665,748
Matched Cohort (AIAN = 209; NHW = 418)						
Cancer-Treatment						
Inpatient	405	0	0-13,624	174	0	0-11,043
Outpatient	3,177	0	0-47,164	3,169	0	0-33,628
Hospice	19	0	0-3,982	45	0	0-7,581

Table 3.2 Continued

Variables	American Indian and Alaska Native			Non-Hispanic White		
	Mean $	Median $	Range, $	Mean $	Median $	Range, $
Surgery	148	0	0-5,029	70	0	0-3,817
Radiation	1,570	0	0-33,657	1,859	0	0-27,655
Chemotherapy	2,211	0	0-29,743	1,749	0	0-23,069
Total Cancer-Treatment	3,634	0	0-47,309	3,483	0	0-33,643
Noncancer-Treatment						
Inpatient	21,597	18,914	0-112,359	20,717	13,941	0-221,684
Outpatient	3,432	2,250	0-23,812	3,221	2,024	0-26,027
Hospice	1,848	128	0-25,197	3,179	2,011	0-26,027
Total Noncancer Treatment	28,505	23,736	0-121,680	28,055	21,453	0-232,544
Total Healthcare Costs	32,139	26,566	0-126,710	31,538	24,092	0-235,013

Table 3.3

Description of Healthcare Utilization (Visits)

Variables	American Indian and Alaska Native			Non-Hispanic White		
	Mean Number of Visits	Median Number of Visits	Range (min-max)	Mean Number of Visits	Median Number of Visits	Range (min-max)
Unmatched Cohort (AIAN = 216; NHW = 55,170)						
Cancer-Treatment						
Inpatient	0.36	0	0-12	0.50	0	0-41
Outpatient	3	0	0-41	3	0	0-144
Hospice	0.005	0	0-1	0.005	0	0-4
Total Cancer-Treatment	3	0	0-41	4	0	0-150
Noncancer-Treatment						
Inpatient	12	10	0-70	13	9	0-244
Outpatient	7	6	0-52	8	6	0-77
Hospice	1	1	0-10	1	1	0-24
Total Noncancer-Treatment	19	17	0-87	21	17	0-244
Total Healthcare Visits	24	20	0-93	25	21	0-244
Matched Cohort (AIAN = 209; NHW = 418)						
Cancer-Treatment						
Inpatient	0.35	0	0-12	0.32	0	0-8
Outpatient	3	0	0-41	3	0	0-32
Hospice	0.005	0	0-1	0.01	0	0-2
Total Cancer-Treatment	3	0	0-41	11	0	0-33

Table 3.3 Continued

Variables	American Indian and Alaska Native			Non-Hispanic White		
	Mean Number of Visits	Median Number of Visits	Range (min-max)	Mean Number of Visits	Median Number of Visits	Range (min-max)
Noncancer-Treatment						
Inpatient	12	10	0-70	13	10	0-150
Outpatient	8	6	0-52	7	5	0-47
Hospice	1	1	0-10	1	1	0-19
Total Noncancer-Treatment	20	17	0-87	20	17	0-152
Total Healthcare Visits	24	20	0-93	24	20	0-152

Table 3.4

Adjusted Generalized Linear Model (GLM) of Total Healthcare Costs by Mortality

Covariates	Any Cause Mortality (*N* = 627)			Lung Cancer Mortality (*N* = 531)		
	Coefficient(β)	exp(β) 95% CI	*p* Value	Coefficient(β)	exp(β) 95% CI	*p* Value
American Indian and Alaska Native Race	0.01	0.90-1.13	0.92	-0.003	0.88-1.13	0.97
Age at Diagnosis						
65-70	Reference					
71-75	-0.01	0.86-1.14	0.91	-0.05	0.82-1.11	0.54
76-80	-0.06	0.81-1.11	0.48	-0.08	0.78-1.10	0.36
81+	-0.10	0.77-1.05	0.19	-0.11	0.75-1.06	0.19
Female	-0.02	0.87-1.33	0.89	-0.05	0.84-1.08	0.48
Grade						
Well Differentiated	Reference					
Moderately Differentiated	-0.22	0.48-1.33	0.39	-0.14	0.50-1.51	0.62
Poorly Differentiated	-0.24	0.48-1.28	0.33	-0.05	0.57-1.61	0.86
Undifferentiated	-0.55	0.34-0.98	0.04	-0.33	0.41-1.28	0.26
Cell Type Unknown	-0.34	0.44-1.15	0.16	-0.14	0.52-1.46	0.61
AJCC 6th Stage of Disease						
Stage I	Reference					
Stage II	-0.36	0.46-1.06	0.10	-0.23	0.49-1.27	0.34
Stage III	-0.36	0.55-0.88	<0.01	-0.31	0.55-0.98	0.04
Stage IV	-0.40	0.54-0.85	<0.01	-0.32	0.55-0.96	0.03

Table 3.4 Continued

Covariates	Any Cause Mortality (*N* = 627)			Lung Cancer Mortality (*N* = 531)		
	Coefficient(β)	exp(β) 95% CI	*p* Value	Coefficient(β)	exp(β) 95% CI	*p* Value
Histology Group						
Adenocarcinoma	Reference					
Large Cell	-0.17	0.61-1.18	0.33	-0.17	0.59-1.19	0.33
Non-Small Cell	-0.21	0.69-0.96	0.02	-0.25	0.65-0.94	0.01
Small Cell	-0.03	0.82-1.15	0.73	-0.06	0.78-1.13	0.51
Squamous Cell	-0.11	0.76-1.05	0.18	-0.11	0.75-1.07	0.24
Other Type	-0.32	0.61-0.87	<0.01	-0.27	0.62-0.93	0.01
Charlson Comorbidity Index	-0.33	0.55-0.94	0.02	-0.36	0.52-0.95	0.02
Marital Status						
Married	Reference					
Single	0.17	0.97-1.45	0.09	0.21	0.99-1.53	0.07
Divorced Widowed	0.00	0.89-1.14	0.95	0.01	0.88-1.16	0.90
Survival Time	0.13	1.10-1.18	<0.01	0.14	1.11-1.19	0.00
Constant	10.77			10.51		

Note. Statistically significant at alpha level of 0.05; AJCC = American Joint Committee on Cancer.

Table 3.5

Adjusted Generalized Linear Model (GLM) of Total Healthcare Costs by Stage of Disease and Mortality

Covariates	Any Cause Mortality			Lung Cancer Mortality		
	Number of AIAN & NHW	Coefficient(β)	*p* Value	Number of AIAN & NHW	Coefficient(β)	*p* Value
Unadjusted						
AIAN Race Stage I and II	53	-0.22	0.41	38	-0.16	0.61
AIAN Race Stage III	163	-0.07	0.53	138	-0.11	0.38
AIAN Race Stage IV	407	0.08	0.27	355	0.11	0.17
Adjusted						
AIAN Race Stage I and II	53	-0.27	0.35	38	-0.35	0.29
AIAN Race Stage III	163	-0.09	0.45	138	-0.13	0.33
AIAN Race Stage IV	411	0.05	0.53	355	0.07	0.39

Note. Statistically significant at alpha level of 0.05; Adjusted model includes: Age, Gender, Grade, Histology, Charlson Comorbidity Index, Survival time, and Marital status; AIAN = American Indian and Alaska Native.

Table 3.6

Adjusted Negative Binomial Regression Model (NBRM) of Total Healthcare Utilization by Mortality

Covariates	Any Cause Mortality (*N* = 619)			Lung Cancer Mortality (*N* = 527)		
	Coefficient(β)	IRR 95% CI	*p* Value	Coefficient(β)	IRR 95% CI	*p* Value
American Indian and Alaska Native Race	-0.04	0.85-1.07	0.47	-0.08	0.81-1.05	0.24
Age at Diagnosis						
65-70	Reference					
71-75	0.01	0.87-1.07	0.92	-0.03	0.83-1.13	0.67
76-80	-0.07	0.87-1.16	0.41	-0.08	0.78-1.10	0.39
81+	-0.17	0.72-0.98	0.03	-0.18	0.70-0.99	0.04
Female	0.02	0.76-1.14	0.76	-0.03	0.86-1.10	0.67
Grade						
Well Differentiated	Reference					
Moderately Differentiated	-0.09	0.55-1.51	0.72	-0.20	0.47-1.42	0.48
Poorly Differentiated	-0.05	0.59-1.55	0.85	-0.10	0.54-1.53	0.72
Undifferentiated	-0.26	0.45-1.32	0.34	-0.23	0.45-1.41	0.43
Unknown	-0.16	0.53-1.38	0.51	-0.20	0.49-1.37	0.45
Stage of Disease						
Stage I	Reference					
Stage II	-0.18	0.55-1.27	0.41	-0.07	0.58-1.51	0.78
Stage III	-0.17	0.67-1.08	0.18	-0.12	0.66-1.18	0.40
Stage IV	-0.21	0.65-1.02	0.08	-0.13	0.67-1.17	0.38
Histology Group						
Adenocarcinoma	Reference					
Large Cell	-0.04	0.69-1.35	0.84	0.00	0.71-1.42	0.99
Non-Small Cell	-0.09	0.77-1.08	0.29	-0.10	0.75-1.09	0.31

Table 3.6 Continued

Covariates	Any Cause Mortality (*N* = 619)			Lung Cancer Mortality (*N* = 527)		
	Coefficient(β)	IRR 95% CI	*p* Value	Coefficient(β)	IRR 95% CI	*p* Value
Small Cell	0.09	0.92-1.31	0.29	0.08	0.90-1.30	0.40
Squamous Cell	-0.05	0.81-1.12	0.55	0.00	0.84-1.19	0.99
Other Type	-0.39	0.56-0.81	<0.01	-0.35	0.57-0.87	<0.01
Charlson Comorbidity Index	-0.08	0.70-1.21	0.57	-0.03	0.72-1.30	0.82
Marital Status						
Married	Reference					
Single	-0.04	0.79-1.18	0.71	-0.06	0.76-1.18	0.62
Divorced	-0.07	0.82-1.05	0.24	-0.05	0.83-1.09	0.46
Survival Time	0.15	1.12-1.20	<0.01	-0.03	0.72-1.30	0.82
Constant	3.19			3.16		

Note. Statistically significant at alpha level of 0.05; IRR = Incidence Risk Ratio.

.

CHAPTER 4

DEPRESSION INCIDENCE, DEPRESSION TREATMENT UTILIZATION, AND RISK FACTORS FOR DEPRESSION AFTER CANCER DIAGNOSIS

4.1 Abstract

Depression disorders are a concern for newly diagnosed AIAN and NHW lung cancer patients. Incidence of depression disorders play an important role in lung cancer survival. **Objective:** We evaluated incidence of depression and depression treatment utilization 60 months after lung cancer diagnosis. We examined risk factors for depression 60 months after lung cancer diagnosis. **Methods:** We used the Surveillance, Epidemiology, and End Results (SEER)-Medicare dataset and identified 121,282 patients diagnosed from January 1, 2000 to December 31, 2011. A Cox proportional hazards regression model was used to identify risks for depression. **Results:** The incidence of depression was 3.67% for American Indian and Alaska Native patients and 6.16% for non-Hispanic White patients. The mean depression treatment visits were 3.67 for American Indian and Alaska Native patients and 2.97 for non-Hispanic White patients. American Indian and Alaska Native patients were not at increased risk for depression after cancer diagnosis after controlling for patient characteristics and cancer prognosis. **Conclusion:** AIAN patients are not at increased risk for depression disorders. AIAN patients suggest a higher percentage of incidence of depression disorders than NHW

patients. Further research should focus on improvement of incidence and prevalent rates related to depression disorders for AIAN patients.

4.2 Introduction

Depression disorders is a major concern for patients among those recently diagnosed with lung cancer. A study reported that older patients with major depression disorders within eight weeks of metastatic non-small cell lung cancer diagnosis had shorter survival (i.e., 5.4 months major depression disorders, 10 months no major depression disorder).[16] Also, patients newly diagnosed with invasive small and non-small cell lung cancer with depression symptoms had significantly higher mortality when more cancer symptoms were present ($p = 0.01$) and when patients had less social support ($p = 0.04$).[57] Depression symptoms coexist with other health conditions in some older adults as part of aging. It is often undiagnosed but when experiencing a new cancer diagnosis it could exacerbate depression symptoms.[58,59] Certain older patients are more at risk of the onset of depression. Lung cancer patients who are female, low income, not married, less educated, and currently smoke were associated with a higher chance of depression symptoms.[57,60]

Depression, anxiety, and serious psychological distress are higher for American Indian and Alaska Native (AIAN) adults without cancer when compared to other racial/ethnicity groups.[61] It is unclear if racial differences in mental health issues exist among individuals with cancer; furthermore, little is known of AIAN elderly patients.[62-64] Studies of incidence rate of depression disorders and risk factors do not exist for AIAN elderly with lung cancer and it is often recommended by other researchers as a step in understanding mental health issues.[65] As well, documentation of depression treatment is

not known for AIAN lung cancer patients.[58,66-68]

The aim is to compare the incidence rates of depression disorders and depression treatment utilization 60 months (5 years) following lung cancer diagnosis among AIAN and non-Hispanic White (NHW) patients. The hypotheses are that AIAN patients will have lower incidence rate of depression disorders and be at increased risk for depression disorders.

4.3 Methods

4.3.1 Study Design and Data Source

This study was a cohort design using the Surveillance, Epidemiology, and End Results (SEER) Medicare dataset from 2000 to 2012. SEER-Medicare is a population-based resource in cancer epidemiology and health services research. The SEER-Medicare database represents 26% of the United States population and 42% of the AIAN population aged 65 and older based on SEER registry locations.[10] This study utilized data from SEER registries in Connecticut, Detroit, Greater California, Greater Georgia, Hawaii, Iowa, Kentucky, Louisiana, Los Angeles, Michigan, New Jersey, New Mexico, Rural Georgia, San Francisco-Oakland, San Jose-Monterey, Seattle-Puget Sound, and Utah. The SEER-Medicare dataset was a linked dataset by using a unique patient identification number in the SEER Registry and Medicare claims. Several files from SEER-Medicare were used in this study: Durable Medical Equipment (DME), Home Health (HHA), Medicare Provider Analysis and Review (MEDPAR), National Claims History (NCH, previously known as Physician/Supplier), Outpatient (OUTSAF), and Patient Entitlement and Diagnosis File (PEDSF).

4.3.2 Study Population

Non-Hispanic White and AIAN Medicare enrollees aged 65 years or older with a first primary cancer date of diagnosis between January 1, 2000 and December 31, 2011 of lung and bronchus cancer (i.e., ICD-O codes C34.0-C34.3, C34.8, C34.9) and stages IA to IV (as defined by the American Joint Committee on Cancer) were included. Further inclusion were patients with continuous enrollment in Part A and Part B from the cancer diagnosis date to at least 12 months before and after cancer diagnosis were included in the study. If patients died during the Part A and B time frame, they were included in the study.

The following are exclusions of patients based on Medicare enrollment, histology, and date of cancer diagnosis. Patients were excluded based on Medicare eligibility status as a managed care plan and/or absence of any Part A and Part B coverage up to 12 months prior to and 12 months following cancer diagnosis. Patients with lung cancer histology codes that were excluded due to origin of tumor location and different treatments: 8585/3 Thymoma, malignant; 8720/3 Malignant melanoma; 8770/3 Mixed epithelial and spindle cell melanoma; 9650/3 Hodgkin lymphoma; 9680/3 Diffuse large B cell; and 9699/3 Marginal zone B-cell lymphoma. Patients with a diagnosis date at death or autopsy, a cancer diagnosis date after date of death, or a cancer diagnosis date prior to age 65 years were excluded due to absence of claims data. The resulting sample for this study was 443,691 subjects and 312,870 were excluded. The sample was a total of 121,282 patients, 409 AIAN and 120,973 NHW patients.

4.3.3 Definition of Depression Disorders

To identify depression disorders, the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR) diagnosis codes by the American Psychiatric Association were aligned with the International Classification of Diseases, Ninth Revision (ICD-9) codes. Patients were considered to have a depression disorder diagnosis if at least one claim in an inpatient or outpatient setting included the following ICD-9 codes: 296.2 - 296.25 (major depressive disorder), 300.4 (dysthymic depression), 309.1 (prolonged depressive reaction), and 311.0 (depressive disorder, not otherwise specified). Similar studies of depression and cancer used the ICD-9 codes mentioned.[58,69]

4.3.4 Definition of Depression After Cancer Diagnosis

Patients with no depression disorder at cancer diagnosis date were examined after lung cancer diagnosis. The focus of determining depression at cancer diagnosis was to isolate patients with depression disorder after cancer diagnosis from those with a history of any depression symptoms. Patients with previous depression may have reoccurring depression disorder and often experience different symptoms and treatment strategies compared to patients newly diagnosed with a depression disorders.[70]

4.3.5 Definition of Depression Treatment Utilization

Depression treatment utilization of patients with depression were examined within 60 (5 years) months following lung cancer diagnosis. Patients with new incidence of depression disorder and patients with depression disorders before cancer diagnosis were analyzed for depression treatment utilization. Depression treatment utilization was defined as mean and median visits. The classification of depression treatment visits

(psychiatry and evaluation and management codes) occurred in outpatient and inpatient settings. The Current Procedural Terminology (CPT) codes by the American Medical Association were used to identify claims for psychiatric or pharmacological treatment for depression disorder and/or other health conditions at a hospital/clinic visit. The following CPT codes were used: 90801, 90804, 90805, 90806, 90807, 90862, 99201-99205, 99212-99215, 99241-99245, 99218-99223, and 99231-99238.[69] Psychiatry codes used in this study are 90801 to 90862 and codes 99201 to 99238 relate to evaluation and management services for counseling or coordination of care by Medicare providers. Depression treatments are typically provided by mental health professionals and other clinical providers.

4.3.6 Statistical Analysis

A summary of patient characteristics was calculated for all patients and those with depression in the cohort after cancer diagnosis. Additionally, lung cancer-treatment and depression diagnosis before or after treatment were described. The chi-square test was used to determine cohort differences for binary and categorical variables. The independent *t* test was used to examine the differences of continuous variables between the cohort groups. Fisher's exact test was used to compare differences for cells with less than five patients. The Charlson Comorbidity Index was derived from physician claims of comorbid conditions.[32-34] To investigate risk factors among all patients for depression disorder, a Cox proportional hazards regression model was used for analysis. Statistical significance was defined as $p < 0.05$. STATA version 14.0 (*Stata Statistical Software: Release 14*. College Station, TX: StataCorp LP) was used for all analyses.

4.4 Results

In this study there were 121,282 patients diagnosed with lung cancer from 2000 to 2011, 409 AIAN patients and 120,973 NHW patients. Patients with depression disorder after cancer diagnosis totaled 7,467 patients, 15 AIAN patients and 7,452 NHW patients.

AIAN patients were not significantly different than NHW patients in terms of gender ($p = 0.95$), Charlson Comorbidity Index ($p = 0.92$), and year of diagnosis ($p = 0.14$) (see Table 4.1). Whereas, the AIAN patients and NHW patients significantly differed in age ($p = 0.01$), stage of disease ($p = 0.03$), histology ($p = 0.01$), marital status ($p < 0.01$), census median income ($p < 0.01$), and US Census Region ($p < 0.01$). Overall, there were more males (52% AIAN, 52% NHW) than females (48% AIAN, 48% NHW), more with stage IV disease (46% AIAN, 45% NHW), diagnosed with cancer after 2004 (54% AIAN, 51% NHW), and had more than one comorbidity condition (54% AIAN, 54% NHW) among both cohorts. NHW patients resided in a higher census median income area than AIAN patients ($49,055 NHW versus $39,495 AIAN).

4.4.1 Depression After Cancer Diagnosis

Of the 121,282, there were 15 (3.67%) AIAN patients and 7,452 (6.16%) NHW patients with depression after cancer diagnosis (see Table 4.2). AIAN patients and NHW patients were similar in age ($p = 0.40$), gender ($p = 0.05$), stage of disease ($p = 0.09$), year of diagnosis ($p = 0.35$), marital status ($p = 0.90$), and Charlson Comorbidity Index ($p = 0.44$). More patients with depression were younger than 70 years old (40% AIAN, 37% NHW), diagnosed after 2005 (67% AIAN, 55% NHW), were married (60% AIAN, 54%), had more than one comorbidity (40% AIAN, 52% NHW), and resided in the West US Census Region (73% AIAN, 34% NHW). The difference in census median income

was fewer for AIAN patients than NHW patients ($37,234 AIAN versus $50,213).

4.4.2 Lung Cancer-Treatment and Depression Diagnosis

Of the 121,282 patients, 61% of AIAN patients and 66% of NHW patients received one or more types of cancer-treatment (i.e., surgery, radiation, chemotherapy) (see Table 4.2). The incidence of depression over 5-years after lung cancer diagnosis was 3.67% for AIAN patients and 6.16% for NHW patients. Among those with depression after cancer diagnosis, 13 (87%) AIAN patients and 6,083 (82%) received one or more types of cancer-treatment. Eighty-seven percent (n = 13) of AIAN patients and 68% (n = 5,095) of NHW patients were diagnosed with depression after cancer diagnosis.

4.4.3 Depression Treatment Utilization

In Table 4.3, among patients with an incidence of depression disorder, their mean visits for depression treatment for the AIAN patients compared with the NHW patients (3.67 AIAN versus 2.97 NHW), and the median number of visits was 3.0 for AIAN patients and 1.0 for NHW patients. Among prevalent cases of depression disorders, AIAN patients had eight mean depression treatment visits and NHW patients had 4.61 visits for depression treatment.

4.4.4 Risk Factors for Depression

In Table 4.4, the Cox proportional hazards regression model is considered for this analysis to relate risk factors to depression disorders. In the unadjusted model, AIAN patients had an increased risk depression disorder compared with NHW patients (HR: 1.37, 95% CI: 0.94-2.59). Similarly, after adjusting in model one for patient characteristics, comorbidities, and cancer prognosis, AIAN patients were not at increased

risk for depression disorders compared with NHW patients (HR: 1.40, 95% CI: 0.84-2.33). In model two, adding census median income of <$44,500 versus >$44,499, AIAN patients were not increased risk for depression disorders.

4.5 Discussion

The study was to examine incidence of depression disorder following 60 months after cancer diagnosis, as well to determine depression treatment utilization and risk factors for depression disorder. We concluded a lower proportion of incidence of depression disorders for AIAN patients than NHW patients, but AIAN patients suggest a higher proportion of healthcare utilization for depression treatment services following cancer diagnosis. When we examined risk factors, AIAN patients suggest a higher risk for depression disorder, but it was not significant. AIAN patients are diagnosed with depression disorders close to their cancer diagnosis date, while NHW patients are diagnosed up to 60 months. A study by Sullivan and colleagues concluded that being younger, female, low income, and unmarried had a higher chance of depression symptoms at five and 12 months after cancer diagnosis.[57] The results suggest a higher proportion of females who had a depression disorder before cancer diagnosis and a higher proportion of males who had a depression disorder after cancer diagnosis.

While studies of risk factors indicate certain similarities to this study, the incidence rates of depression disorder are lower compared to other studies. The majority of the research in the United States focuses on the prevalence of depression among cancer patients.[71] For example, a head and neck cancer study using SEER-Medicare data with similar methodologies examined preexisting and new depression diagnosis. They concluded that 10.6% of patients had preexisting depression and 8.9% of patients had

new depression after head and neck cancer diagnosis.[71] The depression rates in the head and neck cancer study were higher; this could be due to their expanded number of depression diagnosis codes that included adjustment disorder with depressive symptoms and depressive personality disorders. In another United States study, [66] researchers examined the association of patient characteristics with chemotherapy among depressed and nondepressed Veteran patients with advanced non-small cell lung cancer patients. Researchers concluded that 16% (1,966) of cancer patients had depression and of those 36% (698 out of 1,966) received chemotherapy, but the study did not indicate if chemotherapy was before or after depression diagnosis.[66] The need for studies of incidence and prevalence of depression disorders among cancer patients has been widely recognized by researchers.

Consequently, more international researchers are investigating the incidence of depression after lung cancer diagnosis with consideration of cancer-treatment time periods.[72,73] For instance, investigators from Japan conducted a 12-month follow-up after curative surgery of adult lung cancer patients and they concluded that prevalence of depression did not change after resection. A limitation of their study was information about preexisting depression before surgery.[73] Another study published by researchers from South Korea showed that 12% of lung cancer patients had preoperative depression and this increased to 19% of patients who had postoperative depression upon surgical treatment.[72] Additional research in the United States on depression disorders before and after cancer-treatment can contribute to patient survival.

Inconsistent findings of prevalence rates of depression disorders among cancer patients are discussed among researchers rather than incidence rates of depression

disorders. Accordingly, a systematic review of depression in adults with cancer concluded that prevalence of depression in outpatients were between 5% to 16%, whereas rates in inpatients were between 4% to 11%. Researchers who contributed to the systematic review suggested that there needs to be consistent measurements and a definition for depression among cancer patients or else prevalence estimates across studies remain noncomparable.[17,74] Another meta-analysis on prevalence of depression in cancer patients echoed similar recommendations that differences in prevalence rates are caused by the type of instrument, cancer type and phases of treatment. In their study, prevalence of depression in cancer patients ranged from 8% to 24%.[18]

Another aspect of this study was to examine depression treatment utilization after lung cancer diagnosis. On average, patients who visited a provider more than once for depression were similar to one study, researchers reported that 55% of lung cancer patients diagnosed with depression after cancer diagnosis had more than one mental health visit.[66] Although 84% of AIAN patients received more than one visit for depression, their visits ended soon after cancer diagnosis. One NHW patient in this study visited a provider for depression 233 times, while an AIAN patient visited only 13 times.

A limitation of this study is the use of claims data to determine depression among lung cancer patients. Claims data can be influenced by coding errors. We were not able to conduct baseline and follow-up using established diagnostic tools, such as Patient Health Questionnaire (PHQ-9) or interviews. Geographically, representation of AIAN patient who utilize Indian Health Service is limited since Indian Health Service Contract Health Service Delivery Areas are not aligned with SEER registry locations. A strength of the study is addressing a gap in knowledge of incidence and prevalence of depression that

can serve as preliminary data for future studies to address disparities between AIAN and NHW patients.

We found evidence to encourage providers to continually screen and support treatment of depression for lung cancer patients throughout their cancer care. As well as to focus on screening for depression among female AIAN patients and before cancer-treatment, since there were no AIAN lung cancer patients who were diagnosed with depression before cancer-treatment. Similar studies need to be conducted to provide comparisons across racial/ethnicity groups. Future research should consider questionnaires and interviews at various time periods (before, during, and after cancer-treatment).

Table 4.1

American Indian and Alaska Native Patient Characteristics

Variables	AIAN All (*N* = 409)		AIAN Depression (*N* = 15 of 409)	
	N	%	*N*	%
Age at Diagnosis (Mean, yrs)	74		72	
65-70 years	135	33.01	6	40.00
71-75 years	121	29.58	6	40.00
76-80 years	84	20.58	2	13.33
81+ years	69	16.87	1	6.67
Gender				
Female	195	47.58	5	33.33
Male	214	52.32	10	66.67
AJCC 6th Stage of Disease				
Stage I	67	16.38	2	13.33
Stage II	23	5.62	1	6.67
Stage III	130	31.78	8	53.33
Stage IV	189	46.21	4	26.67
Year of Diagnosis				
2000-2005	187	45.72	5	33.33
2006-2011	222	54.28	10	66.67
Histology				
Adenocarcinoma	114	27.87	3	20.00
Large Cell	15	3.67	0	0.00
Non-Small Cell	74	18.09	2	13.33
Small Cell	64	15.65	6	40.00
Squamous Cell	103	25.18	4	26.67
Other Type	39	9.54	0	0.00
Marital Status				
Married	166	40.59	9	60.00
Single	37	9.05	1	6.67
Divorced	191	46.70	5	33.33
Unknown	15	3.67	0	0.00
Census Median Income (2000) ($)	39,495		37,234	
Missing	3		0	
Baseline Charlson Comorbidity Index				
0	67	16.38	4	26.67
1	120	29.34	5	33.33
≥2	222	54.28	6	40.00
US Census Region				
Northwest	28	6.85	2	13.33

Table 4.1 Continued

Variables	AIAN All (*N* = 409)		AIAN Depression (*N* = 15 of 409)	
	N	%	*N*	%
Midwest	33	8.07	1	6.67
South	22	5.38	1	6.67
West	326	79.71	11	73.33
Depression Disorder at Cancer Diagnosis				
Yes	26	6.36	-	
No	383	93.64	-	

Note. AIAN = American Indian and Alaska Native; NHW = Non-Hispanic White.

Table 4.2

Non-Hispanic White Patient Characteristics

Variables	NHW All (*N* = 120,973)		NHW Depression (*N* = 7,452 of 120,973)	
	N	%	*N*	%
Age at Diagnosis (Mean, yrs)	75		74	
65-70 years	35,976	29.74	2,719	36.49
71-75 years	31,482	26.02	2,066	27.72
76-80 years	27,685	22.89	1,545	20.73
81+ years	25,830	21.35	1,122	15.06
Gender				
Female	57,498	47.53	4,352	58.40
Male	63,475	52.47	3,100	4,352
AJCC 6th Stage of Disease				
I	26,626	22.01	3,013	40.43
II	5,281	4.37	559	7.50
III	34,859	28.82	2,043	27.42
IV	54,207	44.81	1,837	24.65
Year of Diagnosis				
2000-2005	59,739	49.38	3,373	45.26
2006-2011	61,234	50.62	4,079	54.74
Histology				
Adenocarcinoma	43,346	35.83	3,315	44.48
Large Cell	4,524	3.74	265	3.56
Non-Small Cell	16,493	13.63	766	10.28
Small Cell	17,724	14.65	869	11.66
Squamous Cell	27,055	22.36	1,866	25.04
Other Type	11,831	9.78	371	4.98
Marital Status				
Married	63,629	52.60	4,057	54.44
Single	7,914	6.54	417	5.60
Divorced	45,184	37.35	2,770	37.17
Unknown	4,246	3.51	208	2.79
Census Median Income (2000 $)	49,055		50,213	
Missing	277		43	
Baseline Charlson Comorbidity Index				
0	19,031	15.73	1,160	15.57
1	36,219	29.94	2,394	32.13
≥2	65,723	54.33	3,898	52.31

Table 4.2 Continued

Variables	NHW All (*N* = 120,973)		NHW Depression (*N* = 7,452 of 120,973)	
	N	%	*N*	%
US Census Region				
Northwest	25,158	20.80	1,541	20.68
Midwest	17,361	14.35	1,045	14.02
South	38,026	31.43	2,348	31.51
West	40,428	33.42	2,518	33.79
Depression Disorder at Cancer Diagnosis				
Yes	7,371	6.09	-	-
No	113,602	93.91	-	-

Note. AIAN = American Indian and Alaska Native; NHW = Non-Hispanic White. AJCC = American Joint Committee on Cancer.

Table 4.3

Lung Cancer-treatment and Depression After Cancer Diagnosis

Variables	AIAN All (*N* = 409)		AIAN Depression (*N* = 15 of 409)		NHW All (*N* = 120,973)		NHW Depression (*N* = 7,452 of 120,973)	
	N	%	*N*	%	*N*	%	*N*	%
Surgery								
Yes	51	12.47	4	26.67	20,750	17.15	2,562	34.38
No	358	87.83	11	73.33	100,223	82.85	4,890	65.62
Radiation								
Yes	178	43.52	9	60.00	48,886	40.41	3,387	45.45
No	231	56.48	6	40.00	72,087	59.59	4,065	54.55
Chemotherapy								
Yes	141	34.47	5	33.33	46,123	38.13	3,321	44.57
No	268	65.53	10	66.67	74,850	61.87	4,131	55.43
Any Cancer-treatment								
Yes	252	61.61	13	86.66	80,074	66.19	6,083	81.63
No	157	38.39	2	13.33	40,899	33.81	1,369	18.37
New incidence of depression before cancer-treatment	-		0	0.00	-		988	13.26
New incidence of depression after cancer-treatment	-		13	86.66	-		5,095	68.37
New incidence of depression and no cancer-treatment	-		2	13.33	-		1,369	18.37

Note. AIAN = American Indian and Alaska Native; NHW = Non-Hispanic White.

Table 4.4

Depression Treatment Utilization 60 Months Following Cancer Diagnosis

a) Utilization of Among Those With Depression Disorders After Cancer Diagnosis

Depression Treatment Utilization	AIAN (*N* = 15)			NHW (*N* = 7,452)		
	Mean Visits	Median Visits	Range	Mean Visits	Median Visits	Range
At least one visit	3.67	3	1-13	2.97	1	1-233

b) Utilization of Depression Treatment Among Those With Depression Disorders Before Cancer Diagnosis

Depression Treatment Utilization	AIAN (*N* = 11)			NHW (*N* = 3,187)		
	Mean Visits	Median Visits	Range	Mean Visits	Median Visits	Range
At least one visit	8.00	2	1-30	4.61	2	1-255

Note. AIAN = American Indian and Alaska Native; NHW = Non-Hispanic White.

Table 4.5

Cox Proportional Hazards Model, Risk Factors for Depression

Covariates (*N* = 7,467)	Model 1		Model 2	
	Hazard Ratio	95% CI	Hazard Ratio	95% CI
American Indian and Alaska Native Race	1.40	0.84-2.33	1.37	0.82-2.27
Age at Diagnosis	1.00	1.00-1.01	1.00	1.00-1.01
Female	0.87	0.83-0.91	0.87	0.83-0.91
AJCC 6th Stage of Disease				
Stage I	1.00		1.00	
Stage II	1.22	1.11-1.34	1.22	1.11-1.33
Stage III	1.42	1.34-1.50	1.42	1.34-1.50
Stage IV	2.23	2.10-2.37	2.23	2.10-2.38
Histology				
Adenocarcinoma	1.00		1.00	
Large Cell	1.16	1.03-1.32	1.16	1.02-1.32
Non-Small Cell	1.14	1.05-1.24	1.13	1.05-1.23
Small Cell	1.18	1.09-1.28	1.17	1.09-1.27
Squamous Cell	1.10	1.04-1.17	1.09	1.03-1.16
Other Type	1.14	1.02-1.27	1.12	0.99-1.25
Marital Status				
Married	1.00		1.00	
Single	1.12	1.01-1.23	1.11	1.00-1.23
Divorced, Widowed, Separated	1.12	1.07-1.18	1.12	1.06-1.18
Unknown	1.14	1.00-1.31	1.14	0.99-1.31
Cancer-treatment >1 Treatment *vs* No Treatment	0.86	0.81-0.91	0.86	1.03-1.13

Table 4.5 Continued

Covariates (N = 7,467)	Model 1		Model 2	
	Hazard Ratio	95% CI	Hazard Ratio	95% CI
Charlson Comorbidity Index				
0	1.00		1.00	
1	1.08	1.01-1.16	1.08	1.00-1.16
≥2	1.14	1.07-1.22	1.14	1.06-1.22
Census Median Income <$44,500 *vs* >$44,499	-	-	1.08	0.88-0.97

CHAPTER 5

CONCLUSION

5.1 Conclusions

The purpose of this study was to examine differences in healthcare cost and utilization 12 months after lung cancer diagnosis and in the last six months of life among AIAN patients compared with NHW patients. Furthermore, to compare the incidence of depression, use of mental health services, and the risk for depression 60 months after lung cancer diagnosis in the two groups. The results suggest that a higher proportion of AIAN patients in the matched sample was diagnosed at stages III or IV disease than stages I and II disease. Non-small cell lung cancer is more common in the United States.[75] The histology suggests a higher proportion of AIAN patients in the matched sample had non-small cell lung cancer (e.g., adenocarcinoma, squamous, large cell, and non-small) compared to small cell lung cancer. We examined disparities between AIAN and NHW lung cancer patients with Medicare coverage in their healthcare spending and use of health services. We found lower total healthcare spending, for cancer-treatment or noncancer-treatment, among AIAN patients with lung cancer 12 months after cancer diagnosis. Our results add to broader cost and care studies using SEER-Medicare data and provide evidence of racial differences in cost and utilization of health services that challenge the CMS and IHS to continue to reduce health disparities.[14,15,76]

The study results support the hypotheses that AIAN patients spent less and

visited providers fewer times than NHW patients for total healthcare and cancer-treatment care 12 months following date of cancer diagnosis. When determining racial/ethnic disparities of AIAN elderly, it is important to consider whether socioeconomic conditions help to explain the differences, since they generally have lower income and less education than NHW. We were able to adjust for median census tract level income and marital status in Chapter 4 (depression risk). In Chapters 2 and 3, we matched and adjusted on marital status. The claims dataset provided socioeconomic variables of the zip code or census tract in which the patients lived, but not for the individuals themselves. Future research will need individual information on AIAN patients to investigate the relative contributions of race and socioeconomic status to disparities to their healthcare costs and utilization.

This study is one of the first studies to our knowledge to examine total healthcare costs from cancer and noncancer-treatment care. Our findings are consistent with those of national spending by Medicare that determined that hospitalizations (either cancer- or noncancer-treatment care) as the cost driver of total Medicare costs of individuals.[77] In this study hospitalizations suggest a higher cost of noncancer-treatment costs than for cancer-treatment costs among AIAN and NHW lung cancer patients. We did not examine specific diagnosis and procedure codes of the noncancer-treatment care. The top five most expensive conditions in inpatient care among Medicare patients are septicemia, acute myocardial infarction, acute cerebrovascular disease, diabetes mellitus and those with complications and congestive heart failure.[77] Future research should focus on disparities of cost drivers of the noncancer-treatment costs among AIAN and NHW lung cancer patients.

In Chapter 3, AIAN patients did not have lower total healthcare costs or utilization in the last six months of life among those with short survival (at or less than six months). The study results did not support our hypotheses that AIAN patients spent less and visited a provider fewer times than NHW patients for cancer-treatment and noncancer-treatment care. Due to insignificant differences in healthcare costs and utilization between AIAN and NHW lung cancer patients during the first six months after diagnosis, further research needs to focus on end-of-life costs at longer intervals of time after diagnosis, as well as the quality of care in cancer-treatment and noncancer-treatment care since AIAN lung cancer patients have lower 5-year lung cancer survival outcomes. In this study, we were not able to examine differences of specific health services among AIAN and NHW lung cancer patients, yet the proportion of total healthcare costs for inpatient care from noncancer-treatment was highest across all patients. These results were similar to Chapter 2; therefore, future research of specific health service disparities is recommended. It is possible to increase the study time period to the last year before date of death, examine hospice and palliative care in the cultural context, and to consider geographic differences in the future.

In Chapter 4, AIAN patients with lung cancer were not at risk for depression disorders and had a lower proportion of incidence rates compared with NHW lung cancer patients. External factors, such as measurement of depression disorders and understanding of depression among AIAN patients, may affect rates. It is ideal to use questionnaires or conduct interviews to collect accurate depression disorder symptoms, but due to the claims database used in this study, this is a limitation. More males in this study were diagnosed with depression disorders after cancer-treatment and diagnosis. The

stigma linked to mental health is another concern in AIAN communities, but cannot be explained in this study due to the dataset. Lastly, adequate mental professionals to provide depression treatment services and detect depression disorder through culturally appropriate screening is another concern. Information regarding mental health professional shortage could help explain these differences and the limitation of effective screening tools in AIAN communities. Co-pay for mental health services can be an obstacle due to monetary reasons, since AIAN patients with depression came from census areas with lower median income than NHW patients.

5.2 Limitations

This analysis concentrated on older patients with Medicare coverage and fee-for-service payments. Managed care plans are encouraged to find more cost-efficient ways to pay providers for services; however, these different ways of payment are then difficult to assign to individual care in datasets. Medicare enrollees with fee-for-service coverage can purchase supplemental private insurance that covers additional health services options. Although supplemental insurance and other payer data were available in the Medicare-SEER data, due to inaccuracies and incompleteness of such payer data without data from the supplemental insurance payer, there was no value in analyzing other payer services and costs. Payments by Medicare, other private insurance payers, and patients were examined. Tribal AIAN patients receive primary care health services from the Indian Health Service through their tribes either directly in IHS or tribal facilities, and they can receive more specialized care from non-IHS or tribal providers through contractual payments. For tribal AIAN with Medicare coverage the IHS and tribal facilities and the tribes try to bill Medicare for all covered primary and specialized services. However,

some suggest that total healthcare costs are not truly represented for Medicare-covered AIAN patients with access to IHS services. The IHS CHSDA boundaries are partially represented in SEER-Medicare regions in this study; therefore, results may not reflect the entirety of AIAN receiving IHS services. In addition, SEER registries are not located in all states. Most of the AIAN patients in the SEER data used in this study are represented in the West (New Mexico and California, as well as Seattle and other metro areas); therefore, the results in this study are not generalizable to all elders. Most important, it was beyond the scope of this study to investigate the types or quality of cancer-treatment that the patients received but future studies could benefit from unencrypted provider and zip code information, plus specific quality of care measures defined for cancer care for the general population and racial/ethnic groups, such as AIAN cancer patients

5.3 Recommendations

It is important to investigate specific health services that contributed to differences in costs and utilization for AIAN patients and NWH patients. Recommendations for future Medicare, Indian Health Service, State, Federal, and Tribal Actions:

- Understand supplemental insurance and other payment resources to determine if co-pays are an obstacle to treatment and other health services.
- Develop culturally appropriate materials to explain cancer-treatment options for all AIAN elders and for those who speak their native language.
- Examine resources for hospice or palliative care services that are culturally appropriate.

- Support adequate and accessible services for cancer patients, such as, hospice, nursing facilities, and home health.

Recommendations for future health care delivery and provider actions:

- Providers receive training to increase awareness of cultural practices and needs versus Western practices regarding cancer-treatment and patient perspectives related to cancer-treatment.
- Providers must continually screen for depression throughout cancer care using questionnaires or interviews that are culturally appropriate.
- Providers must conduct follow-up for depression treatment more often.

Recommendations for future research:

- Understand specific noncancer-treatment cost differences by using diagnosis and procedure codes.
- Incorporate social behaviors and risk factors (i.e., current smoking) in addition to costs and utilization measures.
- Conduct a study using claims data from certain health care facilities. Oversampling methods will increase AIAN representation. Include different payers to assess costs, such as out-out-pocket, private insurance, and public programs.
- Design mixed method studies to incorporate patient perspectives
- Improve self-report on the incidence of depression disorders and seek utilization data from specific health care facilities.

REFERENCES

1. Centers for Disease Control and Prevention. 1999-2014 Cancer incidence and mortality data [Internet]. Atlanta (GA); Centers for Disease Control and Prevention [cited 2016Aug10]. Available from: https://nccd.cdc.gov/uscs/

2. American Cancer Society. Cancer Facts & Figures 2017 [Internet]. American Cancer Society; [cited 2016Aug10]. Available from: https://www.cancer.org/research/cancer-facts-statistics/all-cancer-facts-figures/cancer-facts-figures-2017.html

3. Kelly JJ, Lanier AP, Schade T, Brantley J, Starkey BM. Cancer disparities among Alaska native people, 1970-2011. Prev Chronic Dis. 2014;11:E221.

4. Edwards BK, Noone AM, Mariotto AB, Simard EP, Boscoe FP, Henley SJ, et al. Annual report to the nation on the status of cancer, 1975-2010, featuring prevalence of comorbidity and impact on survival among persons with lung, colorectal, breast, or prostate cancer. Cancer. 2014;120(9):1290-314.

5. Plescia M, Henley SJ, Pate A, Underwood JM, Rhodes K. Lung cancer deaths among American Indians and Alaska Natives, 1990-2009. Am J Public Health. 2014;104 Suppl 3:S388-95.

6. Pallis AG, Syrigos KN. Lung cancer in never smokers: disease characteristics and risk factors. Crit Rev Oncol Hematol. 2013;88(3):494-503.

7. Centers for Disease Control and Prevention. Tobacco use among U.S. racial/ethnic minority groups—African Americans, American Indians and Alaska Natives, Asian Americans and Pacific Islanders, and Hispanics: A report of the Surgeon General [Internet]. Atlanta (GA): Centers for Disease Control and Prevention; 1998 [cited 2016 Sept 1]. Available from CDC: https://www.cdc.gov/tobacco/data_statistics/sgr/1998/index.htm

8. Mowery PD, Dube SR, Thorne SL, Garrett BE, Homa DM, Nez Henderson P. Disparities in smoking-related mortality among American Indians/Alaska Natives. Am J Prev Med. 2015;49(5):738-44.

9. Jemal A, Clegg LX, Ward E, Ries LA, Wu X, Jamison PM, et al. Annual report to the nation on the status of cancer, 1975-2001, with a special feature regarding survival. Cancer. 2004;101(1):3-27.

10. Javid SH, Varghese TK, Morris AM, Porter MP, He H, Buchwald D, et al. Guideline-concordant cancer care and survival among American Indian/Alaskan Native patients. Cancer. 2014;120(14):2183-90.

11. Shiovitz S, Bansal A, Burnett-Hartman AN, Karnopp A, Adams SV, Warren-Mears V, et al. Cancer-directed therapy and hospice care for metastatic cancer in American Indians and Alaska Natives. Cancer Epidemiol Biomarkers Prev. 2015;24(7):1138-43.

12. Fesinmeyer MD, Goulart B, Blough DK, Buchwald D, Ramsey SD. Lung cancer histology, stage, treatment, and survival in American Indians and Alaska Natives and whites. Cancer. 2010;116(20):4810-6.

13. Falk SA, Williams C. Lung Cancer. 3rd ed. Oxford: Oxford Univeristy Press; 2010. 158 p.

14. Warren JL, Yabroff KR, Meekins A, Topor M, Lamont EB, Brown ML. Evaluation of trends in the cost of initial cancer treatment. J Natl Cancer Inst. 2008;100(12):888-97.

15. Yabroff KR, Lamont EB, Mariotto A, Warren JL, Topor M, Meekins A, et al. Cost of care for elderly cancer patients in the United States. J Natl Cancer Inst. 2008;100(9):630-41.

16. Pirl WF, Greer JA, Traeger L, Jackson V, Lennes IT, Gallagher ER, et al. Depression and survival in metastatic non-small-cell lung cancer: effects of early palliative care. J Clin Oncol. 2012;30(12):1310-5.

17. Linden W, Vodermaier A, Mackenzie R, Greig D. Anxiety and depression after cancer diagnosis: prevalence rates by cancer type, gender, and age. J Affect Disord. 2012;141(2-3):343-51.

18. Krebber AM, Buffart LM, Kleijn G, Riepma IC, de Bree R, Leemans CR, et al. Prevalence of depression in cancer patients: a meta-analysis of diagnostic interviews and self-report instruments. Psychooncology. 2014;23(2):121-30.

19. Salazar M. Federal and state recognized tribes [Internet]. List of federal and state recognized tribes [cited 2016Oct15]. Available from: http://www.ncsl.org/research/state-tribal-institute/list-of-federal-and-state-recognized-tribes.aspx

20. National Congress of American Indians. Indian Health Care Improvement Act Permanent; Supreme Court Decision Upholds Reauthorization [Internet]. National Congress of American Indians [cited 2016Nov30]. Available from: http://www.ncai.org/news/articles/2012/06/28/indian-health-care-improvement-act-permanent-supreme-court-decision-upholds-reauthorization

21. U.S. Census Bureau. Native Population: 2010, 2010 Census Briefs [Internet]. U.S. Census Bureau; 2010 [cited 2017 Jan 16]. Available from U.S. Census Bureau: https://www.census.gov/prod/cen2010/briefs/c2010br-10.pdf

22. Indian Health Service. Indian Health Manual, Chapter 3 - Contract Health Services [Internet]. Indian Health Service; [cited 2017Feb22]. Available from: https://www.ihs.gov/ihm/index.cfm?module=dsp_ihm_pc_p2c3#2-3.6B

23. LeBeau M, O'Connell J, Ouellet J, Rockwell J. The burden of diabetes among American Indians and Alaska Native Medicare enrollees. Colorado: University of Colorado; 2015.

24. Indian Health Service [Internet]. Tribal Consultation: Centers for Medicare and Medicaid Services; 2009 [cited 2017Feb22]. Available from: https://www.ihs.gov/ihm/index.cfm?module=dsp_ihm_pc_p2c3#2-3.6B.

25. Lee JA, Roehrig CS, Butto ED. Cancer care cost trends in the United States: 1998 to 2012. Cancer. 2016;122(7):1078-84.

26. Rosenbaum PR, Rubin DB. The centrol role of the propensity score in observational studies for causal effects. Biometrika. 1983;70(1):41-55.

27. Austin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. Multivariate Behav Res. 2011;46(3):399-424.

28. Harder VS, Stuart EA, Anthony JC. Propensity score techniques and the assessment of measured covariate balance to test causal associations in psychological research. Psychol Methods. 2010;15(3):234-49.

29. Klabunde CN, Potosky AL, Legler JM, Warren JL. Development of a comorbidity index using physician claims data. J Clin Epidemiol. 2000;53(12):1258-67.

30. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40(5):373-83.

31. Quan H, Sundararajan V, Halfon P, Fong A, Burnand B, Luthi JC, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. Med Care. 2005;43(11):1130-9.

32. Lin CC, Virgo KS, Robbins AS, Jemal A, Ward EM. Comparison of comorbid medical conditions in the National Cancer Database and the SEER-Medicare Database. Ann Surg Oncol. 2016;23(13):4139-4148.

33. Leuven E, Sianesi B. PSMATCH2: Stata module to perform full Mahalanobis and propensity score matching, common support graphing, and covariate imbalance testing Version 4.0.11. Boston College Department of Economics. (2003). Available from: https://ideas.repec.org/c/boc/bocode/s432001.html#statistics

34. Oakes MJ, Kaufman JS. Methods in Social Epidemiology. San Francisco, CA: Jossey-Bass; 2006. 400 p.

35. Actual regulation market basket change and Medicare payment updates as published in the "Federal Register" [Internet]. Medicare Program & Statistics. Centers for Medicare & Medicaid Services; 2017 [cited 2017Mar13]. Available from: https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/MedicareProgramRatesStats/MarketBasketData.html

36. Yabroff KR, Guy GP, Jr., Ekwueme DU, McNeel T, Rozjabek HM, Dowling E, et al. Annual patient time costs associated with medical care among cancer survivors in the United States. Med Care. 2014;52(7):594-601.

37. Simianu VV, Morris AM, Varghese TK, Jr., Porter MP, Henderson JA, Buchwald DS, et al. Evaluating disparities in inpatient surgical cancer care among American Indian/Alaska Native patients. Am J Surg. 2016;212(2):297-304.

38. Smith CB, Bonomi M, Packer S, Wisnivesky JP. Disparities in lung cancer stage, treatment and survival among American Indians and Alaskan Natives. Lung Cancer. 2011;72(2):160-4.

39. Schrag D, Li L, Chen AB. Predictors of radiation therapy (RT) use among Medicare patients with metastatic non-small cell lung cancer (NSCLC). J Clin Oncol. 2015;33(29_suppl):124.

40. Morris AM, Doorenbos AZ, Haozous E, Meins A, Javid S, Flum DR. Perceptions of cancer-treatment decision making among American Indians/Alaska Natives and their physicians. Psychooncology. 2016;25(9):1050-6.

41. Boccuti C, Swoope C, Artiga S. The role of Medicare and the Indian Health Service for American Indians and Alaska Natives: health, access and coverage. Kaiser Family Foundation; 2014.

42. White MC, Espey DK, Swan J, Wiggins CL, Eheman C, Kaur JS. Disparities in cancer mortality and incidence among American Indians and Alaska Natives in the United States. Am J Public Health. 2014;104 Suppl 3:S377-87.

43. LoPresti MA, Dement F, Gold HT. End-of-life care for people with cancer from ethnic minority groups: A systematic review. Am J Hosp Palliat Care. 2016;33(3):291-305.

44. Sawchuk CN, Van Dyke E, Omidpanah A, Russo JE, Tsosie U, Goldberg J, et al. Barriers to cancer care among American Indians and Alaska Natives. J Health Care Poor Underserved. 2016;27:84-96.

45. Kitzes J, Berger L. End-of-life issues for American Indians/Alaska Natives: insights from one Indian Health Service area. J Palliat Med. 2004;7(6):830-8.

46. Colclough YY, Brown GM. End-of-life treatment decision making: American Indians' perspective. Am J Hosp Palliat Care. 2014;31(5):503-12.

47. Guadagnolo BA, Cina K, Helbig P, Molloy K, Reiner M, Cook EF, et al. Medical mistrust and less satisfaction with health care among Native Americans presenting for cancer-treatment. J Health Care Poor Underserved. 2009;20(1):210-26.

48. Cipriano LE, Romanus D, Earle CC, Neville BA, Halpern EF, Gazelle GS, et al. Lung cancer-treatment costs, including patient responsibility, by disease stage and treatment modality, 1992 to 2003. Value Health. 2011;14(1):41-52.

49. Chastek B, Harley C, Kallich J, Newcomer L, Paoli CJ, Teitelbaum AH. Health care costs for patients with cancer at the end of life. J Oncol Pract. 2012;8(6):75s-80s.

50. Bremner KE, Krahn MD, Warren JL, Hoch JS, Barrett MJ, Liu N, et al. An international comparison of costs of end-of-life care for advanced lung cancer patients using health administrative data. Palliat Med. 2015;29(10):918-28.

51. Guadagnolo BA, Huo J, Buchholz TA, Petereit DG. Disparities in hospice utilization among American Indian Medicare beneficiaries dying of cancer. Ethn Dis. 2014;24(4):393-8.

52. Zuckerman RB, Stearns SC, Sheingold SH. Hospice use, hospitalization, and Medicare spending at the end of life. J Gerontol B Psychol Sci Soc Sci. 2016;71(3):569-80.

53. Saito AM, Landrum MB, Neville BA, Ayanian JZ, Weeks JC, Earle CC. Hospice care and survival among elderly patients with lung cancer. J Palliat Med. 2011;14(8):929-39.

54. Carlson MD, Herrin J, Du Q, Epstein AJ, Barry CL, Morrison RS, et al. Impact of hospice disenrollment on health care use and medicare expenditures for patients with cancer. J Clin Oncol. 2010;28(28):4371-5.

55. Cintron A, Hamel MB, Davis RB, Burns RB, Phillips RS, McCarthy EP. Hospitalization of hospice patients with cancer. J Palliat Med. 2003;6(5):757-68.

56. Locher JL, Kilgore ML, Morrisey MA, Ritchie CS. Patterns and predictors of home health and hospice use by older adults with cancer. J Am Geriatr Soc. 2006;54(8):1206-11.

57. Sullivan DR, Forsberg CW, Ganzini L, Au DH, Gould MK, Provenzale D, et al. Depression symptom trends and health domains among lung cancer patients in the CanCORS study. Lung Cancer. 2016;100:102-9.

58. Himelhoch S, Weller WE, Wu AW, Anderson GF, Cooper LA. Chronic medical illness, depression, and use of acute medical services among Medicare beneficiaries. Med Care. 2004;42(6):512-21.

59. Lo C, Zimmermann C, Rydall A, Walsh A, Jones JM, Moore MJ, et al. Longitudinal study of depressive symptoms in patients with metastatic gastrointestinal and lung cancer. J Clin Oncol. 2010;28(18):3084-9.

60. Fagundes C, Jones D, Vichaya E, Lu C, Cleeland CS. Socioeconomic status is associated with depressive severity among patients with advanced non-small-cell lung cancer: treatment setting and minority status do not make a difference. J Thorac Oncol. 2014;9(10):1459-63.

61. Kim G, Bryant AN, Parmelee P. Racial/ethnic differences in serious psychological distress among older adults in California. Int J Geriatr Psychiatry. 2012;27(10):1070-7.

62. Naughton MJ, Weaver KE. Physical and mental health among cancer survivors: considerations for long-term care and quality of life. N C Med J 2014;75(4):283-6.

63. Grandbois D. Stigma of mental illness among American Indian and Alaska Native nations: historical and contemporary perspectives. Issues Ment Health Nurs. 2005;26(10):1001-24.

64. Office of the Surgeon General. Mental health: culture, race, and ethnicity: a supplement to mental health: a report of the Surgeon General [Internet]. Rockville (MD); Office of the Surgeon General; 2001 [cited 2016Dec1]. Available from: https://www.surgeongeneral.gov/library/reports/index.html

65. Garrett MD, Baldridge D, Benson W, Crowder J, Aldrich N. Mental health disorders among an invisible minority: depression and dementia among American Indian and Alaska Native elders. Gerontologist. 2015;55(2):227-36.

66. Sullivan DR, Ganzini L, Duckart JP, Lopez-Chavez A, Deffebach ME, Thielke SM, et al. Treatment receipt and outcomes among lung cancer patients with depression. Clin Oncol (R Coll Radiol). 2014;26(1):25-31.

67. Traeger L, Cannon S, Pirl WF, Park ER. Depression and undertreatment of depression: potential risks and outcomes in Black patients with lung cancer. J Psychosoc Oncol. 2013;31(2):123-35.

68. Mosher CE, Winger JG, Hanna N, Jalal SI, Fakiris AJ, Einhorn LH, et al. Barriers to mental health service use and preferences for addressing emotional concerns among lung cancer patients. Psychooncology. 2014;23(7):812-9.

69. Boyd CA, Benarroch-Gampel J, Sheffield KM, Han Y, Kuo YF, Riall TS. The effect of depression on stage at diagnosis, treatment, and survival in pancreatic adenocarcinoma. Surgery. 2012;152(3):403-13.

70. Fava GA, Ruini C, Sonino N. Treatment of recurrent depression: a sequential psychotherapeutic and psychopharmacological approach. CNS Drugs. 2003;17(15):1109-17.

71. Rieke K, Boilesen E, Lydiatt W, Schmid KK, Houfek J, Watanabe-Galloway S. Population-based retrospective study to investigate preexisting and new depression diagnosis among head and neck cancer patients. Cancer Epidemiol. 2016;43:42-8.

72. Park S, Kang CH, Hwang Y, Seong YW, Lee HJ, Park IK, et al. Risk factors for postoperative anxiety and depression after surgical treatment for lung cancerdagger. Eur J Cardiothorac Surg. 2016;49(1):e16-21.

73. Uchitomi Y, Mikami I, Nagai K, Nishiwaki Y, Akechi T, Okamura H. Depression and psychological distress in patients during the year after curative resection of non-small-cell lung cancer. J Clin Oncol. 2003;21(1):69-77.

74. Walker J, Holm Hansen C, Martin P, Sawhney A, Thekkumpurath P, Beale C, et al. Prevalence of depression in adults with cancer: a systematic review. Ann Oncol. 2013;24(4):895-900.

75. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines): Non-Small Cell Lung Cancer National Comprehensive Cancer Network; Version 4.2016.

76. Eichner J, Vladeck BC. Medicare as a catalyst for reducing health disparities. Health Aff (Millwood). 2005;24(2):365-75.

77. National inpatient hospital costs: The most expensive conditions by payer, 2013 [Internet]. Agency for Healthcare Research and Quality; [cited 2017Apr5]. Available from: https://www.hcup-us.ahrq.gov/reports/statbriefs/sb204-Most-Expensive-Hospital-Conditions.jsp