THE ASSOCIATION OF HOSPITAL AND PATIENT CHARACTERISTICS WITH TREATMENT INITIATION AMONG VETERANS WITH STAGE I, II, OR III LUNG, COLON OR RECTAL CANCER

Alecia S. Clary

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Approved by:

Stephanie Wheeler

Bryan Weiner

Justin Trogdon

Leah Zullig

Karyn Stitzenberg

ABSTRACT

Alecia S. Clary: The Association of Hospital and Patient Characteristics with Treatment Initiation Among Veterans with Stage I, II, or III Lung, Colon or Rectal Cancer
(Under the direction of Stephanie B. Wheeler)

Evidence suggests that underserved patients such as black patients and rural residents experience less timely, high quality cancer treatment resulting in increased upstaging, increased patient anxiety, and higher cancer-specific mortality. In addition to black race and rural residence, cancer treatment disparities have been associated with sociodemographic, clinical factors, and hospital-level factors. Recognizing the importance of hospital-level factors, the overall objective of this dissertation was to determine the extent to which race, rurality, and hospital-level factors influence the timing of treatment initiation for cancer patients. This dissertation used data from the Veterans Health Administration (VA): the Epidemiology of Cancer in Veterans database, linked with data from the VA Corporate Data Warehouse, the VA Central Cancer Registry and the 2009 VA Oncology Facilities Survey. Hospital-level factors evaluated included receiving cancer treatment at a hospital with the following resources: a colorectal and/or lung cancer-specific tumor board; a mechanism to track patients from diagnosis through posttreatment care; a measurement system to track the hospital's adherence to guideline-based cancer care and timelines of care. In this dissertation, the outcome, timely cancer treatment, was defined as receipt of first course of treatment (evidence of surgical resection, chemotherapy, radiation, chemoradiation) within 10 weeks of diagnosis. Our results suggest a centralization of oncology-specific resources

in urban areas, resulting in increased access to the resources evaluated in this study for black veterans who were more likely to live in urban areas. In contrast, rural veterans are vulnerable to this centralization due to fewer specialists living in rural areas and increased rural hospital closures. We also found that receiving treatment at facilities with differential hospital-level cancer resources is associated with racial disparities in cancer treatment: receiving treatment at a hospital with cancer-specific tracking was associated with increased odds of receiving timely treatment. Finally, we found evidence that receiving treatment in a hospital that tracks the timeliness and guideline concordance of its cancer care was associated with a 4-percentage point reduction in racial disparities in timely cancer treatment. The results of this dissertation suggest that access to hospital-level factors plays an important role in cancer treatment disparities.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AOR	Adjusted Odds Ratio
CCQMS	Colorectal Cancer Quality Measurement System
CDW	VA Corporate Data Warehouse
Choice Act	2014 Veterans Access, Choice, and Accountability Act
CI	Confidence Interval
CRC	Colon and rectal cancers
CT	Compute Tomography
EHR	Electronic Health Record
EpiCAN	Epidemiology of Cancer in veterans
EPRP	External Peer Review Program
ICD	International Classification of Disease
IOM	Institute of Medicine
IRB	Institutional Review Board
Mission Act	2018 VA Maintaining Systems and Strengthening Integrated Outside Networks Act
MMCI	Modified-Modified Continuity Index
MSI	Minority Serving Institution
NCCN	National Comprehensive Cancer Network
NSCLC	Non-Small Cell Lung Cancer
ORH	VA Office of Rural Health
PCP	Primary Care Provider
PET	Positron Emission Tomography
PP	Percentage Point
RUCA	Rural Urban Commuting Area
SEER	Surveillance, Epidemiology and end Results Program

UPC	Usual Provider of Care index
US	United States
VA	Veterans Health Administration
VACCR	VA Central Cancer Registry
VINCI	Veterans Affairs Informatics Computing Infrastructure
VISNS	Veterans Integrated Service Networks

CHAPTER 1: INTRODUCTION

Racial minorities and rural residents are more likely to experience cancer treatment disparities[1] including receiving less timely, high-quality cancer treatment[2]. These disparities may lead to poorer health outcomes including decreased survival time[3], increased risk of upstaging and disease progression[3], and negative psychosocial effects such as patient anxiety[1]. A common thread in the literature about racial disparities in cancer treatment quality is unequal treatment within the health care system. While evidence suggests that the Veterans Health Administration (VA) provides more equitable care than community providers[4], there is also evidence within the VA and the community suggesting that black patients are more likely than white patients to receive health care at facilities that have fewer resources or that provide lower quality care[5-7]. Black patients are also more likely to receive their treatment in lower quality hospitals[5,7] that are characterized by features such as less access to high-quality subspecialists[8] and providers that are less likely to be board-certified[9]. Patients within these hospitals face longer time to treatment[8] and worse health outcomes, including higher odds of death[10].

Often, rural residents receive care at lower-resourced hospitals[5]. Within the VA this includes receiving treatment at hospitals with less access to resources including: medical oncologist, radiation oncologist, and urologist staffing; radiation therapy services; and American College of Surgeons Commission on Cancer Certification[11]. In

contrast with black veterans, less resources were not associated with worse health outcomes amongst rural veterans[11].

Within the VA, researchers have investigated the association between the site of care and racial disparities in cancer treatment by modeling a hospital-specific fixed effect[12] or hospital-specific random intercept[13]. Studies investigating specific hospital-level factors that may be associated with racial disparities in cancer treatment have been limited to modeling academic affiliation and racial composition of patients within the hospital[14]. Despite evidence suggesting an association between the site of care and racial disparities in cancer treatment, there is little evidence about how resources are distributed across the VA. To better understand the determinants of racial disparities of cancer treatment in the VA and in other settings, additional research is needed to identify which organizational features are present or absent from the sites of care that black patients receive cancer treatment.

While evidence suggests that differences at the site of care are important, differences at the site of care likely do not explain all of the disparity in outcomes. Processes of care, such as continuity of care, may explain some within-hospital variation in treatment. If black and white patients receive comparable processes of care, such as continuity of care, racial disparities in care may be attenuated. The extent to which black patients experience equal continuity of care within the VA and whether increased continuity of care is associated with reduced racial disparities in cancer treatment are unclear.

We have limited knowledge about, but need to investigate, the factors that are driving site of care differences in racial disparities in cancer in order to inform system

level interventions. There is an urgent need to understand how much of the racial disparities in care can be attributed to the site of care and processes within the site of care and which specific aspects of the health care system or the process of care explain those disparities. Without that knowledge, those factors are likely to go unaddressed and disparities will persist. This study examined the distribution of cancer resources and continuity of care within the VA, whether cancer resources and continuity of care are associated with racial disparities in timely cancer treatment, and quantified how much of the existing racial disparities in timely cancer treatment can be attributed to cancer resources and continuity of care.

As the largest integrated health care system in the US, the largest integrated provider of cancer care in the US, and an equal access health care system, the VA is an ideal setting to investigate whether oncology-specific resources and continuous patient-PCP relationships defined by Gulliford and colleagues[15] is “the patient's experience of a 'continuous caring relationship' with an identified health care professional” are associated with cancer treatment disparities. As an equal access system[16], where every eligible veteran can receive cancer treatment[17], the VA reduces some of the barriers to care that are associated with increased racial disparities (such as lack of insurance and ability to pay).

The overall objective of this study was to determine the extent to which race and the site and processes of care influence the timing of treatment initiation for cancer patients. This study’s central hypothesis is that black patients within the VA are receiving treatment at facilities with less cancer-specific resources than white patients and experience less continuity of care than white veterans, and that racial disparities in

the time to treatment initiation for lung, colon, and rectal cancer are accounted for by observable hospital factors and continuity of care. This central hypothesis was tested using three separate Aims:

Aim 1: Describe differences in access to hospital factors and in continuity of care among veterans with stage I, II, or III lung, colon, and rectal cancer within the VA

Aim 2: Estimate the joint effect of hospital factors, such as patient tracking mechanisms and continuity of care on racial disparities in the timeliness of treatment among veterans with stage I, II, or III lung, colon, and rectal cancer in the VA

Aim 3: Estimate the extent to which hospital factors, such as patient tracking mechanisms, and continuity of care are associated with racial disparities in the timeliness of treatment among veterans with stage I, II, or III lung, colon, and rectal cancer in the VA

Aim 1 sought to describe how care continuity and oncology-specific resources are distributed amongst underserved veterans receiving cancer care in the VA using data from the Epidemiology of Cancer in veterans (EpiCAN) database, linked with data from the VA Corporate Data Warehouse (CDW)[18], the VA Central Cancer Registry (VACCR)[19] and the 2009 VA Oncology Facilities Survey. EpiCAN is a unified data source allowing researchers to analyze VA cancer care and outcomes. EpiCAN data originates from the VACCR[19] and the CDW[18]. The VACCR is a database of cancer cases diagnosed within the VA since 1995[20]. The CDW compiles information from the patient's electronic health record including their labs, ICD9 codes, procedures and treatments[18]. The study included 23,195 underserved veterans who were black or lived

in a rural area and were diagnosed with incident stage I, II, or III colon, rectal, or lung cancer between 2009 and 2014. The outcomes of interest included three longitudinal measures of continuity of care: provider dispersion using the Modified-Modified Continuity Index (MMCI)[21], provider concentration using the Usual Provider of Care index (UPC)[21], duration of relationship with the modal primary care provider. Hospital factors evaluated included receiving cancer treatment at a hospital with the following resources: an on-site medical oncologist; a social worker with specialized training in oncology; a psychologist with specialized training in oncology; a colorectal and/or lung cancer-specific tumor board; a cancer-specific tumor board with regular attendance by support staff including palliative care specialists, social workers, nutritionists or cancer registrars; a mechanism to track patients from diagnosis through posttreatment care; a patient navigator; a measurement system to track the hospital's adherence to guideline-based cancer care and timelines of care. The results of the multivariate logistic regressions suggested that there is a centralization of oncology-specific resources in urban areas. This centralization resulted in increased access to the resources evaluated in this study for black veterans who were more likely to live in urban areas. In contrast, rural veterans are particularly vulnerable to this centralization due to fewer specialists living in rural areas and increased rural hospital closures.

Aim 2 uses the same data sources to assess whether continuity of care and cancer-specific resources were associated with the receipt of timely cancer treatment. In this analyses, timely cancer treatment was defined as receipt of first course of treatment (evidence of surgical resection, chemotherapy, radiation, chemoradiation) within 10 weeks of diagnosis. The results of this study suggested that receiving

treatment at facilities with differential cancer resources is associated with racial disparities in cancer treatment. In this analysis, receiving treatment at a hospital with cancer-specific tracking was associated with increased odds of receiving timely treatment and receiving treatment at a hospital with cancer-specific tumor boards decreased the odds of receiving timely treatment.

Using the same data sources and sample, Aim 3 sought to quantify how much of the disparities these resources accounted for using the Oaxaca-Blinder Decomposition method. The Oaxaca-Blinder Decomposition quantifies how much inequalities in the outcome (e.g. timely treatment) can be explained by group differences in the magnitude of observed characteristics (e.g. group mean differences in access to oncology clinical trials) sometimes called the explained portion vs. the effect of the observed characteristics (e.g. oncology clinical trials may be more beneficial to white veterans than black veterans) sometimes called the unexplained portion. The results of this study suggested that cancer-specific tumor boards have a differential effect, by race, suggesting that they operate differently for black and white veterans. The results of the decomposition suggest that while the differential returns are significantly negative for black veterans, overall the effect on existing racial disparities in timely treatment for black veterans within the VA are small and unlikely to be clinically significant. In contrast, receiving treatment in a hospital that tracks the timeliness and guideline concordance of its cancer care was positively associated with a significant reduction in racial disparities in timely treatment. This association was statistically significant and resulted in a 4 percentage point reduction in racial disparities in timely cancer treatment.

Together, the results of this dissertation suggest that 1.) rural veterans may be particularly susceptible to receiving care in hospitals without on-site access to the cancer-specific factors evaluated in this study, and the centralization of resources in urban areas may unintentionally result in an increased access burden overall, as well as increased receipt of lower quality care in lower-resourced facilities; 2) black and white veterans have differential access to hospitals with cancer-specific resources; 3) that specific attributes of the hospital where veterans receive their cancer treatment are associated with racial disparities in the timeliness of cancer treatment; and 4) that continuity of care was not associated with racial disparities in the timeliness of cancer treatment in the VA.

This study has several limitations. First, the models do not include all variables that are known to influence treatment timeliness. We used administrative and encounter data for this analysis, which does not include factors such as patient preferences, provider prejudice, or any number of subjective influences. Second, we are not able to assess causation with the secondary data sources used in this analysis, limiting our interpretation to associations. Third, the Oncology Facilities Survey was self-reported and the questions were open to individual interpretation, however respondents were not incentivized to answer questions in any particular way. Additionally, the survey included one respondent per facility, therefore the data is solely based on the respondent's interpretation. Fourth, timeliness of care is a VA priority; however, it is only one measure of quality of cancer care, this study did not assess the receipt of guideline-concordant care. Finally, while we assessed whether these resources were

available, we could not assess whether they were utilized. Implementation and utilization may be variable.

There are a few policy implications for this work. First, interventions directing VA patients to receive care outside of the VA and in their communities may not effectively reduce disparities in treatment because non-VA rural hospitals tend to be under-resourced[22]. The VA coordinates the use of available services in the community on behalf of veterans, but should still should evaluate resource distribution across the VA health care system. The VA bolsters rural cancer providers' efforts with additional resources, such as offering virtual tumor boards and placing navigators in rural areas, but could ensure that support staff such as cancer social workers and psychologists are available and accessible, potentially through teleconferencing[23]. Second, this dissertation suggests that even within equal access systems, the hospital where a patient receives their care could have implications for the quality of care they receive. Administrators should carefully weigh the potential impact of hospital resources associated with cancer care on the various segments of patient populations they serve. Policy makers should consider increased oversight on how operating and clinical decisions affecting cancer care, including the distribution of resources associated with improved quality outcomes, such as tracking systems, affects underserved veterans. Third, practitioners, policy makers and researchers should be aware that "a rising tide does not lift all boats." There may be resources that are particularly positively or negatively salient for black veterans.

CHAPTER 2: LITERATURE REVIEW

Overview

Compared to white patients, black patients are more likely to experience cancer treatment disparities. Rural residents, compared to urban residents, are also more likely to experience cancer treatment disparities[1]. These disparities include receiving less timely, high-quality cancer treatment[2]. Cancer treatment disparities may lead to an increased likelihood of dying from treatment amenable cancers[24]. Sources of cancer treatment disparities are complex and multifaceted; they can be attributed to patient[25]- and system- level[26] factors.

Evidence suggests that compared to white patients, black patients receive their health care at lower quality hospitals.[5,7] Black patients are more likely to receive their care at hospitals that serve populations that are at least 40% minority, minority serving institutions (MSI)[12]. Compared to physicians at non-MSIs, physicians at MSIs report feeling less equipped to provide quality care[9]. Similarly, compared to urban residents, rural residents often receive cancer care at lower-quality hospitals[5]. Consequently, patients receiving their care at these face poorer health outcomes[8,10].

These poorer health outcomes, such as higher odds of death[10], cannot be solely attributed to differences between hospitals. Some of the racial disparities in treatment may be explained by within-hospital differences such as differences in continuity of care. When black patients experience equal continuity of care, such as having existing

relationships with their providers, they may experience more equitable cancer treatment – despite systematic differences in where they receive their care.

Some health care systems, such as the Veterans Health Administration (VA), provide more equitable care[4]. Evidence suggest that overall, rural Veterans receive timely, quality care within the VA[11]; although there is evidence suggesting that subgroups of rural populations may experience treatment disparities[27]. However, there is evidence suggesting that black patients within the VA are more likely than white patients to receive health care at hospitals that have fewer resources or provide lower quality of care[13,14,28]. To date, there is little evidence about how oncology-specific resources are distributed at VA hospitals across the United States (U.S.). Additional research is also needed to identify which hospital factors are present or absent from the hospitals where underserved patients are receiving their cancer treatment. This will help us better understand the determinants of disparities of cancer treatment in the VA and in other settings.

Despite decades of research, racial disparities in cancer treatment still exist. We have knowledge about some underlying cases of racial disparities in cancer treatment, but need to further investigate the underlying causes of these disparities. Identifying the etiology of disparities will enable us to create and implement targeted interventions to reduce them. Identifying the role of specific hospital factors in perpetuating or reducing disparities could provide evidence to support targeted systematic interventions to reduce disparities over time. Continuity of care may be more readily modifiable than oncology-specific resources. Continuity of care can be modified by measuring continuity of care, setting performance goals, and providing feedback; increasing the number of

days providers see patients; improving same day or next day access to providers; and creating and enforcing policies about continuity and access[29]. Improving continuity of care may result in a faster reduction in racial disparities in cancer treatment than modifying access to oncology-specific resources.

The VA

The VA is the largest integrated health care system in the United States[20],providing primary care, mental health, rehabilitation and other specialty services, including cancer care. It provides care for approximately 6 million veterans annually[20]. The VA has eligibility criteria. Veterans who were other than dishonorable discharged from the Air Force, Army, Navy, Marines or Coast Guard are eligible for VA services. Reservists or members in the National Guard who served active duty may be eligible for VA services. Within the VA, access to care is increased because of reduced financial barriers to care. Patient payment for services is determined by their service-connected disability status, net worth, and their previous year's gross household income[30]. A service-connected disability is a disease or injury that started or became aggravated while the veteran was on active duty. Veterans who are low income, received a Purple Heart or were prisoners of war are eligible to receive care free care through the VA health care system[30].

In the U.S., approximately 3% of all cancer diagnosis are made within the VA[20]. Currently there are 143 VAs with cancer diagnostic and treatment capabilities[31]. The VA Central Cancer Registry (VACCR) is a database of cancer cases diagnosed within the VA since 1995[20]. The VACCR contains information about 3% of U.S. cancer cases diagnosed in the United States[20]. System-wide, VA cancer treatment capabilities include

tumor boards, clinical trials, patient tracking, and specialist staffing of oncologists, radiologists, and surgical oncologists.

Lung, Colon, and Rectal Cancer

Cancer is the second leading cause of death in the U.S. Lung, colon and rectal cancer are among the top diagnosed cancers in the United States[32]. In the VA, lung, colon and rectal cancer are among the top 3 cancer diagnoses[20]. In 2010, there were an estimated 222,520 lung and bronchus cancer cases diagnosed. Among the new lung and bronchus cancer cases, 15% and 14% were diagnosed in men and women as a percentage of all cancers respectively. In 2010, there were 102,900 new cases of colon cancer and 39, 670 new cases of rectal cancer diagnosed[20]. Colon and rectal cancers (CRC) accounted for 9% and 10% of all new cancer cases diagnosed in men and women respectively[32]. Within the VA, lung and bronchus cancers account for 20% of cancer diagnosis and CRC accounts for 9% of cancer diagnosis[33]. Although prostate cancer is also among the top diagnosed cancers, prostate cancer was not included for analysis because "active surveillance" is among the treatment options[34].

Cancer Diagnosis, Treatment Planning and Treatment

Clinical Practice Guidelines

Clinical practice guidelines facilitate clinician decision-making to ensure the delivery of consistent, high-quality care. The National Comprehensive Cancer Network (NCCN) issued comprehensive guidelines for lung, colon and rectal cancers[34]. The VA has endorsed NCCN as its cancer practice guidelines[35]. NCCN guidelines provide recommendations for diagnosis, treatment, and post-treatment stages[34]. They commonly recommend the use of blood tests (including fecal occult blood testing), imaging tests (including compute tomography (CT), low-dose computed tomography,

and positron emission tomography (PET)), sigmoidoscopy and colonoscopy during diagnosis and treatment planning. Frequent communication with the patient is also recommended throughout the duration of care. Following diagnosis, the provider initiates treatment planning by taking the patient's medical history into account. Treatment plans include imaging tests that help doctors rate the extent of the cancer via staging/grading. Cancer staging involves testing nodules further than the nodule that likely has cancer for the presence of abnormal cells. In treatment planning, the cancer stage is used to decide additional testing and the best course of treatment. Cancer can usually be treated by less invasive means such as chemotherapy or radiation therapy, more invasive means such as surgery, or a combination of them.

Cancer Diagnosis

Per the NCCN[34], lung cancers are typically diagnosed by examining small masses, called nodules, located in the lungs. Nodules can be caused by many things, including cancer. Physicians determine if a nodule is cancerous by performing a risk assessment, reviewing tests, and repeating tests to evaluate changes in the nodules[34]. Cancer confirmation is accomplished by biopsy or surgery where tissues or fluid is removed from the lung and tested for the presence of cancer[34].

Colon and rectal cancers begin as polyps that can be removed and tested for cancer cells[34]. Colon and rectal cancer can be diagnosed via a combination of colonoscopy, blood tests, and imaging tests[34]. They may be confirmed via a needle biopsy or surgery to remove fluid to look for the presence of cancer cells[34]. The VA has implemented a colorectal cancer screening program to improve the VA's delivery of cancer care. This includes improving the timeliness of VA's follow-up of positive CRC

screening tests[36]. CRC screening rates are higher in VA than in the community and VA consistently reports screening rates higher than the national average[37].

Cancer Treatment Planning

The NCCN recommends that following diagnosis, the patient's medical history, the size of the cancer, cancer location, cancer stage and grade, comorbid conditions and patient age help the provider assess whether the patient's suitability for various treatment options[34]. The medical history is often followed by blood tests including a blood count and a chemistry profile to evaluate the number of blood cells in the sample[34]. Blood and imaging tests are used to assess whether the cancer has spread, stage the cancer and evaluate which sites have cancer[34].

Cancer Treatment

Cancer treatment is based on stage at diagnosis, the patient's health, and the patient's preferences[25]. Surgery, radiation therapy, chemotherapy, and chemoradiation (chemo and radiation delivered at the same time) are common cancer treatments. Surgery is the only way to cure stage I or II lung cancer[38]. The goal of surgery is to remove the cancer form the body. Radiation therapy involves the use of high energy rays to kill the cancer cells or stop new cancer cells from being made. Chemotherapy includes drugs that disrupt the cancer cell's life cycle. Chemotherapy may be given before or after surgery, and sometimes with in conjunction with radiation therapy[34].

Racial Disparities

Despite the existence of these guidelines, clinical practice remains highly variable. While physicians generally agree with specific guidelines, variations in care are commonly experienced by patients that are older, poorer and of minority race[39].

After controlling for cancer stage, racial disparities in screening, diagnosis, treatment regimens and survival remain[25].

Prevalence

The existing research suggests that in the U.S., racial disparities in the prevalence of lung, colon and rectal cancer continue to persist. Overall, incidence rates of lung cancer are declining, after peaking in the early 1990's[40]. Among men, the incidence rate peaked in the 1990's and then began declining[40]. Among women, the incidence rate increased until it began stabilizing in 2007[41]. Black and white men are experiencing similar, declining trend in new diagnoses, but the incidence rate for black men remains higher[41]. While white women are experiencing stability and a subsequent decline in the number of new diagnoses, black women are not yet experiencing a decline in the number of new diagnoses[41]. The difference in incidence rates between black patients and white patients remains relatively unchanged since the 1970's[41].

Before the 1980's, CRC rates were higher for white men than black men. After the 1980's, black men experienced a sharp increase in CRC diagnoses. During the same time period, white men saw a decline in the number of CRC diagnoses[42]. In the 1970's, white and black women experienced similar rates of CRC; however, in the late 1990s, black women saw an increase in the number of CRC diagnosis[42]. Black women remain more likely to be diagnosed with higher stages of CRC and lung cancer[43,44].

Treatment

Most people receive guideline concordant treatment[45], but black patients are less like than white patients to do so[45]. The literature evaluating racial disparities in cancer treatment between black patients and white patients suggest that treatment disparities exist. However, there are few studies that have showing equality in treatment receipt[46].

In contrast, evidence suggests the use of treatment regimens vary by race[25]. There is evidence of disparities in staging[47], chemotherapy[48], radiation therapy[26], surgery[47,49,50], and adjuvant therapy[51]. Overall, black patients are less likely than their white counterparts to receive standard treatment[45] or adjuvant therapy[51]. Black patients are less likely to be treated with less-invasive therapies such as radiation therapy[26,48] and chemotherapy[48]. The relationship between race and radiation therapy treatment holds after adjustment for sociodemographic factors, region, hospital volume, tumor registry, teaching hospital status, and the presence of on-site radiation therapy[26]. In addition, to racial disparities in less invasive treatments such as chemotherapy and radiation, black patients are also less likely to receive more invasive surgical treatment for colon and rectal cancer[45,52], even after adjustment for SES, patient and tumor characteristics[52].

The relationship between race and receipt of appropriate treatment is complicated because black patients often present at later stages[53], with poorer functional health status[54] and higher numbers of comorbidities[54]. These factors may be contraindicative for the receipt of less invasive, non-surgical[26,48] and surgical therapies[54].

Survival

Various studies have provided evidence suggesting that there is a racial difference in 5-year survival. Population based studies have indicated that after adjustment for demographic characteristics, clinical characteristics, treatment modalities and insurance coverage, black patients have significantly higher mortality across cancer treatments[55]. After surgical resection, compared to white patients, independent of

comorbidities, symptoms, treatment modality and tumor characteristics, black patients experience higher mortality[56,57] up to 2-years after surgical resection[57].

Results from population-based Surveillance, Epidemiology and end Results Program (SEER) studies largely substantiate this evidence. Mortality rates for CRC rank third among men and women diagnosed with cancer, but have been declining over the last few decades[25]. Since the 1950's, mortality rates for white women have been declining. Since the 1980's, mortality rates for white men have been declining. In contrast, mortality rates for black women and men increased before leveling off in the 1980's and1990's respectively[25]. Black patients and white patients with CRC have seen increases in 5-year survival rates over time[32], these increases were found to be less pronounced for black patients[32,58]. This difference has led to increase racial disparities in survival[58,59]. These disparities persist at each stage of diagnosis [25].

Du[52] found that while black patients experienced higher mortality compared to white patients after adjusting for age, sex, and tumor stage, this relationship was primarily driven by SES. In contrast, results from a study of stage II and III CRC patients, indicated that black patients experienced increased risk of death after adjusting for treatment, pathological and sociodemographic factors[51,60].

Overall, despite a few studies indicating no racial disparities, these findings persist in University and medical center studies. A study of Medicare and Medicaid dully enrolled adults with CRC in Tennessee, Rogers and colleagues[61] found no difference in overall mortality between black and white patients. In contrast, several studies have found racial differences in cancer-specific mortality. Black patients within 11 comprehensive cancer centers in the U.S. were found to experience an increased risk

of death after being diagnosed with colon and rectal cancer[62]. In fact, mortality rates remain about 1.4 times higher for black patients[25]. This increased risk persisted after adjustment for age, SES, and treatment modalities[63]. This association remains for all stages except unstaged cancers where black patients experience lower mortality rates[25]. Black patients also experience lower median survival than white patients. This persists despite similarities in stage at diagnosis, treatment modality and surgeon, where black patients also face a lower median survival than white patients[64].

Evidence indicates that there are no racial disparities in long-term survival. A 1999 study, Merrill and colleagues[65] did not find an association between race and long-term survival. Their analysis did not adjust for receipt of adjuvant chemo or radiation therapy, therefore, their results may have been biased and attenuated towards a reduction in disparities[65]. Among those with stage I or II lung cancer, after adjustment for zip code level median income, zip code level education, SEER registry site, rurality, comorbid status and stage at diagnosis, Farjah and colleagues[66] also found that disparities in 5-year survival rates for black and white patients did not remain. Their analysis excluded people who were not recommended surgical resection, therefore, their results may have been biased if there were racial differences in treatment recommendations.

Cancer Disparities in VA

Treatment

Evidence of racial disparities in cancer treatment within the VA is mixed. Nationwide examinations of cancer care within the VA found no significant differences in the proportion of black and white patients who receive less invasive therapies such as chemotherapy[67] and radiation therapy[67-70] or more invasive therapy such as surgical

resection[67]. A study of veterans with late stage cancer non-small cell lung cancer also found no significant difference in mean times from diagnosis to surgical resection[16].

There is evidence that cancer treatment within the VA varies by race. Williams[54] and Wang [71]found that among patients with all stages of non-small cell lung cancer, black patients are less likely to receive cancer treatment. Despite similar rates of refusal of chemotherapy amongst black and white patients with early stage colon cancer[50], black patients within the VA are less likely to receive chemotherapy[68].

Overall, about 20% of VA the patients underwent surgical resection[46]. Although black patients are equally likely to be referred to a surgeon for stage I or II lung cancer[50], staged black patients were less likely to receive a recommendation for surgery when it was not clearly contraindicated and were more likely to decline surgery[47]. Those that did receive a recommendation for surgery were more likely to decline surgery[47]. Black patients in the VA are also less likely to receive surgery[54,67,69,70,72]. There are no differences in age, ethnicity or sex between those undergoing resection and those denied surgery[46].

Survival

Lathan and colleagues[47] found that after equal rates of surgical resection, race was not associated with survival. Consistent with literature in the private sector, Rabeneck and colleagues[73] found an increase in survival over a time period for patients with CRC, but black patients' survival increased less, so they faced greater mortality during the follow up period. Studies evaluating race and CRC survival suggest that race is associated with survival, with black patients experiencing higher mortality than whites[67,74]. This relationship held after adjustment for clinical characteristics[73,74].

Origins of Disparities

These disparities are caused by many factors. Physicians have reported not providing treatment for a number of reasons including lack of clinical indication[26], comorbidities[26,38], and patient refusal[26,45,50]. Black patients are more likely than white patients to be diagnosed at a higher stage[53], which has implications for their cancer treatment. Black patients' health may be too poor to recommend therapy[50]. However, compared to white patients, black patients with two or more comorbid conditions have been found to have lower rates of surgical resection[38]. Finally, black patients are more likely to refuse treatment[45,50].

Reasons for patient refusal varied by race. Within the VA, white patients are more likely to report that they did not want to be forced to wait for surgery[75]. This may result in increased likelihood of receiving treatment and decreased wait time[75]. In contrast, black patients express doubt that they need surgery, question its efficacy and are more likely to prefer complementary and alternative medicine to surgery[76]. This may result in decreased likelihood of receiving treatment and increased wait times. Black patients may have strongly-held beliefs that influence their willingness to have cancer treatment and the timeliness of their care[77]. Their beliefs may not be acknowledged by physicians who interact with them, leading to negative physician-patient interactions, complicating patient decision making[77]. Despite knowledge of how patient beliefs affect treatment decisions and timeliness, hospital factors and interactions between the patient and the physician may be more likely to account for racial disparities in cancer treatment[25].

Health Care System Factors

The quality of care that patients receive is influenced by the system of care. Evidence suggests that receiving quality cancer care is predicted by receiving care in hospitals that have an academic affiliation and teaching hospital status[8,78-80]. Quality of care is also associated with provider academic affiliation[81] and hospital type including disproportionate share hospitals[80] (e.g. hospitals that serve a large portion of Medicare beneficiaries), public hospitals[80], and government-owned hospitals[82].

Quality of care is also associated with hospital volume[79,83] and surgeon volume[79,84]. Evidence suggests that there were significant differences in survival between university-affiliated medical centers and nonteaching community hospitals[25,64]. In 2006, Schrag and colleagues[85] found no association between hospital volume or surgeon volume and mortality among women with ovarian cancer, but found that hospital volume and surgeon volume are was associated with mortality following colon cancer surgery. This suggests that the physician/hospital volume-outcome relationship may be motivated by more complicated procedures[86].

Physician and hospital volume may be driven by geographic region[81,87] and community size[81] which are also predictive of receiving quality care. People who receive care in urban regions are more likely to receive quality care[87] compared to those in rural hospitals[80]. In addition to physician and hospital volume and rurality, geographic region and community size may be associated with quality of care through a correlation with the distance that patients have to travel to receive care. Lower quality of care is associated with greater distance to the provider[82].

Quality of care may be predicted by several specific hospital features. Having on-site radiation therapy is predictive of receiving radiation therapy treatment[82]. Receipt

of curative-intent surgery among patients with stage I or II non-small cell lung cancer (NSCLC) has been associated with physician attendance at weekly tumor board meetings[88]. When those tumor boards included an evaluation of prior treatment decisions, patients were also more likely to receive curative intent surgery[88]. When those tumor boards reviewed specific cancer sites, compared to multiple cancer sites, curative intent surgery was more likely[88]. The presence of hospital clinics for specific cancers, such as the lung mass clinic within the Birmingham VAMC is also associated with higher surgical resection rates[46].

Hospital patient racial composition is also associated with quality of care[87] and long-term outcomes including mortality[8,77]. Evidence within and outside of the VA suggests that health care is highly concentrated for black patients. Racial disparities in cancer treatment may be due to difference between hospitals. Black patients are likely to receive their care at MSIs[12] that are less likely to perform well on quality measures[89] and lower rates of evidence-based treatment use[90]. People who receive care at MSI experience lower quality of care[87] and greater mortality[8].

The segregation of care has implications for the types of providers that black patients see. Bach and colleagues[9] found that 80% of black veterans visited 22% of physicians. Those physicians provided less care to white patients and were less likely to be board certified. They reported facing difficulties obtaining access to high-quality subspecialists, non-emergency hospital admissions, and diagnosis tools. Perhaps because of feeling under resourced, physicians at MSIs report feeling unable to provide good quality of care[9]. The segregation of care also has important implications for outcomes. After adjustment, black patients are more likely to receive cancer surgery at

low-volume surgical centers and consequently experience increased post-operative mortality[77].

Patient-Physician Factors

In addition to differences between hospitals, process within sites of care have implications for the quality of cancer care patients receive. While black patients are equally likely as white patients to receive a consultation with a medical oncologist or a radiation oncologist, they consult with both less frequently[48].

After consulting with an oncologist, black patients remained less likely to receive treatment[48]. Even when referrals are equal black patients may experience negative interactions with the providers, affecting their treatment decisions. In a prospective study of patients visiting thoracic surgery or oncology clinics for treatment for suspicious pulmonary nodules or lung cancer, Gordon and colleagues[91] found that prior to their visits, black and white patients had similar levels of physician trust. Following their visits, black patients reported less physician trust. They reported feeling that the physicians' communication was not informative, supportive, respectful, and partnering. After clustering by physician, there were not significant differences by race, indicating that there is some variation by physician[92].

In contrast with NCCN recommendations, physicians may not engage black veterans in effective partnerships, negatively impacting shared-decision making[91-93]. Compared to white patients, black patients may be provided with less information to help them make an informed decision about their treatment[91-93]. Gordon and colleagues[92] observed patient-provider visits and found that black patients received less information from doctors and participated less actively than white patients. Black

patients are less assertive and active in their care, and have less trust in their providers[92].

Black patients evaluated by a surgeon were more likely to have a negative recommendation for surgery and more likely to refuse surgery compared to white patients, suggesting that miscommunication or bias during the patient, physician encounter impacts treatment recommendations and decisions[94]. Negative perceptions about the physician-patient interaction impacts treatment decisions[38], potentially increasing treatment disparities.

Summary

Together, the literature suggests that the quality of cancer care has improved in the general population, but less so for black patients, widening disparities in cancer outcomes.[95] . Efforts to account for (explain) the cancer disparities within the VA have primarily focused on patient characteristics (e.g. socioeconomic status, communication style, trust) and clinical characteristics (e.g. stage at diagnosis and tumor type)[69,76,91,92,96]. Yet, after accounting for these factors, disparities remain, suggesting that structural factors also influence racial disparities in care within the VA. Care within the VA is segregated such that black patients are likely to receive their care at minority serving institutions (facilities with high proportions of minority patients).[97,98] Research suggests that the site of care is an underlying cause some racial disparities in care[89]. Minority-serving institutions have been characterized by features such as less access to oncology specific resources. Within the VA, there may be differences in oncology-specific resources between those minority serving VAs and non-minority serving VAs that may explain some of the racial disparities in cancer treatment. A systematic review of racial and ethnic disparities within the VA identifies “determining facility

characteristics associated with health care quality" among promising areas for future research[6]. Little is known about the distribution of these resources across the VA system and whether this distribution affects racial disparities in cancer treatment. For example, research suggests that organizational features, such as patient tracking mechanisms, are positively associated with receipt of timely treatment.[99] However, the extent to which specific, observable hospital factors, such as patient tracking mechanisms, explain racial disparities within the VA is unknown. While evidence suggest that differences in the site of care, even within the VA, significantly contribute to racial disparities in treatment, other factors exist. For example, it is hypothesized that differences in care processes, such as continuity of care, may mitigate the influence of the site of care, even within facilities where black patients receive their treatment. The extent to which continuity of care is associated with disparities in cancer treatment within the VA is unknown.

This research addresses these gaps by 1) assessing how hospital factors are distributed across the VA system; 2) assessing the association between continuity of care for black patients within the VA could further reduce racial disparities in treatment, regardless of where the veteran receives their cancer treatment; and 3) identifying the specific observable hospital factors that may explain racial disparities in cancer treatment within the VA, and their relative contributions to those disparities. These contributions are significant for two reasons. First, *understanding how much of the racial disparities in treatment can be attributed to the differences in observable hospital factors at the site of care can help us identify and address the most important factors and reduce racial disparities in care.* Secondly, *observable hospital factors may not be*

readily modifiable; therefore understanding how the process of care within the hospital moderates the relationship between specific aspects of the health care system and racial disparities may provide evidence to suggest areas that are ripe for more immediate intervention. This contribution is also generalizable. While the VA serves a specific veteran population, it is the largest integrated health care system within the United States; therefore signals from this study may be relevant to other U.S. integrated health care systems.

CHAPTER 3: STUDY DESIGNS AND METHODS

Overview and Rationale

This dissertation is a secondary data analysis using data from the VA Health Care System (VA). This retrospective design used data from the VA's Epidemiology of Cancer among Veterans (EpiCAN) database, the VA Central Cancer Registry (VACCR), and the VA Corporate Data Warehouse (CDW) and the 2009 VA Oncology Facilities Survey. EpiCAN is a unified data source allowing researchers to analyze VA cancer care and outcomes. EpiCAN data originates from the VA Central Cancer Registry (VACCR)[19] and the VA Corporate Data Warehouse (CDW)[18]. These data were used to identify men and women who had a primary colon, rectal or lung cancer diagnosis and treatment within the VA between December 1, 2009 and January 31, 2014.

In Aim 1, the dependent variables of interests were binary indicators of whether the veteran received treatment at a VA hospital with specific oncology-specific staffing, cancer-specific tumor boards, patient tracking capabilities, and oncology clinical trial and whether they experienced continuous care in the two years prior to diagnosis. In Aims 2 and 3, the dependent variable of interest was a binary indicator of timely treatment, defined as receiving the first course of treatment (e.g. first evidence of surgical resection, chemotherapy or radiation therapy) within 10 weeks of diagnosis. The key explanatory variable, across all Aims, was race. In Aim 1, rurality was also assessed as a key explanatory variable. Additional key explanatory variables in Aims 2 and 3 included the interaction of race and hospital factors and continuity of care

variables. This analysis examined the association between the site of care and racial disparities in the timelines of primary colon, rectal, or lung cancer treatment.

Conceptual Framework

The Donabedian model for quality care was the overall framework guiding this work. The Donabedian model posits that the "quality" of care is determined by the structural attributes of the hospital, processes of care and the outcomes of care[100]. This framework was a good fit for this study because it allowed us to attribute the quality of care to the multiple dimensions of the care encounter.

Structure. Hospital factors represent the structure of the health care setting. In this dissertation, these hospital factors were attributes that are associated with good quality cancer care[101], such as tumor board presence and patient tracking mechanisms. They are often used by cancer accreditation bodies, payers and government organizations as proxies for cancer care quality[102].

Process

Structural factors are necessary, but not sufficient to provide good quality of care. Processes of care include the actions that providers take with patients and the skill with which they take those actions. Once such process, continuity of care, has been associated with improved provider communication in primary care[21]. There are three types of continuity of care (Figure 2). *Informational continuity* is the understanding of and transfer of non-medical information about patients (e.g. personal impressions, values, preferences, social context, and support mechanisms)[103]. Primary care providers with ongoing relationships with patients will know more about their medical and social histories[104] than is written in their medical record[103]. This has been associated with better quality care[103]. *Relational continuity* is sustained contact between

the patient and the provider over time[103]. It is characterized by increased informational continuity, trust, mutual understanding, and a sustained sense of responsibility toward the patient[103]. *Management continuity* is characterized by a consistent and coherent approach to the management of a health condition that is responsive to a patient's changing needs and is characterized by care that is delivered in a complementary and timely manner[103].

Institute of Medicine – Origins of Health Care Disparities

Along the cancer treatment continuum, disparities are a result of patient[25]- and hospital-level[26] factors. Throughout the course of treatment, physicians undergo medical decision-making under time constraints. Medical decision-making is supposed to be an evidence-based process where the physician **weighs clinical findings, the diagnosis and the appropriate treatment**; but physicians are not always rational and their actions are not always in-line with evidence-based practice. Physicians' actions may be guided by preferences that may be influenced by misinformation or prior experiences. Physicians may be especially susceptible to these influences under time constraints and when they face uncertainty while interpreting symptoms and making treatment recommendations.

Uncertainty arises from three sources: 1) ambiguity about the diagnostic implications of clinical factors; 2) incomplete information about the efficacy of diagnostic and treatment interventions; and 3) ambiguity about how to value potential clinical outcomes[105]. Together the uncertainty providers face and the autonomy they practice result in providers having clinical discretion, which can be shaped by subjective influences including prejudice and stereotypes that could cause racial disparities in treatment[105].

Observable hospital factors may be associated with racial disparities timely treatment. They may *reduce uncertainty and increase consistency in the clinical encounter.* Organizational features could reduce provider uncertainty and increase consistency of care across races in three ways: 1) ensuring providers have more access to information about treatment efficacy across races; 2) exposing providers to a wider variety of cases; and 3) providing an opportunity for multiple providers to interact on a case, reducing opportunities for subjective influences.

Continuity of care may reduce uncertainty by improving the patient-provider relationship. Strong patient – provider relationships are likely to improve communication about patient treatment preferences, symptoms, and concerns, reducing provider uncertainty in clinical encounters with black patients. Significant reductions in treatment disparities could result from greater consistency in clinical encounters across races.

Research Questions and Hypotheses

This analysis began with a *descriptive* analysis to understand differences in access to hospital factors and continuity of care within the VA. The following research questions were evaluated in Aim 2 and Aim 3.

Research Question 1: Does the presence of specific, observable hospital factors and continuity of care reduce racial disparities in the time to initiation of lung, colon, or rectal cancer treatment among veterans with stage I, II, or III cancer receiving cancer treatment within the VA?

H1: Receiving treatment at a hospital that has oncology-specific resources associated with quality cancer care and having an established, continuous relationship with a primary care provider reduce racial disparities in the time to treatment initiation among veterans with stage I, II, or III lung, colon, or rectal cancer.

Research Question 2: How much do observable hospital factors and continuity of care reduce racial disparities in the time to initiation of lung, colon, or rectal cancer treatment?

H2: Patient tracking mechanisms will reduce racial disparities in treatment more than other features because the allow the hospital to measure disparities and intervene to reduce disparities.

Data

Data for this dissertation were obtained from the VA EpiCAN database. EpiCAN originated from the VA Central Cancer Registry (VACCR)[19] and the VA Corporate Data Warehouse (CDW)[18]. Data will be accessed through the Veterans Affairs Informatics Computing Infrastructure (VINCI)[106]. A description of these datasets is below.

The VACCR is a database of cancer cases diagnosed within the VA since 1995[20]. The VACCR contains information about 3% of U.S. cancer cases diagnosed in the United States[20]. It contains patient demographics and information about the patient's cancer care including their tumor characteristics[20]. VACCR will be used to ascertain information about the data of diagnosis, treatment initiation date, treatment type, and disease characteristics.

This data source was linked with the VA CDW that compiles information from the patient's electronic health record including their labs, International Classification of Disease (ICD-9) codes, procedures, treatments, and visit information. Data from CDW[18] was accessed for information about provider visits to assess continuity of care, race and other sociodemographic variables.

Data about hospital factors was obtained from the 2009 VA Oncology Services Survey, a survey of VA Oncology Facilities. This survey was web-based, administered

by the VA Healthcare Analysis and Information Group, and distributed to hospital Chiefs of Staff at the 140 VA hospitals with cancer diagnostic and treatment capabilities. The survey had a 100% response rate. The survey includes information about the care that is provided at each hospital, the complexity of the hospital, tumor board characteristics, and staffing levels/ratios.

Study Sample and Inclusion and Exclusion Criteria

Inclusion criteria are listed in Table 1. The study population included veterans diagnosed with incident stage I, II, or III colon, rectal, or lung cancer between January 1, 2009 and December 31, 2014. These cancers were chosen because they are the top three cancer diagnoses in the VA[20]. The date of cancer diagnosis in EpiCAN is assessed using a signed pathology report[107]. The sample was limited to black and white veterans who received their first course of treatment (i.e. first evidence of surgical resection, chemotherapy, or radiation therapy) or declined to receive treatment at a VA hospital. In the VA, race is self-reported. We also excluded patients with stage IV disease, without a documented stage, or who did not have colon or rectal adenocarcinoma or non-small cell lung cancer. Finally, we excluded patients who did not live at least 31 days after diagnosis, who did not identify as male or female, and without a reliable zip code. The small number of Asians, American Indians and other races did not reach a level that would be statistically powered to detect differences among them, therefore they were excluded from analysis. The samples for Aims 2 and 3 were further limited to veterans whose first course of treatment was at a VA hospital according to the EpiCAN database and the VACCR.

Sample Size

EpiCAN included 74,574 patients diagnosed with lung, colon or rectal cancer between January 1, 2009 and December 31, 2014. We excluded 6,587 patients who were diagnosed with a secondary cancer within 6 months of the incident cancer diagnosis. We further excluded 31,381 patients with unstaged or stage IV cancer. Next, 3,918 patients with small cell lung cancer, non-colon adenocarcinoma or non-rectal adenocarcinoma were excluded. Fifteen patients had evidence of treatment before the date of diagnosis and were excluded. We excluded 649 patients who died within 30 days of diagnosis, 31 whose zip code was unreliable in the data, and 120 who were not a veteran. We also excluded 726 veterans who reported a race other than black or white. Finally, 7,941 veterans who received cancer treatment were excluded because we were unable to identify a first course of treatment within 7 days of the first course of treatment reported in the VACCR. This resulted in a final sample of 23,195 veterans for Aim 1. Of those, 19,059 where white and 4,136 were black. We further excluded 10,727 veterans who refused treatment at the VA and did not receive their first course of treatment at the VA resulting in a final sample of 20,430 veterans for Aims 2 and 3. Of those, 16,745 were white and 3,665 were black.

Variables and Measurement

Dependent Variables

Aim 1 was a descriptive Aim where we described Veteran's access cancer resources at VAs with cancer diagnostic and treatment capabilities.

Hospital Factors

Nine specific organizational dependent variables were analyzed for Aim 1 including:

- An indicator for the availability of 1) an on-site medical oncologist and 2) social workers and psychologists with cancer specialties at the treating hospital
- Indicators of whether the patient's treating hospital had colorectal or lung cancer-specific tumor boards and whether support staff (e.g., palliative care specialists, social workers, nutritionists, or cancer registrars) regularly attended the cancer-specific tumor boards
- Indicators of whether the patient's treating hospital had: 1) a mechanism to track patients from diagnosis through post-treatment care; 2) a patient navigator available; and 3) a measurement system that tracked the hospital's adherence to guideline-based cancer care or overall care timeliness
- An indicator of whether an oncology-related clinical trial was available at the treating hospital between 2006 and 2009

These data were derived from the 2009 Oncology Facilities Survey.

Continuity of Care Measures

Three, longitudinally measured continuity of care dependent variables were analyzed for Aim 1: Modified-Modified Continuity Index (MMCI)[21], Usual Provider of Continuity (UPC)[21], and duration of care with the Primary Care Provider (PCP). First, we measured provider dispersion, the number of PCPs the patient consulted, using the Modified-Modified Continuity Index (MMCI), defined as:

$$MMCI = \frac{1 - \frac{\#\ of\ PCPs}{[\#\ of\ primary\ care\ visits + 0.1]}}{1 - \frac{1}{[\#\ primary\ care\ visits + 0.1]}}$$

MMCI ranges from 0 (each visit with a different PCP) to 1 (all visits made with a single PCP). Second, we measured visit concentration, the proportion of consultations with the

PCP, identified as the modal provider, using the Usual Provider of Continuity (UPC), defined as:

$$UPC = \frac{\#\ of\ visits\ with\ \ PCP}{[\#\ of\ primary\ care\ visits]}$$

UPC ranges from 0 (no visits with a regular PCP) to 1 (all visits with a PCP). Third, we measured the length of the relationship with the modal PCP. A higher score for all three measures indicates more continuity of care.

We calculated MMCI and UPC using all primary care visits in the two years prior to diagnosis. For ease of interpretation, UPC and MMCI, and duration of relationship were dichotomized at the median value for the population to indicate high continuity of care[108]. An MMCI≥0.610 represented low provider dispersion, a UPC≥0.375 represented high visit concentration, and a relationship of 955 days represented a long relationship. All continuity of care measures excluded telephone contacts, home-based contacts, or contacts with a non-PCP[21], and were constructed with data from the CDW.

The dependent variable for Aims 2 and 3 was a binary indicator of timely treatment, defined as whether treatment was initiated within 10 weeks of diagnosis. Late treatment initiation has been associated with mental health issues, less quality of life, and excess health care utilization[109]. Based upon clinical input from oncology specialists treating colon, rectal and lung cancers, we selected 10 weeks to allow for patients to seek counsel on their treatment options, seek a second opinion, or prepare for the toll treatment will take on their daily lives. Importantly, there are no current federal guidelines specifying a time window for timely cancer care. While the literature is mixed about the benefits of timely cancer treatment, it is widely accepted that the timeliness of lung and colorectal cancer treatment is an indicator of quality cancer care[1]

and the VA has made efforts to improve cancer care timeliness system-wide[16]. The cancer diagnosis date and date of first course of treatment used to calculate the number of days between diagnosis and treatment were assessed using EpiCAN and the VACCR, respectively.

Key Explanatory Variables

Race was the key explanatory variable for all Aims (white; black). Since 2009, within the VA, race has been self-reported[110]. Patients, or their proxies, are asked to use VA Form 10-10EZ to report their race. They are asked at enrollment, hospital admission and outpatient visits or pre-registration. They can provide this information online, via telephone or in-person. VA personnel collect the information and enter it into the veteran's medical record.[111] In this dissertation, race was modeled as a binary indicator (e.g. black = 0, white = 1). In Aim 1, rurality of residence at diagnosis was also an explanatory variable. Rurality of residence was based on patient-level zip code and assessed using United State Department of Agriculture's Rural Urban Commuting Area (RUCA)[112] code zip code approximations.[113] In this dissertation, rurality of residence was modeled as a binary indicator (e.g. urban = 0, rural = 1). Race and patient zip code were assessed using EpiCAN and the CDW respectively.

Other Explanatory Variables

For Aim 2 and Aim 3, the other key explanatory variables included interaction terms constructed of self-reported patient race, assessed from EpiCAN, and measures hospital and continuity of care factors including:

- Binary indicators of access to social workers and psychologists with cancer-specific training (0: no; 1: yes)

- A categorical measure of whether the treating hospital had colorectal or lung cancer-specific tumor boards and whether support staff, including palliative care specialists, social workers, nutritionists, or cancer registrars, regularly attended the cancer-specific tumor boards, (0: no cancer-specific tumor board, 1: cancer-specific tumor board without regular specialist attendance, 2: cancer-specific tumor board with regular specialist attendance)
- A binary indicator for whether the treating hospital had a measurement system that tracked their adherence to guideline-based cancer care or overall timeliness of care (0: no; 1: yes)
- A binary indicator of whether an oncology-related clinical trial was available at the treating hospital between 2006 and 2009 (0: no; 1: yes)
- A binary indicator of low provider dispersion (MMCI≥0.610) (0:no; 1: yes)
- A binary indicator of high visit concentration (UPC≥0.375) (0:no; 1:yes).

Control Variables

The control variables across all Aims were similar. They include regional, patient, and disease-specific characteristics.

Distance to care

Straight-line distance to care was calculated from the center of the patient's current zip code to the treating hospital's zip code using the "zipcitydistance" program in SAS version 9.4 (SAS Institute Inc, Cary, NC, USA).

Age

Age at diagnosis was extracted from EpiCAN. NCCN Clinical Guidelines do not provide age-specific guidelines for the timing of the initiation of cancer treatment,

however older adults may present too ill to immediately initiate cancer treatment in a timely manner, or at all[114].

Copayment Status

Copayment status, which establishes the cost of care, was assessed from the CDW. Copay status is determined by the veteran's socioeconomic status and service-connected disability status[115]. A service connected disability is a physical or mental disease or injury that occurred during active duty[116]. Although the VA is an equal access system where care is provided to all eligible veterans regardless of ability to pay, a veteran's decision to use VA care may be influenced by their copayment status[17].

Marital Status

Current marital status was obtained from EpiCAN from data that originated in the CDW. Patients that have social support, such as support from a spouse, are more likely to receive better cancer treatment[26,51]. This may be due to better access to transportation[117].

Sex

Sex was obtained from EpiCAN.

Stage and Diagnosis and History of Cancer

We controlled for clinical characteristics including stage at diagnosis and history of care. Stage at diagnosis was be obtained from EpiCAN and previous history of cancer was obtained from the CDW. NCCN guidelines specify treatment based on stage at diagnosis[34]. This may have implications for timeliness of care because treatment timeliness may depend on the type of treatment initiated.

Risk Adjustment

We controlled for expected health care utilization and expected health care expenditures using the Nosos risk score. The Nosos risk score is a risk score that measures the veteran's expected health care utilization.[118] Physicians may include information about comorbidities in an assessment of the patient's functional status[119]. This may have implications for the type of treatment initiate and the timeliness of that treatment[119]. Patients with higher risk scores may be less likely to receive more invasive treatments such as cancer surgery.

Cancer Treatment Type

In Aims 2 and 3, we also controlled for the type of treatment received, chemotherapy, radiation therapy, or surgical therapy.

Statistical Analyses by Aim

We began the analysis for each Aim by reviewing summary statistics. Proportions and means of patient demographics, disease characteristics, hospital characteristic and continuity of care were evaluated over the total sample and stratified by race. Statistical significance (evaluated at alpha = 0.05) across variables was analyzed using Pearson chi-square or t-tests. Aim 1 also included an assessment of bivariate differences in covariates and outcomes stratified by rural residence. Aim 2 included an unadjusted Kaplan-Meier survival curve stratified by race, compared using a log-rank test of equality comparing the number of days between the date of diagnosis and the date of the first course of treatment.

Each binary dependent variable for Aim 1 was evaluated using a multivariate logistic regression with adjusted odds ratios (AOR) and 95% confidence intervals (CI),

adjusted for age, marital status, Nosos risk score, history of cancer and stage at diagnosis.

We also used a multivariate logistic regression to estimate AORs and 95% Cis to estimate the association of race with the patient- and hospital-level independent variables of interest and timely treatment for Aim 2. This model included interaction terms of race and the hospital-level factors and race and continuity of care and was adjusted for age, comorbidity status, marital status, Nosos risk score, history of cancer, stage at diagnosis, cancer type, treatment type.

For Aim 3, we used the Oaxaca-Blinder Decomposition[120] to assess how much group-level inequalities in the receipt of cancer treatment within 10 weeks of diagnosis could be explained by group-level differences in the distribution of observed characteristics vs. differences in the group-level effects of the observed characteristics.

This study was approved by the Durham VAMC Institutional Review Board (IRB) and the University of North Carolina at Chapel Hill IRB. All data analyses and management were conducted using Stata version 15.1 (StataCorp LP, College Station, TX, USA) and SAS version 9.4 (SAS Institute Inc, Cary, NC, USA) software.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	• Lung, colon, or rectal cancer diagnosis (January 1 2009 – December 31, 2014) • Black or White Race • Veteran
Exclusion Criteria	• Lung, colon, and rectal cancer diagnosis after date of treatment • Non-lung, colon, and rectal cancer primary cancer (other cancer diagnosis occurred first during the study period) • Stage IV disease • Rectal: Non-Rectal Adenocarcinoma • Colon: Non-Rectal Adenocarcinoma • Lung: Small-Cell Lung Cancer • Did not live 31 days after diagnosis • No Reliable zip code • Did not self-identify as male or female

CHAPTER 4: TREATMENT HOSPITAL CHARACTERISTICS AMONG DIVERSE VETERANS RECEIVING LUNG, COLON, AND RECTAL CANCER CARE

Overview

Background: As the largest integrated healthcare system in the United States, the Department of Veterans Affairs Health Care System (VA) is uniquely suited to evaluate how different hospital features affect disparities in cancer care for underserved populations such as racial minorities and rural residents. The study objectives are to understand how care continuity and oncology-specific resources are distributed amongst underserved veterans within the VA, with a focus on differences by race and rurality.

Methods: The VA's Epidemiology of Cancer among Veterans database was used to identify veterans diagnosed with stage I, II, or III colon, rectal, or lung cancer between 2009 and 2014. Using multivariate logistic regressions, we assessed whether self-reported patient race and zip-code approximated Rural Urban Commuting Areas (RUCA) were associated with three measures of continuity of care and nine indicators of well-resourced cancer treatment hospitals.

Results: Eighteen percent of our sample were black and 75% lived in an urban area. Black veterans were younger (*P<0.001*) and more likely to live in urban areas (*P<0.001*). Rural veterans were older (*P<0.001*) and travelled longer distances to receive treatment (*P<0.001*). In multivariate analyses, black veterans were more likely to be treated at treatment hospitals with oncology-specific resources such as oncology clinical trials (adjusted odds ratio (AOR) 1.16, 95%CI:1.06,1.28). Rural veterans

experienced more continuity of care (lower visit dispersion, AOR 1.21, 95%CI: 1.12,1.29) but were less likely to be treated at treatment hospitals with oncology-specific resources such as oncology clinical trials (AOR 0.69, 95%CI: 0.63-0.75).

Conclusions: Our results suggest centralization of oncology-specific resources in urban areas, where black veterans typically live. Rural veterans are particularly vulnerable to this centralization due to fewer specialists living in rural areas and increased rural hospital closures among non-VA hospitals.

Background

In the United States, underserved populations such as racial minorities and rural residents are more likely to experience cancer treatment disparities. These treatment disparities include lower-quality cancer treatment compared to white[24] and urban[121] patients. This results in poorer outcomes including an increased likelihood of death. Determinants of treatment disparities are complex and can be attributed to patient, provider, and hospital factors. Often, racial minorities and rural residents receive cancer care at lower-quality hospitals[5,7].

According to the Institute of Medicine (IOM), quality cancer care delivery requires continuous patient-primary care provider (PCP) relationships and oncology-specific resources at the treatment hospital[101]. The IOM acknowledges that patient-PCP collaborations are important for quality cancer care. Patient-PCP provider relationships may facilitate the delivery of quality cancer care by eliciting patients' preferences for their care[101,122] including counseling on treatment options[122], managing comorbidities[122], and diagnosing and treating depression[122]. Oncology-specific resources may additionally improve the cancer care quality. These resources include: 1) access to medical oncologists and support staff (e.g. social workers and psychologists) with

specialized training in oncology; 2) a care plan outlining the goals of care such as those informed by tumor boards that integrate multidisciplinary clinical and social information to manage cancer care; and 3) access to high-quality clinical trials. Additionally, the IOM recommends that treatment hospitals track and measure their care quality and delivery. Individual patient tracking systems improve the care team's ability to track patient adherence to the care plan. Hospital-level data improves the healthcare system's ability to monitor its adherence to cancer treatment guidelines.

As the largest integrated healthcare system in the United States, the Department of Veterans Affairs Health Care System (VA) is uniquely suited to evaluate differential access to cancer care resources. The VA provides health care for approximately nine million veterans annually, including underrepresented groups: 12% are black and 33% reside in rural areas[123]. The VA aims to ensure consistent care regardless residence location[123]. However, little evidence exists about the structure and continuity of underserved patients' relationships with PCPs and little has been reported about how oncology-specific resources are distributed amongst underserved veterans who access cancer care at VA health care facilities[11]. The study objectives are to understand how care continuity and oncology-specific resources are distributed amongst underserved veterans within the VA, with a focus on differences by race and rurality.

Methods

Study Setting and Population

The VA is organized into Veterans Integrated Service Networks (VISNS) where care is centrally administered and hospital leaders can be held accountable for the quality of care provided at their hospitals[124]. This results in a fully integrated health care system that provides care equal to or better than care in the private sector[31,125]. The

VA provides care for approximately 6 million veterans annually. Approximately 3% of all cancer diagnosis in the U.S. are made in the VA[33]. Currently, eligible veterans can receive cancer care at one of the 143 VAs cancer diagnostic and treatment capabilities[31]. System-wide, VA cancer treatment capabilities include tumor boards, clinical trials, patient tracking, and specialist staffing of oncologists, radiologists, and surgical oncologists.

The study population included veterans diagnosed with incident stage I, II, or III colon, rectal, or lung cancer between January 1, 2009 and December 31, 2014. The sample was limited to black and white veterans who received their first course of treatment (first evidence of surgical resection, chemotherapy, or radiation therapy) or declined to receive treatment at a VA hospital. We excluded veterans who had a different cancer diagnosis within 6 months of the primary cancer diagnosis (N=6,587). We also excluded veterans with stage IV disease or without a documented stage (N=31,381) and who did not have colon or rectal adenocarcinoma or non-small cell lung cancer (N=3,918). We also excluded veterans whose treatment date occurred before the date of diagnosis (N=15). We excluded patients who did not self-identify as male or female (N=10), who self-reported a race other than black or white (N=726), who did not live at least 31 days after diagnosis (N=649), without a reliable zip code (N=31), and were not a veteran (N=120). Finally, we excluded patients without evidence of the first course of treatment or treatment refusal within 7 days of the date of first course of treatment recorded in EpiCAN and the VACCR (N=7,941) (Consort Diagram Appendix 1). The National Cancer Institute's Surveillance, Epidemiology and End Results

Program site codes, histology codes, procedural codes, and billing codes used to identify the sample are presented in Appendix 2.

Data

We used the VA's Epidemiology of Cancer among Veterans (EpiCAN) database linked with data from the VA Corporate Data Warehouse (CDW)[18] and the 2009 VA Oncology Facilities Survey to conduct this study. All data were accessed through the Veterans Affairs Informatics Computing Infrastructure. EpiCAN contains patient demographic information and cancer diagnosis and treatment related information from the VA Central Cancer Registry (VACCR)[19] and the CDW. The VACCR is a database of all cancer cases diagnosed within and reported to the VA since 1995[33]. The VACCR contains patient demographics and information about the patient's cancer, including tumor characteristics[12]. CDW compiles information from the patient's electronic health record including sociodemographic, procedural and billing code, and visit, and treatment information. These data represent all veteran VA health care utilization.

Outcomes

Continuity of Care

We assessed patient-PCP relationships with the patient's modal PCP using three, longitudinally measured continuity of care outcomes[21]. First, we measured provider dispersion, the number of PCPs the patient consulted, using the Modified-Modified Continuity Index (MMCI), defined as:

$$MMCI = \frac{1 - \frac{\#\ of\ PCPs}{[\#\ of\ primary\ care\ visits + 0.1]}}{1 - \frac{1}{[\#\ primary\ care\ visits + 0.1]}}$$

MMCI ranges from 0 (each visit with a different PCP) to 1 (all visits made with a single PCP). Second, we measured visit concentration, the proportion of consultations with the PCP, identified as the modal provider, using the Usual Provider of Continuity (UPC), defined as:

$$UPC = \frac{\#\ of\ visits\ with\ \ PCP}{[\#\ of\ primary\ care\ visits]}$$

UPC ranges from 0 (no visits with a regular PCP) to 1 (all visits with a PCP). Third, we measured the length of the relationship with the modal PCP. A higher score for all three measures indicates more continuity of care.

We calculated MMCI and UPC using all primary care visits in the two years prior to diagnosis. For ease of interpretation, UPC and MMCI were dichotomized at the median value for the population to indicate high continuity of care[108]. An MMCI≥0.610 represented low provider dispersion, a UPC≥0.375 represented high visit concentration, and a relationship of 955 days represented a long relationship.

Oncology-Specific Resources

We identified well-resourced treatment hospitals using four oncology-specific resource indicators: staffing, tumor board, patient tracking system, and oncology clinical trial resources (Appendix 3). Staffing resources included an indicator for the availability of 1) an on-site medical oncologist and 2) social workers and psychologists with cancer specialties at the treating hospital. Tumor board resources included indicators of whether the patient's treating hospital had colorectal or lung cancer-specific tumor boards and whether support staff (e.g., palliative care specialists, social workers, nutritionists, or cancer registrars) regularly attended the cancer-specific tumor boards. Patient tracking resources included indicators of whether the patient's treating hospital

had: 1) a mechanism to track individual patients from diagnosis through post-treatment care, 2) a patient navigator to monitor the individual patient tracking, and 3) a population-level measurement system that tracked their adherence to guideline-based cancer care or overall care timeliness capable of providing a dashboard or report card of cancer care delivery within the hospital. Lastly, we evaluated whether an oncology-related clinical trial was available at the treating hospital between 2006 and 2009.

Key Explanatory Variables

Key explanatory variables included: self-reported patient race (white; black) assessed from EpiCAN and United State Department of Agriculture's Rural Urban Commuting Area (RUCA)[112] code zip code approximations[113] for rurality of residence at diagnosis based on patient-level zip code (urban; rural).

Covariates

We examined patient characteristics and disease characteristics associated with receipt of treatment at a well-resourced treating hospital (Appendix 3). Covariates obtained from EpiCAN and the CDW included: age at diagnosis (<40, 40–64, 65-79, >79); sex (male, female); marital status at diagnosis (married, widowed or divorced, never married, missing); straight-line distance between the centroid of the patient's zip code to the centroid of the treating hospital's zip code (<10.8, 10.8–32.4, 32.5-75.9, >75.9, missing); Nosos, a risk score[118], measuring expected health care utilization, (≤ 1, 1.1–2.6, 2.7-5.4, >5.4); and history of cancer (no, yes). We also controlled for VA copayment status, which establishes care costs and may influence veterans' decisions to use VA care[17] (no copay-service connected disability, no copay-low income, copay required, missing). Copayment status is determined by whether the veteran suffered a service-connected disability, disease, or injury during active duty and the Veteran's

socioeconomic status[115]. We were unable to assess distance to care for veterans living in Puerto Rico or on Native American reservations, therefore they were categorized as "missing". Age was presented categorically as in previous research[126]. Other categorical variables were categorized by quartile.

Statistical Analysis

We described our cohort using chi-square or t-tests, assessing univariate differences in covariates and outcomes, stratified by race and rurality (evaluated at alpha = 0.05) as presented in Table 2. We used multivariate logistic regressions to estimate adjusted odds ratios (AOR) and 95% confidence intervals (CI) to examine factors associated with having high continuity of care and receiving treatment at a well-resourced cancer treatment hospital.

This study was approved by the Durham VAMC Institutional Review Board (IRB) and the University of North Carolina at Chapel Hill IRB. All data analyses and management were conducted using Stata version 15.1 (StataCorp LP, College Station, TX, USA) and SAS version 9.4 (SAS Institute Inc, Cary, NC, USA) software.

Results

Our final cohort (Table 2 and Figure 1) included 23,195 patients, of which 20,430 received their first course of cancer treatment at a VA hospital. Eighteen percent of veterans in our sample were black, 97% were male, 45% were married, and 75% lived in an urban area at diagnosis. The mean diagnosis age was 67.7 years (SD=9.3). On average, patients who received their first course of treatment at a VA hospital traveled 32.4 miles to receive cancer treatment. Compared to white veterans, black veterans were significantly younger (*P<0.001*), more likely to live in an urban area (*P<0.001*), and travelled a shorter distance to receive cancer treatment (*P<0.001*). Compared to urban

veterans, rural veterans were older (*P<0.001*) and travelled a longer distance to cancer treatment (*P<0.001*). The outcome variables were not highly correlated with one another, with correlations ranging from -0.0004 (on-site medical oncologist and length of relationship with PCP) to 0.4786 (cancer psychologist and cancer social worker).

Continuity of Care

In multivariate analyses, race was not significantly associated with any measure of continuity of care. Rural residence was associated with increased likelihood of low visit dispersion, meaning more consultations with fewer providers, compared to urban residence (AOR 1.21, 95%CI: 1.13,1.29). Rural residence was not significantly associated with visit concentration of length of relationship with the PCP.

Oncology-Specific Resources

In multivariate analyses, neither race nor rural residence were associated with access to an on-site medical oncologist. Black race was associated with higher odds of receiving cancer treatment at a hospital with a cancer social worker (vs. white race; AOR 1.17, 95%CI: 1.08–1.27) and a cancer psychologist (vs. white race; AOR 1.70, 95%CI: 1.58-1.85). Rurality was associated with lower odds of receiving cancer treatment at a hospital with a cancer social worker (vs. urban residence; AOR 0.81, 95%CI: 0.75–0.87) and a cancer psychologist (vs. urban residence; AOR 0.67, 95%CI: 0.62–0.73).

There were significant associations between race, place of residence and tumor board resources. Black race was associated with higher odds of receiving cancer treatment at a hospital with cancer-specific tumor boards (vs. white race; AOR 1.38, 95%CI: 1.28–1.49) and where support staff regularly attend the cancer-specific tumor boards (vs. white race; AOR 1.49, 95%CI: 1.38–1.61). Rurality was associated with

lower odds of receiving treatment at a hospital with cancer-specific tumor boards (vs. urban residence; AOR 0.86, 95%CI: 0.80–0.92). The association of rural residence and support staff attendance at the cancer-specific tumor boards was not statistically significant.

Black race was associated with higher odds of receiving cancer treatment at a hospital that conducts oncology clinical trials (vs. white race; AOR 1.16, 95%CI: 1.06–1.28). Rurality was associated with lower odds of receiving cancer treatment at a hospital that conducts cancer clinical trials (vs. urban residence; AOR 0.69, 95%CI: 0.63–0.75). The results showing the effect of race and residence are presented in Figures 2-4.

Finally, black race was associated with receiving treatment at a hospital with any individual tracking mechanisms for cancer care (vs. white race; AOR 1.11, 95%CI: 1.03–1.20). Black race was associated with higher odds of receiving treatment at a hospital that uses patient navigators to track patients (vs. white race; AOR 1.09, 95%CI: 1.00-1.17). Black race was associated with lower odds of receiving cancer treatment at a hospital with hospital-level guideline concordance and timeliness tracking (vs. white race; AOR 0.83, 95%CI: 0.77–0.90). Place of residence was not associated with any tracking measure.

The results showing covariate effect sizes from the fully adjusted models are presented in Appendices 4-7.

Conclusions

We examined the influence of race and rural residence on care continuity and access to resources for cancer treatment at the VA. We found that compared to white veterans, black veterans, were equally likely to have continuous care and to receive

treatment in facilities with on-site medical oncologists. We also found that overall, compared to white veterans, black veterans are more likely to receiving treatment in hospitals with cancer social workers and cancer psychologists and more access to cancer-specific tumor boards that support staff regularly attended, and oncology clinical trials. Black veterans were less likely to receive treatment at hospitals that track their overall guideline concordance and timeliness of care. This may reflect that these tracking systems can be implemented through participation in various quality improvement pilot projects, such as the Colorectal Cancer Quality Measurement System (CCQMS). CCQMS involved the use of a tracking and management system to map or describe the cancer care delivery process, and was implemented in one hospital per VISN, limiting wide dissemination[107]. Overall, these findings contrast with previous research suggesting that physicians caring for high proportions of black patients experience difficulties obtaining access to high-quality specialists.[9] Our findings may reflect that black veterans are more likely to receive care in urban areas, where VAs are likely to have affiliations with academic medical centers.

We also found that compared to urban residents, rural residents are more likely to have low visit dispersion and less likely to receive cancer treatment at VA hospitals with oncology-specific resources. Rural residents low visit dispersion may reflect that urban residents, seen at facilities commonly affiliated with academic medical centers, may receive primary care from residents with frequent rotations. Rural residents are less likely to have access to cancer social workers and cancer psychologists and to receive care at VAs that have cancer-specific tumor boards with consistent support staff attendance, or oncology clinical trials. Our study suggests that they are, however,

equally like to receive care at VAs with on-site medical oncologists. Our findings contrast with a 2013 study by Skolarus and colleagues[11] finding that among veterans with prostate cancer, compared to urban veterans, rural veterans were less likely to receive cancer treatment at hospitals certified by the American College of Surgeons Commission on Cancer, hospitals that have an onsite medical oncologist, radiation oncologist, or urologist, and less likely to have on-site radiation therapy services offered at their treating hospital. Our analysis extended their work by evaluating differences in access to support staffing and other resources.

Our results suggest a centralization of cancer resources around facilities that serve urban patients. The VA concentrates most specialty care in urban centers[127], which are commonly affiliated with academic medical centers. While centralization of procedures such as complex cancer surgery may improve population-level cancer outcomes, there is little evidence suggesting that centralization of cancer resources is beneficial for less complex medical procedures. Rural veterans, who are largely concentrated in the southeastern U.S.[128], may face an unequitable burden to access these resources as increased centralization results in increased travel time for this population to access these services[127]. Although during this time period, the VA was taking steps to reduce travel burden[129] by providing financial assistance (i.e. for parking and gasoline)[130], these increased distances may be more burdensome[131], especially among veterans who lack social support[117], and associated with less VA health care utilization[130]. Further reducing the burden of travel, current VA policies, such as the Veterans Access, Choice and Accountability Act of 2014 allow veterans to receive care from a community provider if the veteran's travel to the nearest VA hospital exceeds 40

miles[132] and the 2018 VA Maintaining Systems and Strengthening Integrated Outside Networks Act (Mission Act) which consolidates the VA's community care programs, facilitating veterans' receipt of healthcare in the community[133].

Despite the IOM's guidance that these features influence quality of care, evidence about whether these factors improve cancer care quality is mixed. For example, studies have found that access to tumor boards, for example, does not increase cancer care quality in the VA[134]. Others have suggested that tumor boards may be more important at hospitals that lack other resources because they promote provider collaboration and enable opportunities for provider education, group decision-making, and patient management[135].

Our findings have three potential implications. First, there do not appear to be racial disparities in access to continuous care and oncology-specific resources in this setting, except with regards to patient tracking. Quality measurement and performance improvement depends on the systematic collection of data, which allows the hospital and individual providers to compare their metrics to clinical practice guidelines, making improvements as necessary. This infrastructure would provide robust evidence from which we can further evaluate disparities across the cancer continuum. The VA has a history as a learning health care system implementing initiatives to track and improve cancer care quality including CCQMS; the External Peer Review Program (EPRP) to monitor hospital performance[136]; and the development and demonstration of a comprehensive lung cancer screening program[137]. While these programs have improved the quality of VA cancer care delivery, most have not been implemented or sustained system-wide.

Secondly, rural veterans may benefit from interventions targeting increased resource allocation in rural VA hospitals. While rural veterans may receive care in VA hospitals in urban areas, they are more likely to receive care in VA hospitals in rural areas, which are supported by the VA Office of Rural Health (ORH)[123]. The ORH develops, field tests, and operates programs to improve rural veterans' access to health care including facilitating transportation services and telemedicine programs. Rural veterans may also benefit from increased staffing by oncology support staff and increased cancer-specific tumor boards. Across the United States, the oncology workforce has not kept up with demand[138], with fewer specialists serving rural areas. More immediately, tumor board participation may be more readily modifiable, particularly through virtual tumor boards. Although operating multiple tumor boards can be time and resource intensive[134], virtual tumor boards may give providers access to expertise unavailable in their hospital.

Finally, although veterans, especially those who live further from VA care or have other health insurance, may receive care in non-VA hospitals, those that live in rural areas are less likely to have access to high-performing non-VA hospitals[139]. Rural veterans may be more vulnerable to changes in the healthcare landscape, including increasing rural hospital closures[140], thus may have to travel further distances to receive care. Because of their strategic location in rural locations where veterans live, rural VA facilities may be able provide resources that would be otherwise unavailable in their local communities. The VA should consider this increased vulnerability when allocating hospital resources.

This study has several limitations. First, although we assessed whether these resources were available on-site at the treating hospital, we were unable to evaluate the quality of the resources or whether providers utilized them. However, availability may make providers feel supported in providing care. Secondly, we were unable to assess whether access to these resources resulted in improved care quality. Future research should evaluate whether receiving treatment at a well-resourced treatment hospital is associated with improved cancer treatment, with an emphasis on reduced disparities for vulnerable populations. Finally, we measured distance using a straight-line method, instead of assessing time traveled; however, this proxy is closely correlated with road distance[141].

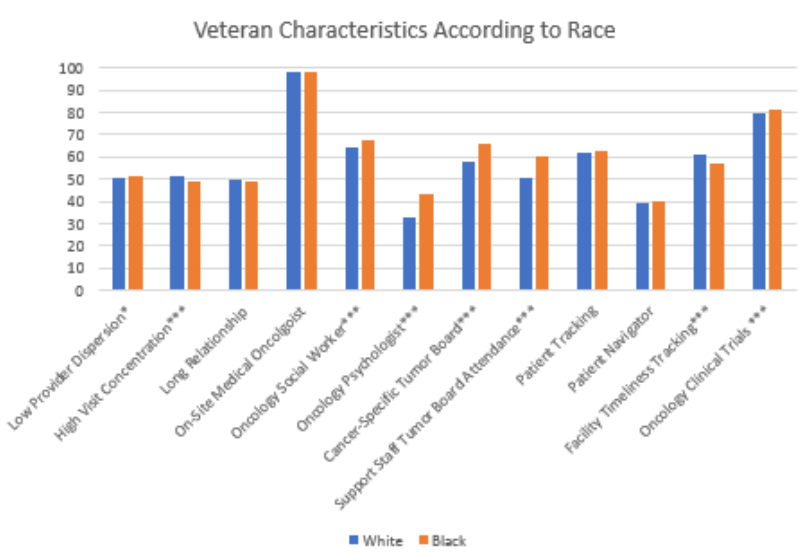
Understanding differential access to cancer treatment resources may help reduce cancer treatment disparities in rural populations and racial minorities. Rural veterans may be particularly susceptible to receiving care in under-resourced facilities, and the centralization of resources in urban areas may unintentionally result in an increased access burden overall, as well as increased receipt of lower quality care in lower-resourced facilities. Interventions directing VA patients to receive care outside of the VA and in their communities may not effectively reduce disparities in treatment since rural hospitals tend to be under-resourced. Therefore, the VA should evaluate resource distribution across the health care system and consider bolstering VA rural cancer providers' efforts with additional resources, such as offering virtual tumor boards, placing navigators in rural areas, and ensuring that support staff such as cancer social workers and psychologists are available and accessible, potentially through teleconferencing[23].

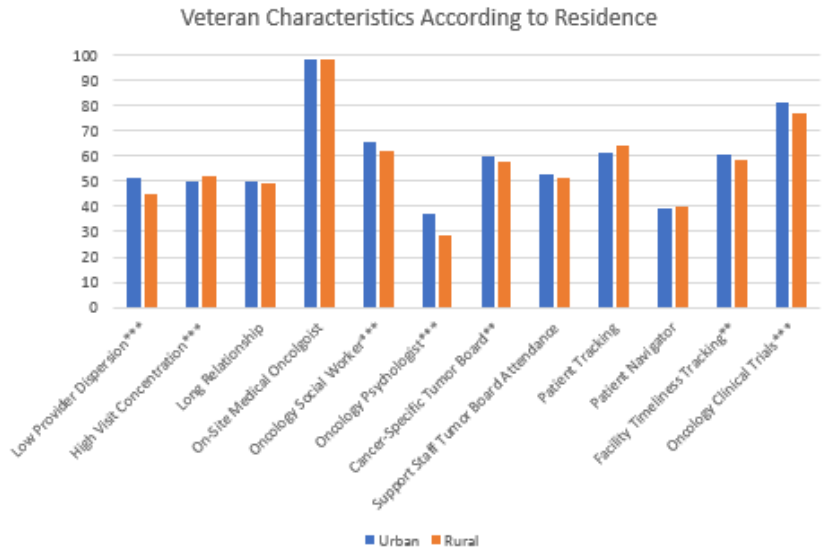
Table 2. Patient Characteristics According to Veteran Race and Residence

	Race No (%)			Residence No (%)		
Characteristics	White	Black	p-value	Urban	Rural	p-value
Number of Patients	19,059	4,136		17,089	6,016	
Race						
White				13,460 (78.8%)	5,599 (91.7%)	<0.001
Black				3,629 (21.2%)	507 (8.3%)	
Rurality						
Urban	13,460 (70.6%)	3,629 (87.7%)	<0.001			
Rural	5,599 (29.4%)	507 (12.3%)				
Age at Diagnosis Mean(SD)	68.15 (9.2)	65.55 (9.9)	<0.001	67.51 (9.5)	68.19 (8.9)	<0.001
Age Category						
<40	26 (0.1%)	5 (0.1%)	<0.001	26 (0.2%)	5 (0.1%)	<0.001
40 – 64	7,365 (38.6%)	2,099 (50.8%)		7,112 (41.6%)	2,352 (38.5%)	
65-79	9,183 (48.2%)	1,609 (38.9%)		7,830 (45.8%)	2962 (48.5%)	
>79	2,485 (13.0%)	423 (10.2%)		2,121 (12.4%)	787 (12.9%)	
Sex						
Male	18,578 (97.5%)	4,011 (97.0%)	0.068	16,613 (97.2%)	5,976 (97.9%)	0.006
Copayment Status						
No Copay – Service Connected Disability	15,145 (79.5%)	3,479 (84.1%)	<0.001	13,723 (80.3%)	4,901 (80.3%)	0.002
No Copay – Low Income	1,016 (5.3%)	230 (5.6%)		871(5.1%)	375 (6.1%)	
Copay	2,869 (15.1%)	419 (10.1%)		2,473 (14.5%)	815 (13.4%)	
Missing	29 (0.2%)	8 (0.2%)		22 (0.1%)	15 (0.3%)	
Marital Status						
Married	8,971 (47.1%)	1,437 (34.7%)	<0.001	7,267 (42.5%)	3,151 (51.4%)	<0.001
Widowed or Divorced	8,415 (44.2%)	2,039 (49.3%)		7,928 (46.4%)	2,526 (41.4%)	
Never Married	1,578 (8.3%)	637 (15.4%)		1,800 (10.5%)	415 (6.8%)	
Missing	95 (0.5%)	23 (0.6%)		94 (0.6%)	24 (0.4%)	
History of Cancer						
Yes	1,355 (7.1%)	360 (8.7%)	<0.001	1,257 (7.4%)	458 (7.5%)	0.71

	Race No (%)			Residence No (%)		
Characteristics	White	Black	p-value	Urban	Rural	p-value
Number of Patients	19,059	4,136		17,089	6,016	
Distance Traveled to Treating Hospital – Mean (SD)	68.83 (123.7)	39.13 (90.4)	<0.001	50.05 (117.4)	101.66 (114.7)	<0.001
Distance Traveled Category						
<10.8 miles	3,305 (17.3%)	1,741 (42.1%)	<0.001	4,918 (28.8%)	128 (2.1%)	<0.001
10.8 – 32.4 miles	4,241 (22.3%)	784 (19.0%)		4,594 (26.9%)	431 (7.1%)	
32.5 – 75.9 miles	4,399 (23.1%)	606 (14.7%)		2,938 (17.2%)	2,067 (33.9%)	
>75.9 miles	4,524 (23.7%)	518 (12.5%)		2,446 (14.3%)	2,596 (42.5%)	
Missing	2,590 (13.6%)	487 (11.8%)		2,193 (12.8%)	884 (14.5%)	
NOSOS mean(sd)	3.88 (4.1)	4.31 (4.3)	<0.001	4.06 (4.2)	3.65 (3.9)	<0.001
NOSOS Category						
≤ 1	4,848 (25.4%)	858 (20.7%)	<0.001	4,009 (23.5%)	1,697 (27.8%)	<0.001
1.1 – 2.6	4,749 (24.9%)	995 (24.1%)		4,230 (24.8%)	1,514 (24.8%)	
2.7 – 5.4	4,821 (25.3%)	1,110 (26.8%)		4,431 (25.9%)	1,500 (24.6%)	
>5.4	4,641 (24.4%)	1,173 (28.4%)		4,419 (25.9%)	1,395 (22.9%)	

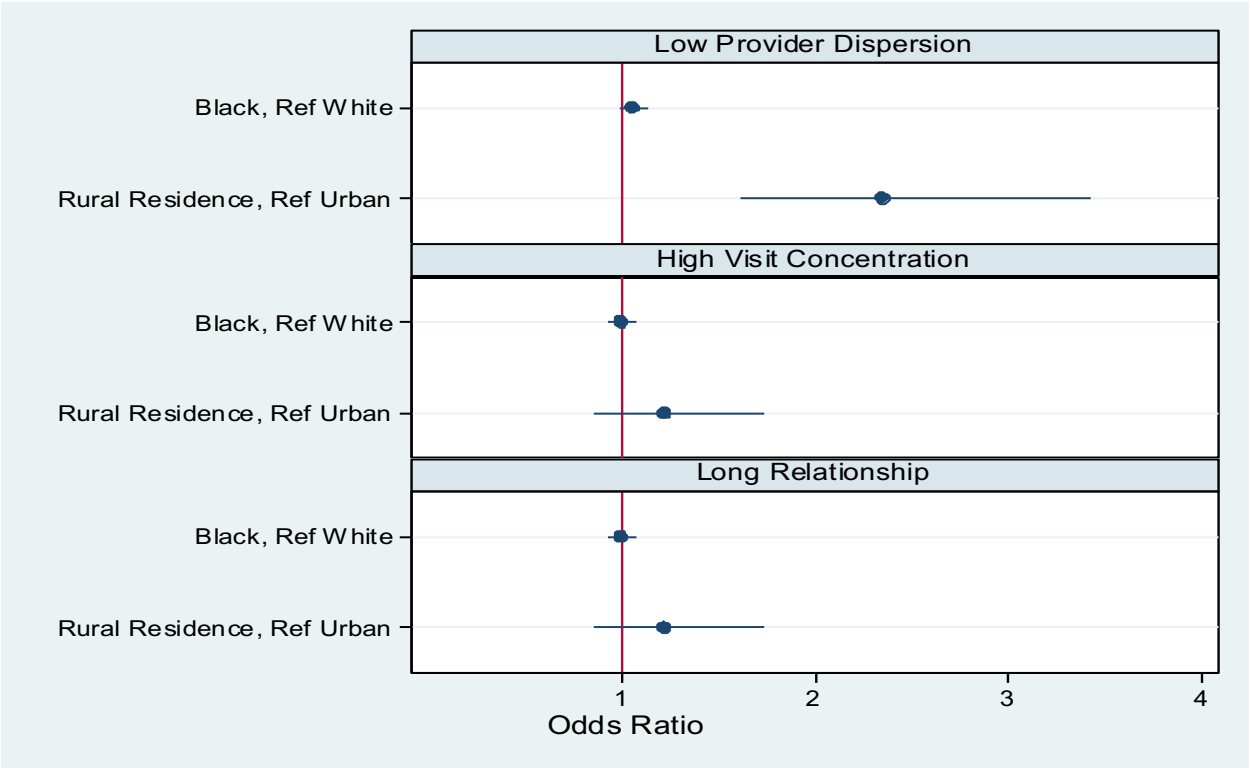
Figure 1. Bivariate Outcome According to Veteran Race and Place of Residence





*p<0.05, ** p<0.01, *** p<0.001
High MMCI = MMCI ≥0.610, High UPC = UPC ≥0.375, Long Relationship = Relationship ≥955 days (2.5 years)
Cancer-specific tumor boards indicate the presence of lung or colorectal cancer-specific tumor boards.
Support staff include: palliative care specialists, social workers, nutritionists and cancer registrars.

Figure 2. Adjusted Associations between Race/Residence and Continuity of Care



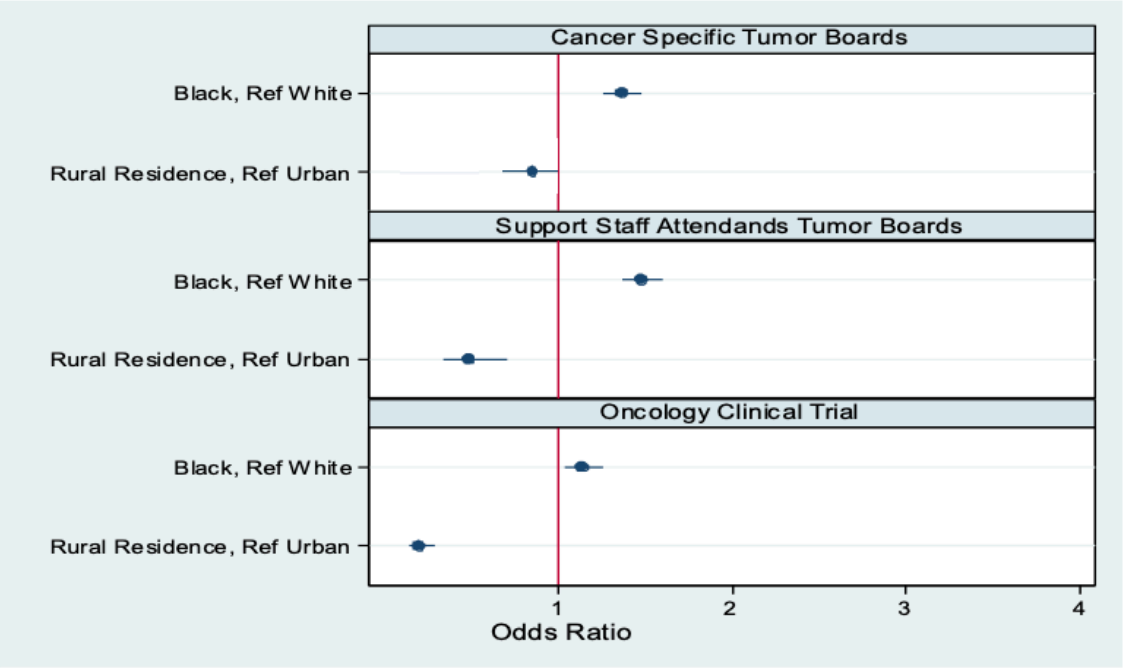
Odds adjusted for age at diagnosis, sex, copayment status, NOSOS risk score, marital status at diagnosis, distance traveled to receive treatment, and previous cancer diagnoses

Low Provider Dispersion=MMCI ≥0.610, High Visit Concentration=UPC ≥0.375, Long Relationship=Relationship ≥955 days (2.5 years)

Figure 3. Adjusted Associations between Race/Residence and Oncology Staffing Resources

Odds adjusted for age at diagnosis, sex, copayment status, NOSOS risk score, marital status at diagnosis, distance traveled to receive treatment, and previous cancer diagnoses

Figure 4. Adjusted Associations between Race/Residence and Tumor Board and Oncology Clinical Trial Resources

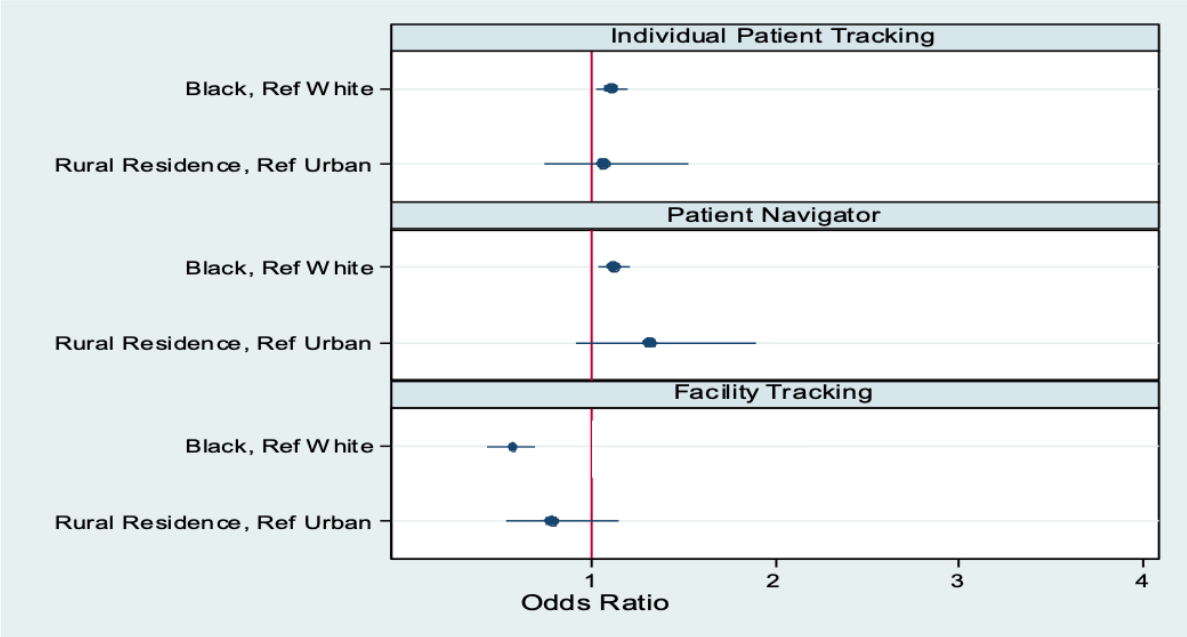


Odds adjusted for age at diagnosis, sex, copayment status, NOSOS risk score, marital status at diagnosis, distance traveled to receive treatment, and previous cancer diagnoses

Cancer-specific tumor boards indicate the presence of lung or colorectal cancer-specific tumor boards

Support staff include: palliative care specialists, social workers, nutritionists and cancer registrars.

Figure 5. Adjusted Associations between Race/Residence and Hospital Patient Tracking Resources



Odds adjusted for age at diagnosis, sex, copayment status, NOSOS risk score, marital status at diagnosis, distance traveled to receive treatment, and previous cancer diagnoses

CHAPTER 5: THE ASSOCIATION OF HOSPITAL AND PATIENT CHARACTERISTICS WITH TIMELY TREATMENT AMONG VETERANS WITH STAGE I, II, OR III LUNG, COLON, OR RECTAL CANCER

Overview

Background: As the largest integrated healthcare system and the largest provider of cancer care in the United States, the Department of Veterans Affairs Health Care System (VA) is uniquely suited to evaluate how different hospital features affect racial disparities in the timeliness of cancer care amongst white and black veterans. The objectives of this study are to examine how oncology-specific resources and continuity of care at VA hospitals modify the effects of black race in the timeliness of lung, colon and rectal cancer treatment among veterans with stage I, II, or III cancer.

Methods: The VA's Epidemiology of Cancer database was used to identify veterans diagnosed with stage I, II, or III colon, rectal, or lung cancer between 2009 and 2014. Using a multivariate logistic regression, we assessed whether self-reported patient race was associated with receipt of cancer treatment (first evidence of surgical resection, chemotherapy, radiation therapy) within 10 weeks of diagnosis.

Results: Eighteen percent of our sample were black. Black veterans had a higher stage at diagnosis *(P<0.001),* were younger *(P<0.001)* and more likely to live in urban areas *(P<0.001)*. Receiving cancer treatment at a VA hospital with a hospital-wide mechanism to track the guideline concordance and timeliness of cancer care attenuated racial disparities in timely treatment, increasing black veterans' probability of

receiving timely treatment by 4 percentage points. (average marginal effect: 0.04; 95% confidence interval: 0.01,0.07).

Conclusions: Our results suggest that although the development and implementation of hospital-wide tracking systems may be complex and require extensive resources, they could facilitate targeted reductions in cancer disparities.

Background

Despite the development of clinical practice guidelines, black patients commonly experience cancer treatment delays[3]. Cancer treatment delay has been associated with negative health outcomes such as decreased survival time[3], increased risk of upstaging and disease progression[3], and negative psychosocial effects such as patient anxiety[1]. The sources of racial disparities in treatment complex. Sources of racial disparities in cancer treatment such as patient factors[25] (e.g. cancer stage and sociodemographic factors such as gender, age, employment status and marital status) and hospital-level factors[26] (e.g. hospital volume and hospital teaching status) are well studied. However, after controlling for these factors, racial disparities in treatment quality remain, suggesting that other patient- and hospital-level factors could influence disparities in cancer treatment.

Hospital-level factors associated with high-quality cancer care may also reduce cancer treatment disparities. These factors include oncology-specific resources such as 1) access to oncology-specific support staff (e.g. social workers and psychologists with specialized training in oncology); 2) tumor boards that share patient information, integrating multidisciplinary clinical and social information to inform treatment plans and manage cancer care; 3) access to oncology clinical trials, the gold-standard for top of the line cancer treatment; and 4) a system to measure the quality of care provided to

patients using hospital-level data; and 5) continuity of care between the patient and a primary care provider (PCP). These factors are important for cancer care quality[101]; however there is a gap in our knowledge about their effect on cancer treatment disparities.

As the largest integrated health care system in the US, the largest integrated provider of cancer care in the US[20], and an equal access health care system the Veteran's Health Administration Health Care System (VA) is an ideal setting to investigate whether oncology-specific resources and continuous patient-PCP relationships are associated with cancer treatment disparities. As an equal access system, financial barriers to care at the VA are reduced because veterans do not pay health insurance premiums. All eligible veterans can access primary care and specialty care, such as cancer treatment, at the VA, sometimes at a reduced cost[20,30]. The veteran's out-of-pocket health care costs are largely based on their previous year's income and their service-connected disability status[17]. A service-connected disability is a disease or injury that started or became aggravated while the veteran was on active duty.

As all eligible veterans can receive care at the VA, black and white veterans have equal access to cancer treatment at VA. Despite equal access to cancer treatment at VA racial disparities remain. The hospital and continuity of care factors evaluated in this study may reduce disparities by *reducing provider uncertainty and increasing consistency in the clinical encounter.* Uncertainty arises from three sources: 1) ambiguity about the diagnostic implications of clinical factors; 2) incomplete information about the efficacy of diagnostic and treatment interventions; and 3) ambiguity about how

to value potential clinical outcomes[105]. Together the uncertainty providers face and the autonomy they practice result in providers having clinical discretion, which can be shaped by subjective influences including prejudice and stereotypes that could cause racial disparities in treatment[105].

Hospital-level factors could reduce provider uncertainty and reduce racial disparities in three ways: 1) ensuring providers have more access to information about treatment efficacy across races; 2) exposing providers to a wider variety of cases; and 3) providing an opportunity for multiple providers to interact on a case, reducing opportunities for subjective influences. This could result in increasing providers' ability to react quickly and decisively when making treatment recommendations, reducing treatment delays.

Continuity of care may reduce racial disparities by improving the patient-provider relationship. Continuity of care is associated with trust, mutual understanding between patient and provider and a sense of responsibility toward the patient[142]. Strong patient-provider relationships are likely to improve communication about patient treatment preferences and reduce provider uncertainty in clinical encounters with black patients. Improved communication about patient treatment preferences, symptoms, and concerns results in increased trust regarding the treatment recommendations, reducing cancer treatment delays.

The objectives of this study are to examine how oncology-specific resources and continuity of care at VA hospitals modify the effects of black race in the timeliness of lung, colon and rectal cancer treatment among veterans with stage I, II, or III cancer. Although there are currently 140 hospitals with cancer diagnosis and treatment

capabilities in the VA, there is variability in resource allocation. We hypothesized that 1) receiving treatment at a VA hospital that has oncology-specific resources that are associated with high-quality care and 2) having an established, continuous relationship with a primary care provider reduce racial disparities in the time to treatment initiation.

Methods

Data

We used Epidemiology of Cancer in veterans (EpiCAN) data linked with data from the VA Corporate Data Warehouse (CDW) and the 2009 VA Oncology Facilities Survey, accessed through the veterans Affairs Informatics Computing Infrastructure[106]. EpiCAN data originate from the VA Central Cancer Registry (VACCR), the VA CDW, and Medicare. The CDW compiles information from the patient's electronic health record including their labs, ICD9 codes, procedures and treatments[18]. The VACCR is a database of cancer cases diagnosed within the VA since 1995[33]. The VACCR contains information about 3% of U.S. cancer cases diagnosed in the United States[33]. It contains patient demographics and information about the patient's cancer care including their tumor characteristics[12]. CDW compiles information from the patient's electronic health record including their labs, ICD9 codes, procedures and treatments. The 2009 VA Oncology Services Survey was a web-based survey of VA Oncology Facilities, administered by the VA Healthcare Analysis and Information Group and distributed to facility Chiefs of Staff. One Chief of Staff, or proxy, from each of the 140 VA hospitals with cancer diagnosis and treatment capabilities completed the survey resulting in a 100% response rate. Together, these data represent all cancer diagnoses in the VA and veteran VA health care utilization.

Study Population

The study population was limited to veterans diagnosed with incident stage I, II, or III colon or rectal adenocarcinoma or non-small cell lung cancer from January 1, 2009 to December 31, 2014 (Appendix 8). Only black and white veterans who received their first course of treatment (first evidence of surgical resection, chemotherapy, or radiation therapy) at the VA were included for analysis. Veterans who had a different cancer diagnosis within 6 months of the primary cancer diagnosis were excluded from analysis (N=6,587). We excluded patients with stage IV disease or without a documented stage (N=31,381) or who did not have colon or rectal adenocarcinoma or non-small cell lung cancer (N=3,918). We excluded veterans with evidence of treatment before the date of diagnosis (N=15). We also excluded patients who did not self-identify as male or female (N=10), did not self-identify as black or white race (N=726), who did not live at least 31 days after diagnosis (N=649), without a reliable zip code (N=31), and who were not a veteran (N=120). Finally, we also excluded veterans whose first course of cancer treatment (i.e., first evidence of surgical resection, chemotherapy, or radiation therapy) was not at a VA hospital according to the VA's EpiCAN database and the VACCR (N= 10,727). The National Cancer Institute's Surveillance, Epidemiology and End Results Program site codes, histology codes, procedural codes, and billing codes used to identify the sample are presented in Appendix 2.

Outcomes

The outcome of interest is a binary indicator of timely treatment, defined as whether treatment was initiated within 10 weeks of diagnosis. Treatment delay has been associated with mental health issues, less quality of life, and excess health care utilization[109]. Based upon clinical input from oncology specialists treating colon, rectal

and lung cancers, we selected 10 weeks to allow for patients to seek counsel on their treatment options, seek a second opinion, or prepare for the toll treatment will take on their daily lives. Importantly, there are no current federal guidelines specifying a particular time window for timely cancer care. We assessed date of cancer diagnosis, based on a confirmed pathology report, and date of first course of treatment using EpiCAN and the VACCR.

Key Explanatory Variables

Key explanatory variables included interaction terms constructed of self-reported patient race, assessed from EpiCAN, and hospital and continuity of care factors hypothesized to reduce racial disparities in timely cancer treatment.

Key Hospital-level Factors

Key hospital-level factors, predicted to reduce treatment disparities, were assessed from the 2009 VA Oncology Facilities Survey. We included binary measures indicating access to social workers and psychologists with cancer-specific training. We included a categorical measure of whether the treating hospital had colorectal or lung cancer-specific tumor boards and whether support staff, including palliative care specialists, social workers, nutritionists, or cancer registrars, regularly attended the cancer-specific tumor boards, (0: no cancer-specific tumor board, 1: cancer-specific tumor board without regular specialist attendance, 2: cancer-specific tumor board with regular specialist attendance). We also included an indicator for whether the treating hospital had a measurement system that tracked their adherence to guideline-based cancer care or overall timeliness of care. Lastly, we evaluated whether an oncology-related clinical trial was available at the treating hospital between 2006 and 2009.

Continuity of Care

Continuity of care measures were constructed using data from the patient's electronic health record (EHR). We included interactions of race and continuity of care with a PCP using two, longitudinally measured continuity of care outcomes[21], where greater continuity was expected to be positively associated with more timely treatment and generally defined as having more visits with the same provider, relative to other providers. First, we measured provider dispersion, the number of PCPs the patient consulted, using the Modified-Modified Continuity Index (MMCI)[21]. MMCI ranges from 0 (each visit with a different PCP) to 1 (all visits made with a single PCP).

$$MMCI = \frac{1 - \frac{\#\ of\ PCPs}{[\#\ of\ primary\ care\ visits + 0.1]}}{1 - \frac{1}{[\#\ primary\ care\ visits + 0.1]}}$$

Second, we measured visit concentration, the proportion of visits with the PCP identified as the modal provider, over all PCP visits, using the Usual Provider of Care Continuity (UPC)[21]. UPC ranges from 0 (no visits with a regular PCP) to 1 (all visits with a PCP).

$$UPC = \frac{\#\ of\ visits\ with\ \ PCP}{[\#\ of\ primary\ care\ visits]}$$

We calculated MMCI and UPC using all primary care visits in the two years prior to diagnosis. A higher MMCI and UPC score indicates greater continuity of care. We dichotomized these measures at the median value for the population to indicate high versus low continuity of care. A MMCI score ≥0.610 represented low provider dispersion (0 = high provider dispersion, 1 = low provider dispersion) and a UPC score ≥0.375 represented high visit concentration (0 = low visit concentration, 1 = high visit concentration).

Covariates

Patient- and disease-characteristics associated with the timely receipt of cancer treatment were also assessed. Covariates obtained from EpiCAN and the CDW included: cancer type (lung, colon, rectal); type of treatment (surgery, chemotherapy, radiation, chemoradiation); age at diagnosis (≤64, 65-79, >79), sex (male, female); marital status at diagnosis (married, single, widowed or divorced, missing); straight-line distance between the centroid of the patient's zip code to the centroid of the treating hospital's zip code, in miles (<10.8 miles, 10.8 – 32.4 miles, 32.5-75.9 miles, >75.9 miles, missing), Nosos risk score measuring the veteran's expected health care utilization[118] (≤ 1, 1.1 – 2.6, 2.7-5.4, >5.4); rurality (urban, rural) based on patient's residential zip code, obtained from the CDW, and assessed using United State Department of Agriculture's Rural Urban Commuting Area code zip code approximations[112]; and prior history of cancer (no, yes). We also controlled for VA copayment status, a proxy for inadequate income and/or disability which may reflect vulnerability and influence a veteran's decision to use VA care[17], determined by the veteran's service-connected injuries and disabilities and socioeconomic status (no copay due to service-connected disability, no copay due to low income status, copay required, missing). We were unable to assess distance to care for veterans living in Puerto Rico or on Native American reservations, therefore they were categorized as "missing". Except where otherwise specified, categorical variables were categorized by quartile. Age was categorized as in previous literature[126]. All variables, definitions, and values are presented in Appendix 9.

Statistical Analysis

First, we described our cancer patient cohorts, using chi-square or t-tests for categorical or continuous variables, respectively, to assess bivariate differences in covariates and outcomes, stratified by race (alpha = 0.05). We also compared unadjusted Kaplan-Meier survival curves stratified by black race, using a log-rank test of equality to evaluate differences in the time between diagnosis and treatment.

We used a multivariate logistic regression, including interactions of race and hospital-level factors, and race and continuity of care, to estimate adjusted odds ratios (AOR) and 95% Confidence Intervals (CI) to assess the association of race and the patient and hospital-level factors associated with receiving timely treatment. Average marginal effects and predicted probabilities are measures of the likelihood or probability that the outcome (e.g. that the veteran received timely treatment) occurs. Average marginal effects are interpreted as the effect of a change in the covariate on the probability that the veteran received timely treatment. Predicted probabilities are interpreted as the probability that a veteran with a specific set of characteristics received timely treatment. Akaike's information criterion suggested that the interacted model best fit the data relative to naïve models without interactions and fully interacted models where race was interacted with each variable of interest and covariate.

This study was approved by the Durham VAMC Institutional Review Board (IRB) and the University of North Carolina at Chapel Hill IRB. All data analyses and management were conducted using Stata version 15.1 (StataCorp LP, College Station, TX, USA) and SAS version 9.4 (SAS Institute Inc, Cary, NC, USA) software.

Results

The final sample included 20,430 veterans (Table 3). In the full sample and across cancer types, compared to white veterans, black veterans were significantly younger (*P<0.001*), more likely to live in an urban area (*P<0.001*), and travelled a shorter distance to receive cancer treatment (*P<0.001*). Black veterans also had a higher stage at diagnosis (*P<0.001*) and a higher Nosos risk score (*P<0.001*), reflecting a higher risk of rehospitalization. The results of the log-rank test of equality suggest statistically significant differences in survival probabilities of time to treatment, in days, between black and white veterans (Figure 6). On average, white veterans initiated treatment within 49.4 days (sd: 44.5) days and black veterans initiated treatment within 53.59 days (sd: 50.9).

Receiving treatment at a hospital with a cancer-specific tumor board was negatively associated with timely treatment for black veterans (vs. white veterans, AME: -0.12; 95%CI: -0.20,-0.05). Receiving treatment at a hospital where support staff attended the cancer-specific tumor boards was also negatively associated with timely treatment for black veterans (AME: -0.05; 95%CI: -0.09,0.02). In contrast, receiving treatment at a hospital with patient tracking was positively associated with treatment for black veterans (AME: 0.04; 95%CI: 0.01,0.07). (Table 4).

None of the continuity of care variables were associated with racial disparities in the receipt of timely cancer treatment.

Predicted Probabilities

Predicted probabilities (the probability that a veteran with a specific set of characteristics received timely treatment) were calculated by changing the values of the covariates of interest, allowing the other variables to maintain their values, using the

method of recycled predictions. Overall, allowing all veterans to maintain their original characteristics, this model suggests that white veterans would have a 77% predicted probability of receiving timely treatment and black veterans would have a 73% predicted probability of receiving timely treatment. Should white veterans receive treatment in hospitals without tracking, they would have a 78% predicted probability of receiving timely treatment, compared to 71% for black veterans. Should white veterans receive treatment in hospitals with tracking, they would have a 77% predicted probability of receiving treatment, compared to 74% for black veterans. Overall, predicted probabilities suggest that receiving treatment at a hospital without a cancer-specific tumor board or receiving treatment at a hospital with tracking attenuate racial disparities in care (Figure 7, Figure 8).

Conclusion

We examined the influence of cancer-specific resources at the treating hospital and continuity of care on racial disparities in the timeliness of cancer treatment amongst veterans who received cancer treatment at the VA. Within the VA, evidence of racial disparities in cancer treatment are mixed. Consistent with Zullig and colleagues' findings amongst veterans with stage 3 and 4 lung cancer across the VA, the veterans in our sample showed a small, statistically significant racial difference in cancer treatment initiation. In our sample, on average, white veterans initiated treatment 4 days earlier than black veterans—a difference that may be interpreted by many as clinically insignificant. Amongst the 2,200 veterans included for analysis in the Zullig study, white veterans presented at a higher stage at diagnosis than black veterans (89% and 87%, respectively). Contrasting these findings, in a 2010 study of 214 veterans at one VA hospital, Robinson and colleagues[53] found there were no racial differences in the time

from diagnosis to elective colon resection. Consistent with our study, white veterans in this study presented at a lower stage at diagnosis than black veterans (17% and 24% presented with more distant disease, respectively). Our research differs from these studies because we evaluate the relationships between hospital-level factors and provider continuity in racial disparities in timely treatment.

We found that overall, hospital-level tracking mechanisms may play an important role in reducing disparities in the timeliness of cancer treatment. The VA has a robust EHR and cancer registry. Both systematically collect patient demographic information, including race and cancer diagnosis and treatment data. Data standardization is key to being able to identify, monitor, and develop interventions to reduce cancer disparities. While data from the VA's EHR has proven accurate when abstracted for non-race demographic data and clinical data such as treatment receipt, these data are commonly used for retrospective analyses[143]. The Institutes of Medicine recognizes the importance of tracking for reducing disparities: you must able to identify and measure disparities before implementing interventions to address them. Prospective tracking mechanisms will also allow for the monitoring of the impact of these intervention activities[107]. Hospital-wide tracking systems may be useful for quality measurement and improvement[107], and for reducing cancer disparities in real-time.

Veterans may benefit from receiving cancer treatment at facilities that track their overall guideline concordance or timeliness of cancer care. The implementation of a tracking system that tracks the hospital's guideline concordance or timeliness from diagnoses through survivorship remains variable. The development and implementation of such systems may be complex and require resources including

collaborations between researchers and operations personnel[107], but could facilitate targeted reductions in cancer disparities. The VA implemented tracking and monitoring programs. One such program, the lung cancer screening program, began as a demonstration project across 8 VA hospitals with an academic medical center affiliation who volunteered for participation[137]. During demonstration, between July 1, 2013 and June 30, 2015, 93,033 primary care patients were assessed, and 2,106 veterans received lung cancer screening[137]. Another program, the lung nodule tracking program, piloted in eight VA hospitals, resulted in a decrease of tracking failure after implementation (74% prior to implementation, 10% post implementation *(P<0.001)*[144]. The implementation of programs like these can be challenging and resource intensive and require careful consideration before becoming part of official guidance for VA facilities[137].

The data also suggest an association between cancer-specific tumor boards and racial disparities in treatment timeliness. These results contrast with findings from a 2013 study of VA tumor boards by Keating and colleagues[134] that suggested that tumor boards have no effect on the quality of cancer treatment or survival. We extended the previous authors' work by finding an association with additional time to treatment for black veterans. We also found that cancer-specific tumor boards that include support staff are associated with racial disparities in cancer treatment timeliness. Of note, in this study, we assessed the whether there was a cancer-specific tumor board present at the treating hospital, we did not assess the use of these tumor boards. Tumor board use is variable, ranging from discussion and presentation of the most challenging cases to discussion and presentation of every case. It is likely that tumor board presence is a

proxy for something not observed in this dataset such as facility or patient complexity. The black veterans in our sample had a higher stage at diagnosis, a higher Nosos risk score, and were more likely to be have a service-connected disability, suggesting that they may be more ill. We lacked data on functional status and overall health that may provide more information about this association.

Our results did not show an association between cancer support staff (social workers and psychologists with specialized training in oncology), available oncology clinical trials, or continuity of care and racial disparities in timely cancer treatment. This may reflect that these hospital services may not be utilized in the time between diagnosis of cancer and treatment, if at all. These resources and continuity of care may be more relevant for other cancer care quality metrics such mental health outcomes and the management of chronic conditions throughout the cancer care spectrum.

This study has several limitations. First, this study was a retrospective analysis of clinical and administrative data, therefore, we were only able to assess associations that do not imply causation. Additionally, the Oncology Facilities Survey was self-reported and the questions were open to individual interpretation, however respondents were not incentivized to answer questions in any particular way. Second, timeliness of care is a VA priority; however, it is only one measure of quality of cancer care. Therefore, this study should be replicated across different quality of care outcomes, particularly the receipt of guideline-recommended treatment and surgical resection. Many VA studies have established that black veterans are less likely to receiving curative-intent surgery, even when there are equal recommendation rates[50]. Third, while we assessed whether these resources were available, we could not assess

whether they were utilized. Implementation and utilization may be variable. Finally, these results should be contextualized, as the data included for analysis predates both the 2018 VA Maintaining Systems and Strengthening Integrated Outside Networks Act (Mission Act)[133] and the 2014 Veterans Access, Choice, and Accountability Act (Choice Act)[145] which address wait time for VA appointments, quality of VA care and the distance veterans must travel to receive health care.

The results of our study suggest that there is an association between some oncology-specific resources within VA hospitals and disparities in timeliness of cancer treatment. This suggests that even within equal access systems, the hospital where a patient receives their care could have implications for the quality of care they receive. While the VA operates as one integrated health care system, each veterans Integrated Services Network (VISN), the 18 geographic areas through which VA healthcare is organized, and hospital has the autonomy to make operating and clinical decisions that best serve their patient populations. Administrators should carefully weigh the potential impact of hospital resources associated with cancer care on the various segments of patient populations they serve. Policy makers should consider increased oversight on how operating and clinical decisions effecting cancer care, including the distribution of resources associated with improved quality outcomes, such as tracking systems, affects underserved veterans. Future research should evaluate how the implementation and patient-specific utilization of tracking mechanisms are implemented and how they may be related to the care received by underserved veterans.

Table 3. Patient Characteristics According to Veteran Race

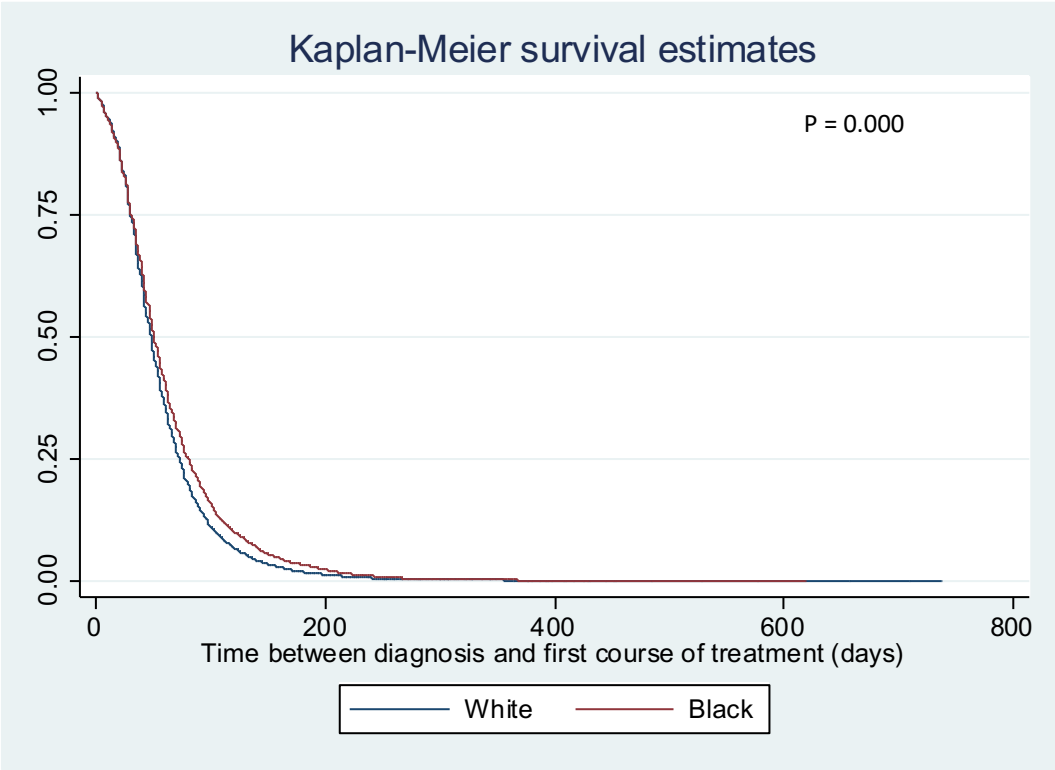
	Race No (%)		
Characteristics	White	Black	p-value
Number of Patients	16,754	3,676	
Urban	11,897 (71.0%)	3,246 (88.3%)	<0.001
Rural	4,857 (29.0%)	430 (11.7%)	
Age at Diagnosis mean(sd)	67.5 (8.9)	64.9 (9.6)	<0.001
< 64	6835 (40.8%)	1951 (53.1%)	<0.001
65-79	8,090 (48.3%)	1,412 (38.4%)	
>79	1,829 (10.9%)	313 (8.5%)	
Sex			
Male	16,323 (97.4%)	3,566 (97.0%)	0.15
Female	431 (2.6%)	110 (3.0%)	
Copay Status			
No Copay – Service Connected Disability	13,248 (79.1%)	3,085 (83.9%)	<0.001
No Copay – Low Income	901 (5.4%)	210 (5.7%)	
Copay	2,582 (15.4%)	375 (10.2%)	
Missing	23 (0.1%)	6 (0.2%)	
Marital Status			
Married	8,034 (48.0%)	1,307 (35.6%)	<0.001
Widowed or Divorced	7,251 (43.3%)	1,785 (48.6%)	
Single	1,387 (8.3%)	565 (15.4%)	
Missing	82 (0.5%)	19 (0.5%)	
History of Cancer			
Yes	1,205 (7.2%)	310 (8.4%)	0.009
No	15,549 (92.8%)	3,366 (91.6%)	
Distance Traveled to Treating Hospital – Mean (SD)	68.8 (123.7)	39.1 (90.4)	<0.001
<10.8 miles	3,305 (19.7%)	1,741 (47.4%)	<0.001
10.8 – 32.4 miles	4,241 (25.3%)	784 (21.3%)	
32.5 – 75.9 miles	4,399 (26.3%)	606 (16.5%)	

	Race No (%)		
Characteristics	White	Black	p-value
Number of Patients	16,754	3,676	
>75.9 miles	4,524 (27.0%)	518 (14.1%)	
Missing	285 (1,7%)	27 (0.7%)	
NOSOS mean(sd)	3.9 (4.1)	4.3 (4.2)	<0.001
≤ 1	4,158 (24.8%)	750 (20.4%)	<0.001
1.1 – 2.6	4,121 (24.6%)	882 (24.0%)	
2.7 – 5.4	4,315 (25.8%)	1,015 (27.6%)	
>5.4	4,160 (24.8%)	1,029 (28.0%)	
Stage at Diagnosis			
1	6,633 (39.6%)	1,391 (37.8%)	<0.001
2	4,198 (25.1%)	816 (22.2%)	
3	5,923 (35.4%)	1,469 (40.0%)	
Treatment Type			
Surgical Resection	11,523 (68.8%)	2,409 (65.5%)	<0.001
Chemotherapy	3,187 (19.0%)	704 (19.2%)	
Radiation Therapy	1,981 (11.8%)	549 (14.9%)	
Chemoradiation	63 (0.4%)	14 (0.4%)	
Cancer-Specific Resources			
Cancer Social Worker	10,728 (64.0%)	2490 (67.7%)	<0.001
Cancer Psychologist	5,474 (32.7%)	1604 (43.6%)	<0.001
No Cancer-Specific Tumor Board	7,023 (41.9%)	1,249 (34.0%)	
Cancer-Specific Tumor Board	1,237 (7.4%)	214 (5.82%)	<0.001
Specialist Attends Cancer-Specific Tumor board	8,494 (50.7%)	2,213 (60.2%)	<0.001
Timeliness Tracking	10245 (61.1%)	2087 (56.8%)	<0.001
Research	13324 (79.5%)	3001 (81.6%)	0.004
Continuity of Care			
High UPC	8596 (51.3%)	1809 (49.2%)	0.021
Low MMCI	8473 (50.6%)	1785 (48.6%)	0.027
Outcomes			
Time to Treatment (Days) mean (sd)	49.4 (44.5)	53.59 (50.9)	<0.001

	Race No (%)		
Characteristics	White	Black	p-value
Number of Patients	16,754	3,676	
Received treatment within 10 weeks	12,963 (77.4%)	2,699 (73.4)	<0.001

Oncology specific tumor boards indicate the presence of lung or colorectal cancer-specific tumor boards.
Support staff include: palliative care specialists, social workers, nutritionists and cancer registrars.

Figure 6. Kaplan Meier Curve: Time to Treatment by Race



First course of treatment indicates first evidence of surgery, chemotherapy, radiation therapy, or chemo radiation.
P-value was calculated by the log-rank test of equality.

Table 4. Association Between Race, Hospital and Continuity of Care Measures and Timely Treatment Initiation (Treatment Initiated Within 10 Weeks)

	Model with Interactions on the Hospital and COC Variables AOR [95%CI]	Average Marginal Effect [95%CI]	Differential Marginal Effect White [95%CI]	Differential Marginal Effect Black [95%CI]	Differential Marginal Effect P-value
Black *(ref: White)*	**0.71***	**-0.04*****			
	[0.54,0.95]	[-0.06,0.03]			
Age at Diagnosis mean(sd) *(ref: ≤ 64)*					
65-79	**0.84*****	**-0.03*****	**-0.03*****	**-0.03*****	**0.0008**
	[0.78,0.90]	[-0.04,-0.02]	[-0.04,-0.02]	[-0.04,-0.02]	
>79	**0.71*****	**-.06*****	**-0.06*****	**-0.06*****	**0.0001**
	[0.63,0.80]	[-0.08,-0.04]	[-0.08,-0.04]	[-0.09,-0.04]	
Sex *(ref: male)*					
Female	**1.52*****	**0.06*****	**0.06*****	**0.07*****	**0.0043**
	[1.20,1.92]	[0.03,0.10]	[0.03,0.09]	[0.03,0.11]	
Copay Status (*ref: no copay service connected disability)*					
No Copay – Low Income	0.96	-0.01	-0.01	-0.01	0.5731
	[0.83,1.11]	[-0.03,0.02]	[-0.03,0.02]	[-0.04,0.02]	
Copay	1.09	0.01	0.01	0.01	0.1238
	[0.98,1.20]	[0.00,0.03]	[0.00,0.03]	[0.00,0.03]	
Missing	0.49	-0.14	-0.13	-0.14	0.0111
	[0.23,1.08]	[-0.30,0.03]	[-0.30,0.03]	[-0.32,0.03]	
Marital status *(ref: married)*					
Widowed or Divorced	**0.88*****	**-0.02*****	**-0.02****	**-0.02****	**0.0035**
	[0.82,0.95]	[-0.03,-0.01]	[-0.03,-0.01]	[-0.04,-0.01]	
Single	**0.84****	**-0.03****	**-0.03****	**-0.03****	**0.0089**
	[0.74,0.95]	[-0.05,-0.01]	[-0.05,-0.0]	[-0.05,-0.01]	
Missing	0.72	-0.06	-0.06	-0.06	0.1460
	[0.45,1.15]	[-0.15,0.03]	[-0.14,0.03]	[-0.16,0.03]	

	Model with Interactions on the Hospital and COC Variables AOR [95%CI]	Average Marginal Effect [95%CI]	Differential Marginal Effect White [95%CI]	Differential Marginal Effect Black [95%CI]	Differential Marginal Effect P-value
Rurality (*ref: urban)*					
Rural	**1.09***	**0.01***	**0.01***	**0.02***	0.0571
	[1.00,1.20]	[0.00,0.03]	[0.00,0.03]	[0.00,0.03]	
Distance Traveled to Treating Hospital – Mean (SD) *(ref: <10.8)*					
10.8 – 32.4 miles	0.96	-0.01	-0.01	-0.01	0.4137
	[0.87,1.06]	[-0.02,0.01]	[-0.02,0.01]	[-0.03,0.01]	
32.5 – 75.9 miles	0.97	0.00	0.00	0.00	0.6252
	[0.88,1.08]	[-0.02,0.01]	[-0.02,0.01]	[-0.02,0.01]	
>75.9 miles	**0.82*****	-0.03	**-0.03*****	**-0.04*****	0.0061
	[0.74,0.91]	[-0.05,-0.01]	[-0.05,-0.01]	[-0.06,-0.01]	
Missing	**0.70***	**-0.06***	**-0.06***	**-0.07***	0.0061
	[0.52,0.94]	[-0.12,0.00]	[-0.11,-0.01]	[-0.13,-0.01]	
NOSOS *(ref: ≤ 1)*					
1.1 – 2.6	1.09	0.01	0.01	0.02	0.1145
	[0.99,1.19]	[0.00,0.03]	[0.00,0.03]	[0.00,0.03]	
2.7 – 5.4	**1.27*****	**0.04*****	**0.04*****	**0.04*****	**0.0004**
	[1.15,1.39]	[0.02,0.06]	[0.02,0.05]	[0.03,0.06]	
>5.4	**1.22*****	**0.03*****	**0.03*****	**0.04*****	**0.0012**
	[1.11,1.35]	[0.02,0.05]	[0.02,0.05]	[0.02,0.06]	
Stage at Diagnosis *(ref: 1)*					
2	1.03	0.01	0.01	0.01	0.4876
	[0.94,1.13]	[-0.01,0.02]	[-0.01,0.02]	[-0.01,0.02]	
3	**1.40*****	**0.06*****	**0.05*****	**0.06*****	**0.000**
	[1.28,1.54]	[0.04,0.07]	[0.04,0.07]	[0.04,0.08]	
Treatment Type *(ref: Surgical Resection)*					
Chemotherapy	**0.75*****	**-0.05*****	**-0.05*****	**-0.05*****	**0.0001**
	[0.67,0.83]	[-0.07,-0.03]	[-0.07,-0.03]	[-0.07,-0.03]	

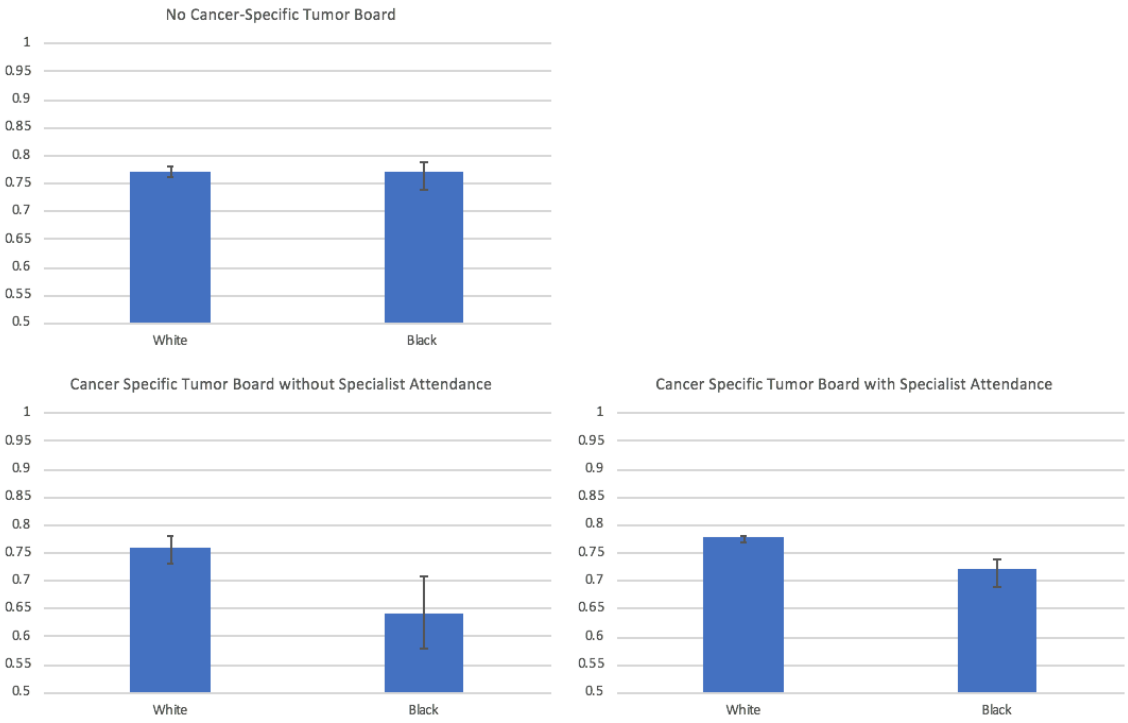
	Model with Interactions on the Hospital and COC Variables AOR [95%CI]	Average Marginal Effect [95%CI]	Differential Marginal Effect White [95%CI]	Differential Marginal Effect Black [95%CI]	Differential Marginal Effect P-value
Radiation Therapy	**0.70*** **	**-0.06*** **	**-0.06*** **	**-0.07*** **	**0.0000**
	[0.63,0.77]	[-0.08,-0.04]	[-0.08,-0.04]	[-0.09,-0.05]	
Chemoradiation	**0.57***	**-0.10***	**-0.10***	**-0.11***	**0.0136**
	[0.35,0.93]	[-0.20,0.00]	[-0.19,0.00]	[-0.21,-0.01]	
Cancer Type *(ref = lung)*					
Colon	**3.42*** **	**0.19*** **	**0.18*** **	**0.21*** **	**0.0000**
	[3.10,3.78]	[0.17,0.20]	[0.17.1.20]	[0.19,0.23]	
Rectal	**1.73*** **	**0.10*** **	**0.10*** **	**0.11*** **	**0.0000**
	[1.54,1.95]	[0.08,0.12]	[0.10,0.13]	[0.09,0.13]	
History of Cancer *(ref: No)*					
Yes	0.99	0.00	0.00	0.00	0.9005
	[0.88,1.12]	[-0.02,0.02]	[-0.02,0.02]	[-0.02,0.02]	
Low Provider Dispersion *(ref: High Provider Dispersion)*					
	1.01	0.00	0.00	-0.01	0.6816
	[0.93,1.09]	[-0.01,0.01]	[-0.01,0.01]	[-0.03,0.02]	
High Visit Concentration *(ref: Low Visit Concentration)*					
	1.02	0.00	0.00	0.00	0.6939
	[0.95,1.11]	[-0.01,0.01]	[-0.01,0.02]	[-0.03,0.03]	
Social Worker					
	1.00	0.00	0.00	0.00	0.8672
	[0.90,1.10]	[-0.02,0.01]	[-0.02,0.02]	[-0.04,0.04]	
Psychologist					
	0.75* **	**-0.04*** **	**-0.05*** **	-0.02	0.2315
	[0.68,0.83]	[-0.06,-0.03]	[-0.06,-0.03]	[-0.06,0.01]	
Cancer-Specific Tumor Board without Support Staff Attendance *(ref: No Cancer-Specific Tumor Board)*					
	0.90	**-0.04** **	-0.02	-0.12**	0.0076
	[0.77,1.05]	[-0.06,-0.01]	[-0.04,0.01]	[-0.20,-0.05]	

	Model with Interactions on the Hospital and COC Variables AOR [95%CI]	Average Marginal Effect [95%CI]	Differential Marginal Effect White [95%CI]	Differential Marginal Effect Black [95%CI]	Differential Marginal Effect P-value
Cancer-Specific Tumor Board with Support Staff Attendance *(ref: No Cancer-Specific Tumor Board)*					
	1.04	-0.00	0.01	**-0.05****	**0.0040**
	[0.94,1.14]	[-0.02,0.01]	[-0.01,0.02]	[-0.09,-0.016]	
Timeliness Tracking					
	1.00	0.01	0.00	**0.04***	**0.0320**
	[0.92,1.08]	[-0.01,0.02]	[-0.01,0.01]	[0.01,0.07]	
Research					
	0.96	0.00	-0.01	0.03	0.0772
	[0.86,1.07]	[-0.02,0.02]	[-0.02,0.01]	[-0.01,0.07]	
Low Provider Dispersion*Black *(ref: High Provider Dispersion * White)*					
	0.96				
	[0.81,1.15]				
High Visit Concentration*Black *(ref: Low Visit Concentration*White)*					
	0.96				
	[0.81,1.15]				
Social Worker * black *(ref: No Social Worker * White)*					
	0.98				
	[0.77,1.25]				
Psychologist * black *(ref: No Psychologist * white)*					
	1.17				
	[0.94,1.44]				
Cancer-Specific Tumor Board without Specialist Attendance * black *(ref: No Cancer-Specific Tumor Board * white)*					
	0.58**				
	[0.39,0.86]				
Cancer-Specific Tumor Board with Specialist Attendance* black *(ref: No Cancer-Specific Tumor Board * white)*					
	0.72**				
	[0.57,0.90]				

	Model with Interactions on the Hospital and COC Variables AOR [95%CI]	Average Marginal Effect [95%CI]	Differential Marginal Effect White [95%CI]	Differential Marginal Effect Black [95%CI]	Differential Marginal Effect P-value
Timeliness Tracking * Black *(ref: No Timeliness Tracking * white)*					
	1.22*				
	[1.01,1.48]				
Research * black (*ref: No Research * black)*					
	1.25				
	[0.98,1.59]				
N	*20,430*				

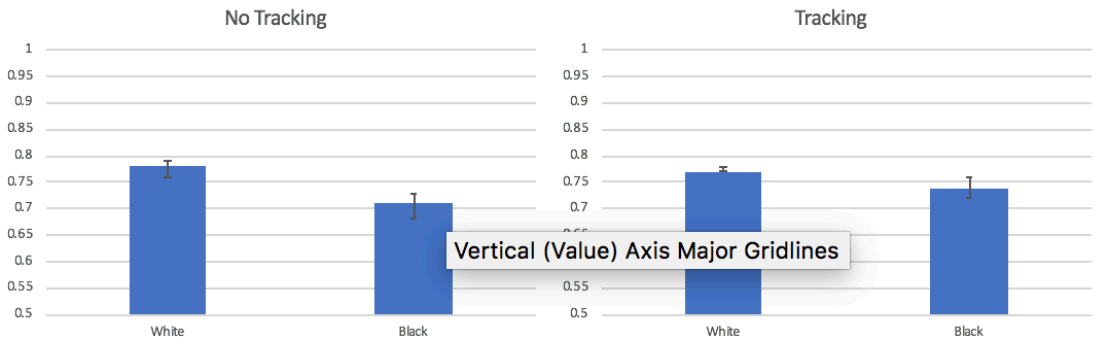
* p<0.05, ** p<0.01, *** p<0.001
Low Dispersion = MMCI ≥0.610 = 1
High Concentration = UPC≥0.375 = 1
Support staff includes palliative care specialists, social workers, nutritionists, or cancer registrars

Figure 7. Predicted Probabilities of Receiving Treatment at Facilities with and without Cancer-Specific Tumor Boards, by Race (with 95% CI)



Predicted probabilities were calculated by changing the values of the covariates of interest, allowing the other variables to maintain their values, using the method of recycled predictions.

Figure 8. Predicted Probabilities of Receiving Treatment at Facilities with and without Timeliness and Guideline Concordance Tracking, by Race (with 95%Ci)



Predicted probabilities were calculated by changing the values of the covariates of interest, allowing the other variables to maintain their values, using the method of recycled predictions.

CHAPTER 6: ASSOCIATION OF RACE AND HOSPITAL CHARACTERISTICS AND CONTINUITY OF CARE WITH TIMELY CANCER TREATMENT: A DECOMPOSITION ANALYSIS

Overview

Background: Racial disparities in timely treatment persist, resulting in poorer health outcomes such as decreased survival time, more rapid disease progression and increased patient anxiety. The sources of this variation have been attributed to patient factors and between- and within- hospital factors; however, little is known about how between- and within-hospital factors may influence the receipt of timely cancer treatment by black and white patients. The objective of this study is to decompose the black-white gap in the receipt of timely cancer treatment to understand whether the race-specific distribution or race-specific effects of hospital-level factors and continuity of care influence this gap.

Methods: The VA's Epidemiology of Cancer among Veterans database was used to identify veterans diagnosed with incident stage I, II, or III colon, rectal, or lung cancer between 2009 and 2014. Using the Oaxaca-Blinder Decomposition, we assessed how much group-level inequalities in the receipt of cancer treatment within 10 weeks of diagnosis can be explained by group-level differences in the distribution of observed characteristics vs. differences in the group-level effects of the observed characteristics.

Results: Eighteen percent of our sample were black. Black veterans had a higher stage at diagnosis, were younger and more likely to live in urban areas. There was a 4% difference in the receipt of timely treatment between white and black veterans

(77% (95%CI: 77%-78%) and 73% (95%CI 72% - 75%), respectively. The differential effect of the observed coefficients, accounted for 4 percentage points (pp) of the difference in timely treatment (p<0.000). Receiving treatment at a hospital that has tracking mechanisms results in a 1.55pp increase in the odds of receiving timely treatment for black veterans (95%CI: 0.23pp - 2.87pp).

Conclusions: Our results suggest the implementation of hospital-wide tracking system may result in a significant reduction in racial disparities in the timeliness of cancer treatment amongst black veterans.

Background

Despite decades of research and the development of clinical guidelines to standardize cancer treatment, racial disparities in cancer treatment persist[3]. These disparities include delays in the timing of cancer treatment initiation [3,82]. Cancer treatment delays are often associated with poorer health outcomes such as decreased survival time[3], more rapid disease progression[3] and increased patient anxiety[1]. The causes of cancer treatment disparities are complex and have previously been attributed to patient factors[25], such as stage at diagnosis and sociodemographic factors (e.g. gender, age, and marital status), as well as hospital factors[26], such as hospital volume and teaching status. Studies evaluating the association of hospital-level factors and racial disparities in cancer treatment suggest that differences between hospitals where patients receive cancer treatment may contribute to racial disparities in cancer treatment. While evidence suggests that differences between hospitals are important, they likely do not explain all the racial disparity in cancer treatment. Processes of care within hospitals, such as the establishment of continuous relationships between patients and primary care providers (PCPs), may explain some of the remaining variation.

The Veteran's Health Administration Health Care System (VA) is the U.S.'s largest integrated health care system, where access barriers, such as the cost of care, are reduced[146]. As an equal access health care system, eligible veterans, who do not pay health insurance premiums, have access to specialty care, such as cancer treatment[30]. The VA is also the largest provider of cancer diagnosis and treatment with the U.S. Approximately 3% of all cancer diagnosis in the U.S. are made within the VA[20]. Within the VA, evidence suggests that compared to white veterans, black veterans are equally likely to have continuous care with PCPs and to have equal access to hospitals with oncology-specific resources such as cancer social workers, cancer psychologists, cancer-specific tumor boards, and oncology clinical trials[147]. However, black veterans have less access to hospitals that track overall guideline concordance and timeliness of their care[147]. Despite continuous PCP relationships and receiving treatment at hospitals with oncology specific resources, evidence suggests that black veterans are less likely than white veterans to ever receive guideline-recommended surgery[47], chemotherapy[48] and radiation[26]. Among those that do initiate treatment, evidence suggests that black veterans are less likely to initiate treatment within a timely manner (i.e. within 10 weeks)[147]. This racial disparity in timely treatment may be due, not to group differences in access to these resources, but differences in how these resources influence timely treatment, by race. To date, little is known about *how* hospital-specific factors and care continuity may influence the receipt of timely cancer treatment by black and white patients.

Hospital-specific factors such as staffing resources, tumor board resources, tracking resources and oncology-clinical trials may help to reduce the uncertainty that

providers face when faced with ambiguity about the diagnostic implications of clinical factors, incomplete information about the efficacy of diagnostic and treatment interventions, and ambiguity about how to value potential clinical outcomes[105]. Provider uncertainty may be particularly salient under time constraints, which can result in providers' clinical discretion being shaped by subjective influences such as prejudice and a reliance on stereotypes[105]. When clinical decisions, are made based on influences such as prejudice and stereotypes, providers may not act quickly and decisively when making treatment recommendations for black patients, resulting in racial disparities in timely treatment. Continuity of care may further reduce uncertainty in clinical encounters with black patients by improving communication and mutual understanding between black patients and their providers. This improved communication and mutual understanding results in increased patient trust regarding treatment recommendations, further increase timely treatment for black patients, reducing racial disparities.

The objective of this study is, therefore, to decompose the black-white gap in the receipt of timely cancer treatment to understand whether the race-specific distribution or race-specific effects of hospital-level factors and continuity of care influence this gap. The first step in addressing racial disparities is to diagnose the disparity. This requires data about whether a disparity exists and whether interventions to address racial disparities are efficacious. The ability to diagnose disparities and track patients from screening through survivorship should result in less racial disparities in treatment. We hypothesized that the use of specific patient tracking mechanisms will reduce racial

disparities in treatment more than other features. The results of this study may inform system-wide VA policies for resource allocation and disparities reduction efforts.

Methods

Data

The VA's Epidemiology of Cancer among Veterans (EpiCAN) data liked with data from the VA Corporate Date Warehouse (CDW) and the 2009 VA Oncology Facilities Survey, accessed through the Veterans Affairs Informatics Computing Infrastructure[106], were used to conduct this analysis. EpiCAN data originate from the VACCR, CDW, and Medicare data. Since 1995, the VA Central Cancer Registry (VACCR) has been collecting patient demographics and cancer care information. CDW contains information from the patient's electronic health record including procedures and treatments[18]. The Oncology Services Survey was a survey of VA Oncology Facilities administered in 2009 by the VA Healthcare Analysis and Information Group. The Oncology Services Survey was distributed to facility Chiefs of Staff at the 140 VAs with cancer diagnosis and treatment capabilities. Each facility Chief of Staff, or their proxies, answered standardized questions about their cancer care delivery.

Study Population

The study population included veterans diagnosed with incident stage I, II, or III colon or rectal adenocarcinoma or non-small cell lung cancer between January 1, 2009 and December 31, 2014. Black and white veterans with a valid zip code who received their first course of treatment at the VA were included for analysis. The first course of treatment included first evidence of surgical resection, chemotherapy, or radiation therapy received at a VA according to EpiCAN and the VACCR. We excluded veterans with a secondary cancer diagnosis within six months of the cancer diagnosis of interest

(N=6,587), without a documented stage or with stage IV disease (N=31,381) or who did not have colon or rectal adenocarcinoma or non-small cell lung cancer (N=3,918), with evidence of treatment before the date of diagnosis (N=15). We also excluded patients who did not self-report male or female sex (N=10) or black or white race (N=726). We excluded patients who did not live at least 31 days after diagnosis (N=649), without a reliable zip code (N=31), and who were not a veteran (N=120). Finally, only veterans whose first course of cancer treatment (i.e., first evidence of surgical resection, chemotherapy, or radiation therapy) was at a VA hospital according to the VA's EpiCAN database and the VACCR were included, excluding those whose first course of treatment was not (N= 10,727). We also excluded veterans who did not self-identify as black or white, and we did not control for Hispanic ethnicity due to small sample size. Histology codes, procedural codes, billing codes and National Cancer Institute's Surveillance, Epidemiology and End Results Program site codes were used to identify the sample. These codes are presented in Appendix 2.

Outcomes

Evidence suggests that black veterans with early stage lung, colon, or rectal cancer are less likely to have timely treatment initiation, defined as receiving their first course of treatment within 10 weeks of diagnosis. While there are currently no federal guidelines specifying a window for timely cancer care, we selected 10 weeks based on clinical input from oncology specialists. Within 10 weeks, patients have time to seek counsel on their treatment options, seek a second opinion, or prepare for the toll treatment will take on their daily lives. Delays in treatment initiation have been associated with mental health issues, lower quality of life, and excess health care

utilization[109]. We assessed date of cancer diagnosis, based on a confirmed pathology report, and date of first course of treatment using EpiCAN and the VACCR.

Key Explanatory Variables

In this analysis, key explanatory variables included hospital and continuity of care factors hypothesized to reduce racial disparities in the receipt of timely cancer treatment.

Key Hospital-Level Factors

The hospital-level factors were assessed from the 2009 VA Oncology Facilities survey. They included binary measures of whether the veteran's treating hospital had social workers and psychologists with training in treating patients with cancer, measurement systems tracking their overall adherence to cancer guidelines and timeliness of cancer care, and whether an oncology-related clinical trial was available between 2006 and 2009. We also included a categorical measure of whether the patient received treatment at a hospital that had colorectal or lung cancer-specific tumor boards and whether palliative care specialists, social workers, nutritionist or cancer registrars regularly attended those meetings (0: no cancer-specific tumor board, 1: cancer-specific tumor board without regular specialist attendance, 2: cancer-specific tumor board with regular specialist attendance).

Continuity of care with the PCP measures were constructed using data from the patient's electronic health record (EHR). We expected greater patient-PCP continuity to be positively associated with more timely treatment. Continuity of care, measured longitudinally, was defined as having more visits with the same PCP, relative to other providers[21]. First, we measured provider dispersion, the number of PCPs the patient

consulted, using the Modified-Modified Continuity Index (MMCI)[21]. MMCI ranges from 0 (each visit with a different PCP) to 1 (all visits made with a single PCP).

$$MMCI = \frac{1 - \frac{\#\ of\ PCPs}{[\#\ of\ primary\ care\ visits + 0.1]}}{1 - \frac{1}{[\#\ primary\ care\ visits + 0.1]}}$$

Second, we measured visit concentration, the proportion of visits with the PCP identified as the modal provider, over all PCP visits, using the Usual Provider of Care Continuity (UPC)[21]. UPC ranges from 0 (no visits with a regular PCP) to 1 (all visits with a single PCP).

$$UPC = \frac{\#\ of\ visits\ with\ \ PCP}{[\#\ of\ primary\ care\ visits]}$$

The COC measures were calculated using all primary care visits in the two years prior to diagnosis. MMCI and UPC scores of 1, indicated perfect continuity of care and scores of 0 indicated no continuity of care. We dichotomized these measures at the median value for the population to indicate high versus low continuity of care. A MMCI score ≥0.610 represented low provider dispersion and a UPC score ≥0.375 represented high visit concentration.

Covariates

Covariates included patient- and disease-characteristics associated with the timely receipt of cancer treatment. They were assessed using patient data in EpiCAN and the CDW and included: cancer type (lung, colon, rectal); type of first course of treatment received (surgery, chemotherapy, radiation, chemoradiation); age at diagnosis (≤64, 65-79, >79); sex (male, female); marital status at diagnosis (married, single, widowed or divorced, missing); straight-line distance between the centroid of the

patient's zip code to the centroid of the treating hospital's zip code, in miles (<10.8 miles, 10.8 – 32.4 miles, 32.5-75.9 miles, >75.9 miles, missing); Nosos risk score measuring the veteran's expected health care utilization and risk of rehospitalization[118] (≤ 1, 1.1 – 2.6, 2.7-5.4, >5.4); rurality (urban, rural) based on patient's residential zip code, assessed using United State Department of Agriculture's Rural Urban Commuting Area (RUCA) code zip code approximations[112]; and a binary indicator of prior history of cancer. VA copayment status, which may reflect vulnerability and influence a veteran's decision to use VA care[17], determined by the veteran's service-connected physical and mental injuries and disabilities and socioeconomic status, was also included as a covariate (no copay due to service-connected disability, no copay due to low income status, copay required, missing). Distance to care for veterans living in Puerto Rico or on Native American reservations, were categorized as "missing" as we were unable to assess the distance. Categorical variables were categorized by quartile, unless otherwise specified. Appendix 10 lists all variables, definitions, and values.

Statistical Analysis

We began by describing our cohort using mean characteristics (and 95% Confidence Intervals (CIs)) as presented in Table 5. We then evaluated bivariable differences in covariates and outcomes, stratified by race assessing differences using chi-square or t-tests (evaluated at alpha = 0.05).

We evaluated associations between observable hospital factors and continuity of care and the receipt of timely treatment using the Blinder-Oaxaca approach[120], stratified by race (white/black). This method has been explained in detail elsewhere[148], but briefly, the Oaxaca-Blinder Decomposition reveals how much group-level inequalities in the outcome (e.g. timely treatment) can be explained by group-level differences in the

distribution of observed characteristics (e.g. group mean differences in access to oncology clinical trials) sometimes called the explained portion vs. differences in the group-level effects of the observed characteristics on the outcome (e.g. oncology clinical trials may be more beneficial to white veterans than black veterans), sometimes called the unexplained portion.

We implemented this method using the Stata (version 15.1) Oaxaca command. This method is commonly used to examine differences in continuous variables, such as the number of days between diagnosis and treatment, but we used the "logit" option in Stata to extend this method to a binary outcome, receipt of timely treatment. Because the Oaxaca-Blinder Decomposition is sensitive to the choice of counterfactual group used to estimate model parameters, we used Stata's "pooled" option to specify the use of the coefficients of a pooled model, including both black and white veterans as the counterfactual. The Oaxaca-Blinder Decomposition can also be sensitive to the choice of base category for categorical variables. We normalized categorical variables using Stata's "normalize" option so that the results of the decomposition are not sensitive to the choice of the base category.

This study was approved by the Durham VAMC Institutional Review Board (IRB) and the University of North Carolina at Chapel Hill IRB. All data analyses and management were conducted using Stata version 15.1 (StataCorp LP, College Station, TX, USA) and SAS version 9.4 (SAS Institute Inc, Cary, NC, USA) software.

Results

The final sample, which has been described elsewhere[147], included 20,430 veterans. Briefly, eighty-two percent of veterans in our sample were white, 97% were male, and 74% lived in an urban area at diagnosis. Compared to white veterans, black

veterans were more likely to live in an urban area (*P<0.001*), had a higher stage at diagnosis (*P<0.001*), and a higher Nosos risk score (*P<0.001*). Baseline characteristics for the cohort are presented in Table 5.

Logit

In this analysis timely treatment is the receipt of the first course of treatment (first evidence of surgical resection, chemotherapy, radiation therapy or chemoradiation) within 10 weeks of diagnosis. Timely treatment was a binary indicator where 0 = no receipt of timely treatment and 1 = receipt of timely treatment. In fully adjusted analysis, white and black veterans were 77% (95%CI: 77%-78%) and 73% (95%CI 72% - 75%) likely to receive timely treatment, respectively (Figure 9). The results of the pooled multivariate logistic regression used to calculate the Oaxaca-Blinder Decomposition are presented in Appendix 12.

Decomposition – Relative Contribution of Variables

Table 6 presents the relative contribution of each of the variables to the observed gap in inequalities using a pooled Oaxaca-Blinder Decomposition, where coefficients from a pooled model, without interactions, including both black and white veterans was used as the counterfactual to estimate models for black and white veterans respectively. In this analysis, black veterans were chosen as the reference category; therefore, a positive point estimate for a variable indicates that white veterans benefit more (e.g. that variable results in the receipt of timely treatment for white veterans) as a combined result of the covariates distribution within the group (explained) or the effect of the covariate on the outcome (unexplained), relative to black veterans, whereas a negative point estimate indicates the opposite is true.

The results of the decomposition suggest that on average, black veterans are 4 percentage points (pp) less likely to receive timely treatment (95%CI: 2.4pp - 5.5pp). The explained portion, differential access to the hospital factors and differential continuity of care among blacks relative to whites, is not a statistically significant contribution to the overall outcome difference. In terms of individual covariates, differential access to a cancer psychologist makes a small, but significantly negative, contribution to the receipt of timely treatment.

The "unexplained portion," the differential effect of the observed coefficients, accounts for 4pp of the difference in timely treatment ($p<0.000$). While differential access to hospital tracking is not significantly associated with racial disparities in timely treatment, having access to a hospital tracking has a greater impact for black veterans. Receiving treatment at a hospital that has tracking mechanisms results in a 1.55pp increase in the odds of receiving timely treatment for black veterans (95%CI: 0.23pp - 2.87pp). Receiving treatment at a hospital that has cancer-specific tumor boards is results in a 0.37pp decrease in the odds of receiving timely treatment for black veterans (95%CI: 0.01pp - 0.74pp). Conversely, receiving treatment at a hospital without a cancer-specific tumor board is associated with a 2.54pp (95%CI: 0.8pp ,- 4.3pp) increase in timely treatment for black veterans. The results of the full model are presented in Appendix 11.

Conclusion

In this study, we examined the effect of access to hospital resources and continuous care on racial disparities in timely treatment and whether the resources had a differential effect on timely treatment, by race. In adjusted analyses, we observed a 4% difference in timely treatment by race. Our results suggest that, in this sample, the

observed difference can be accounted for by the differential effect that the included covariates have on timely treatment, by race, as opposed to differential distribution of the covariates by race in the sample. In this study, we found that, equalizing access to oncology-specific resources, such as facilities that offer tracking mechanisms, may not in itself reduce disparities in timely treatment; rather, when these resources are introduced, they may operate differently in different groups to influence treatment timeliness.

Of the factors included in this study, receiving treatment in a hospital that tracks the timeliness and guideline concordance of its cancer care was positively associated with a statistically significant reduction in racial disparities in timely treatment, suggesting that hospital-level tracking that is particularly important for black veterans. There are several ways in which tracking could be more relevant for timely care amongst black veterans. Identifying disparities requires systematically collecting demographic and clinical data across a hospital. These hospital-level tracking mechanisms may have allowed VA hospital to identify where they were not providing equal care for black and white veterans, enable accountability, and suggest opportunities to intervene. In these analyses, we could not evaluate the motivation behind the adoption of hospital-level tracking mechanisms.

We also found that cancer-specific tumor boards have a differential effect, by race, suggesting that they operate differently for black and white veterans. This is consistent with previous research suggesting a negative association between cancer-specific and black race[147]. As we only assessed the presence of cancer-specific tumor boards, not use, it is likely that cancer-specific tumor boards may be a proxy for facility

or patient complexity. This study adds to those findings by suggesting that while the association between cancer-specific tumor boards and race is statistically significant it accounts for a very small portion of the observed disparity. Therefore, with equal access to cancer-specific tumor boards, we may not see a large increase in racial disparities in timely treatment, and in fact, may see more patient-centered care resulting from the multidisciplinary collaboration that occurs in tumor boards.

These findings have important policy implications. Practitioners, policy makers and researchers should acknowledge that "a rising tide does not lift all boats." We found differential covariate effects, suggesting that racial disparities in cancer treatment may not be reduced by equalizing access to all cancer resources, but that there may be resources that are particularly positively or negatively relevant for black veterans. Additionally, evidence suggesting significant associations with racial disparities should be contextualized with regard to their clinical significance; the magnitude of these effects may not be clinically significant.

This study has several limitations. First, our model does not include all variables that are known to influence treatment timeliness. We used administrative and encounter data for this analysis, which does not include measures of patient preferences, provider prejudice, or any number of subjective influences. Second, another limitation of using secondary data is that we are not able to assess causation, limiting our interpretation to associations. Third, timeliness of care is only one measure of quality cancer care. This analysis could be replicated with any number of other measures of quality cancer care to evaluate whether these factors are associated with quality care across the continuum. Finally, our analysis was limited to hospital oncology

resource availability; we were unable to assess whether patients or providers used these hospital-specific oncology resources prior to treatment initiation, if at all.

The results of this study suggest that differential effects of hospital factors have a greater impact on racial disparities in the VA than does differential access to those hospital resources. We also found that while equal access to some hospital resources can result in increased racial disparities, the variables that are negatively associated with timely treatment for black veterans are not likely to result in clinical meaningful increases in disparities. There is, however, evidence to suggest, that regardless of the motivation, hospital-level tracking is associated with more equitable timing of cancer treatment. Future research should explore how and why hospitals adopt resources that could reduce racial disparities in cancer treatment, such as tracking mechanisms and the mechanisms by which they may reduce disparities.

Table 5. Patient Characteristics According to Veteran Race

	Race No (%)		
Characteristics	White	Black	p-value
Number of Patients	16,754	3,676	
Urban	11,897 (71.0%)	3,246 (88.3%)	<0.001
Rural	4,857 (29.0%)	430 (11.7%)	
Age at Diagnosis mean (sd)	67.5 (8.9)	64.9 (9.6%)	<0.001
< 64	6835 (40.8%)	1951 (53.1%)	<0.001
65-79	8,090 (48.3%)	1,412 (38.4%)	
>79	1,829 (10.9%)	313 (8.5%)	
Sex			
Male	16,323 (97.4%)	3,566 (97.0%)	0.15
Female	431 (2.6%)	110 (3.0%)	
Copay Status			
No Copay – Service Connected Disability	13,248 (79.1%)	3,085 (83.9%)	<0.001
No Copay – Low Income	901 (5.4%)	210 (5.7%)	
Copay	2,582 (15.4%)	375 (10.2%)	
Missing	23 (0.1%)	6 (0.2%)	
Marital Status			
Married	8,034 (48.0%)	1,307 (35.6%)	<0.001
Widowed or Divorced	7,251 (43.3%)	1,785 (48.6%)	
Single	1,387 (8.3%)	565 (15.4%)	
Missing	82 (0.5%)	19 (0.5%)	
History of Cancer			
Yes	1,205 (7.2%)	310 (8.4%)	0.009
No	15,549 (92.8%)	3,366 (91.6%)	
Distance Traveled to Treating Hospital – Mean (sd)	68.8 (123.7)	39.1 (90.4)	<0.001
<10.8 miles	3,305 (19.7%)	1,741 (47.4%)	<0.001
10.8 – 32.4 miles	4,241 (25.3%)	784 (21.3%)	
32.5 – 75.9 miles	4,399 (26.3%)	606 (16.5%)	
>75.9 miles	4,524 (27.0%)	518 (14.1%)	
Missing	285 (1,7%)	27 (0.7%)	

	Race No (%)		
Characteristics	White	Black	p-value
Number of Patients	16,754	3,676	
NOSOS mean (sd)	3.9 (4.1)	4.3 (4.2)	<0.001
≤ 1	4,158 (24.8%)	750 (20.4%)	<0.001
1.1 – 2.6	4,121 (24.6%)	882 (24.0%)	
2.7 – 5.4	4,315 (25.8%)	1,015 (27.6%)	
>5.4	4,160 (24.8%)	1,029 (28.0%)	
Stage at Diagnosis			
1	6,633 (39.6%)	1,391 (37.8%)	<0.001
2	4,198 (25.1%)	816 (22.2%)	
3	5,923 (35.4%)	1,469 (40.0%)	
Treatment Type			
Surgical Resection	11,523 (68.8%)	2,409 (65.5%)	<0.001
Chemotherapy	3,187 (19.0%)	704 (19.2%)	
Radiation Therapy	1,981 (11.8%)	549 (14.9%)	
Chemoradiation	63 (0.4%)	14 (0.4%)	
Cancer-Specific Resources			
Cancer Social Worker	10,728 (64.0%)	2490 (67.7%)	<0.001
Cancer Psychologist	5,474 (32.7%)	1604 (43.6%)	<0.001
No Cancer-Specific Tumor Board	7,023 (41.9%)	1,249 (34.0%)	
Cancer-Specific Tumor Board	1,237 (7.4%)	214 (5.82%)	<0.001
Specialist Attends Cancer-specific tumor board	8,494 (50.7%)	2,213 (60.2%)	<0.001
Timeliness Tracking	10245 (61.1%)	2087 (56.8%)	<0.001
Research	13324 (79.5%)	3001 (81.6%)	0.004
Continuity of Care			
High UPC	8596 (51.3%)	1809 (49.2%)	0.021
Low MMCI	8473 (50.6%)	1785 (48.6%)	0.027
Outcomes			
Time to Treatment (Days) mean (sd)	49.4 (44.5)	53.59 (50.9)	<0.001
Received treatment within 10 weeks	12,963 (77.4%)	2,699 (73.4)	<0.001

Cancer-specific tumor boards indicate the presence of lung or colorectal cancer-specific tumor boards.
Support staff include: palliative care specialists, social workers, nutritionists and cancer registrars.

Figure 9. Unadjusted Probability of Receiving Timely Treatment (Treatment Initiated within 10 Weeks of Diagnosis), by Race and 95% Confidence Interval

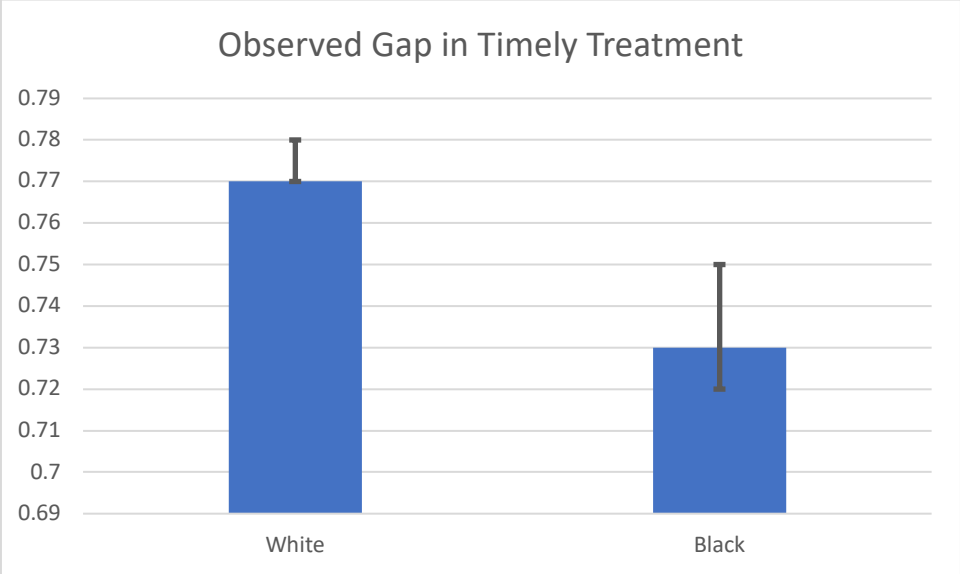


Table 6. Relative Contribution of Hospital and Continuity of Care Variables to the Observed Gap in Timely Treatment (E.G. Treatment Initiated Within 10 Weeks of Diagnosis) – Results of an Oaxaca-Blinder Decomposition

	Explained Percentage points (PP) [95% Confidence Intervals (CI)]	Unexplained PP [95% CI]
No Cancer-Specific Tumor Board	0.06	**-2.54****
	[-0.01,0.12]	[-4.28,-0.89]
Cancer-Specific Tumor Board without Support Staff Attendance	-0.02	**0.37***
	[-0.04,0.00]	[0.01,0.74]
Cancer-Specific Tumor Board with Support Staff Attendance	-0.04	0.54
	[-0.11,0.02]	[-1.47,2.55]
High Provider Dispersion	0.00	-0.29
	[-0.01,0.01]	[-1.36,0.78]
Low Provider Dispersion	0.00	0.28
	[-0.00,0.00]	[-0.74,1.30]
Low Provider Concentration	-0.00	-0.12
	[-0.01,0.01]	[-1.18,0.93]
High Provider Concentration	-0.00	0.12
	[-0.01,0.01]	[-0.91,1.16]
No Cancer Social Worker	-0.00	0.04
	[-0.02,0.02]	[-0.90,0.98]
Cancer Social Worker	-0.00	-0.10
	[-0.02,0.02]	[-2.01,1.82]
No Cancer Psychologist	**0.16*****	1.12
	[0.07,0.24]	[-0.35,2.59]
Cancer Psychologist	**0.16*****	-0.80
	[0.07,0.24]	[-1.85,0.24]
No hospital guideline concordance or timeliness tracking	-0.01	**1.14***
	[-0.01,0.03]	[0.17,2.11]
Hospital guideline concordance or timeliness tracking	-0.02	-1.55*
	[-0.02,0.03]	[-2.87,-0.23]
No Oncology Clinical Trial	-0.00	0.51
	[-0.01,0.01]	[-0.04,2.06]
Oncology Clinical Trial	-0.00	2.21
	[-0.01,0.01]	[-4.60,0.19]
Total Contribution the difference explained	-0.39	**4.34*****
	[-1.01,0.24]	[2.78-5.90]
N	***20,430***	***20,430***

Oaxaca-Blinder Decomposition, using a "pooled" logit where the coefficients from a pooled model, including both black and white veterans are the counterfactual. Categorical variables were normalized and not sensitive to the choice of base category.

Black veterans were the reference category: a positive estimate indicates that white veterans benefit from the covariate distribution (explained) and/or the effect of the covariate on the outcome (unexplained) relative to black veterans. A negative point estimate indicates the opposite.
* $p<0.05$, ** $p<0.01$, *** $p<0.001$
Low Dispersion = MMCI ≥0.610 = 1
High Concentration = UPC≥0.375 = 1
Support staff includes palliative care specialists, social workers, nutritionists, or cancer registrars

CHAPTER 7: SUMMARY OF FINDINGS AND IMPLICATIONS FOR POLICY, PRACTICE AND RESEARCH

Summary of Findings

The objective of this dissertation was to assess the extent to which factors at the site of care and continuity of care influence racial disparities in the timing of treatment initiation for cancer patients. The results of the analyses suggest several key findings. First, there is differential access to cancer-specific resources amongst underserved veterans (e.g. black and rural residents). Black race is largely associated with receiving treatment at a hospital with these cancer-specific resources and rural residence is largely associated with not receiving treatment at a hospital with these cancer-specific resources. In Aim 1, our results demonstrated that black race was associated with higher odds of receiving cancer treatment at a hospital with a cancer social worker and a cancer psychologist, cancer-specific tumor boards and where support staff regularly attend the cancer-specific tumor boards, that conducts oncology clinical trials, with any individual tracking mechanisms for cancer care, and that uses patient navigators to track patients. Conversely, black race was associated with lower odds of receiving cancer treatment at a hospital with hospital-level guideline concordance and timeliness tracking. Rural residence was associated with lower odds of receiving cancer treatment at a hospital with a cancer social worker and a cancer psychologist, cancer-specific tumor boards, and conducts cancer clinical trials.

Second, hospital features are associated with racial disparities in cancer treatment. In Aim 2, our results suggested that, receiving treatment with cancer-specific

tumor boards was negatively associated with receiving timely cancer treatment (e.g. first evidence of surgical resection, chemotherapy, radiation therapy, or chemoradiation within 10 weeks of diagnosis) for black veterans. Conversely, our results suggest that receiving treatment at a hospital that tracks overall guideline concordance or timeliness of cancer care was positively associated with receiving timely cancer treatment for black veterans.

Third, the effect of the hospital resources on disparities was not due to differential access to the cancer-specific resources, but differential returns to the resources, by race. In Aim 3, we found that cancer-specific tumor boards are negatively associated with timely cancer treatment for black veterans and hospital-level tracking is positively associated with timely cancer treatment for black veterans. However, the results of an Oaxaca-Blinder Decomposition further illuminated that although black veterans are 4 percentage points (pp) less likely to receive timely treatment than white veterans, receiving treatment at hospital with a cancer-specific tumor board accounted for 0.37pp of that disparity when a specialist did not attend those meetings. When a specialist did attend the cancer-specific tumor board, there was no significant contribution to the disparity. Hospital-tracking mechanisms, however, also accounted for 1.55pp of the observed disparity in the receipt of timely treatment. The results of Aim 3 suggest that cancer-specific tumor boards are not a large determinant of racial disparities in treatment, and that hospital-tracking mechanisms could help to reduce racial disparities in timely cancer treatment.

Finally, continuity of care was not significantly associated with race or any of the outcomes assessed in this study. In Aim 1, race was not significantly associated with

any measure of continuity of care. In Aim 2, continuity of care was not significantly associated with timely treatment. In Aim 3, neither equal likelihood of high continuity of care nor differential returns to high continuity of care were associated with the observed racial disparity in timely treatment.

Policy and Practice Implications.

The findings from this dissertation have important policy and practice implications. First, the VA should consider rural veterans' increased vulnerability when allocating hospital resources. While programs such as Council on Cancer Accreditation and Quality Oncology Practice Initiative Certifications may incentivize the implementation of cancer-specific resources, the VA does not participate in those accreditation programs, reducing the outside incentive to provide cancer-specific resources. Thus, the motivation behind the distribution of resources may be influenced by financial and policy considerations. Rural veterans may benefit from interventions targeting increased resource allocation in rural VA hospitals. While rural veterans may receive care in VA hospitals in urban areas, they are more likely to receive care in VA hospitals in rural areas, which are supported by the VA Office of Rural Health (ORH)[123]. The ORH develops, field tests, and operates programs to improve rural veterans' access to health care including facilitating transportation services and telemedicine programs. Rural veterans may also benefit from increased staffing by oncology support staff and increased cancer-specific tumor boards.

Second, VA administrators should consider the impact of current policies in the quality of care rural veterans receive. The VA is increasingly relying on community-based care to provide timely treatment for veterans. Current VA policies, such as the Veterans Access, Choice and Accountability Act of 2014 which allow veterans to

receive care from a community provider if the veteran's travel to the nearest VA hospital exceeds 40 miles[132] and the 2018 VA Maintaining Systems and Strengthening Integrated Outside Networks Act (Mission Act) which consolidates the VA's community care programs[133], facilitate veterans' receipt of healthcare in the community. Veterans that live in rural areas are less likely to have access to high-performing non-VA hospitals[139]. Rural veterans may be more vulnerable to changes in the healthcare landscape, including increasing rural hospital closures[140]. Because of their strategic location in rural locations where veterans live, rural VA facilities may be able provide resources that would be otherwise unavailable in their local communities. The results of this study suggest that VA administrators should consider the quality of cancer care that veterans receive when implementing policies that increase timely access to care through initiatives that rely on community care.

Third, the results of our study suggest that even within equal access systems, the hospital where a patient receives their care could have implications for the quality of care they receive. The VA has a history as a learning health care system implementing initiatives to track and improve cancer care quality including the Colorectal Cancer Quality Measurement System (CCQMS)[107]; the External Peer Review Program (EPRP) to monitor hospital performance[136]; and the development and demonstration of a comprehensive lung cancer screening program[137]. While these programs have improved the quality of VA cancer care delivery, most have not been implemented or sustained system-wide. Administrators should carefully weigh the potential impact of hospital resources associated with cancer care on the various segments of patient populations they serve. Policy makers should consider increased oversight on how

operating and clinical decisions effecting racial disparities in cancer treatment. The results of this study suggest that the VA administrators should carefully consider implementing hospital-wide tracking systems that monitor the guideline concordance and timeliness of care in VA hospitals with large populations of black veterans.

Finally, the results of this study suggest that equal access alone would not necessarily results in a meaningful reduction in racial disparities in timely treatment. Practitioners, policy makers and researchers should acknowledge that "a rising tide does not lift all boats." We found differential covariate effects, suggesting that racial disparities in cancer treatment may not be reduced by equalizing access to all cancer resources, but that there may be resources that are particularly positively or negatively relevant for black veterans. Additionally, evidence suggesting significant associations with racial disparities should be contextualized in their clinical significance and we should evaluate the magnitude of their effects. The VA is widely known for piloting research and operations initiatives. In addition to evaluating the overall effect of these initiatives on VA care, VA administrators should consider evaluating how these initiatives affect underserved populations such as black veterans.

Limitations

This study has several limitations. First, the models do not include all variables that are known to influence treatment timeliness. We used administrative and encounter data for this analysis, which does not include things such as patient preferences, provider prejudice, or any number of subjective influences. Second, another limitation of using secondary data is that we are not able to assess causation, limiting our interpretation to associations. Third, the Oncology Facilities Survey was self-reported and the questions were open to individual interpretation, however

respondents were not incentivized to answer questions in any particular way. Fourth, timeliness of care is a VA priority; however, it is only one measure of quality of cancer care. Therefore, this study should be replicated across different quality of care outcomes, particularly the receipt of guideline-recommended treatment and surgical resection. Many VA studies have established that black veterans are less likely to receiving curative-intent surgery, even when there are equal recommendation rates[50]. Finally, while we assessed whether these resources were available, we could not assess whether they were utilized. Implementation and utilization may be variable.

Future Directions

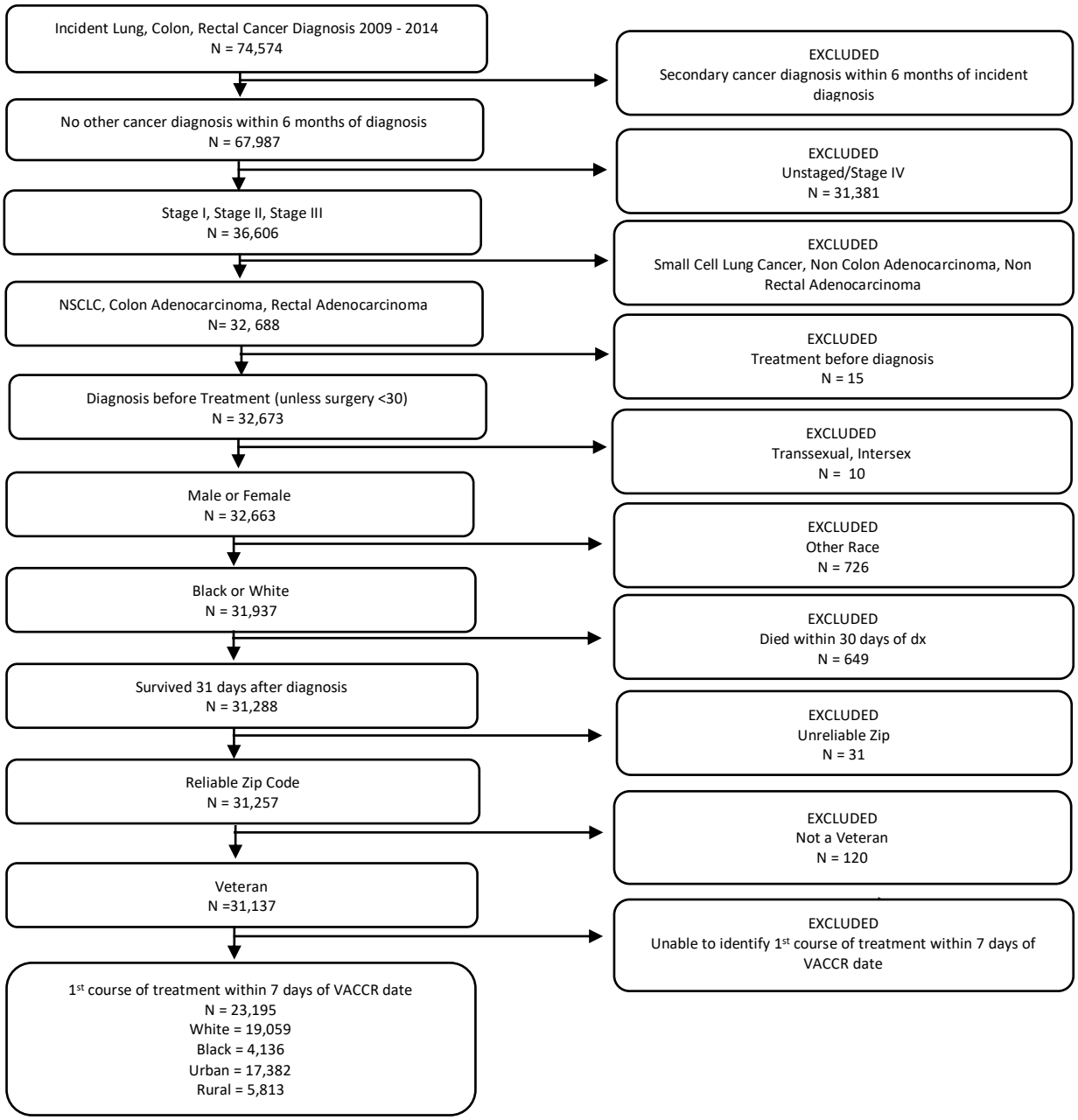
This dissertation provides a foundation for future research. First, in this dissertation, we assessed racial disparities in one measure of quality of care: timeliness. Although this outcome may be particularly relevant to VA and policy makers, other measures of quality care may also be of interest to VA, policy makers, and clinicians. Future research could evaluate the association between the features assessed in this dissertation, and others, with other measure of quality cancer care such as the receipt of guideline concordant treatment and patient acceptability of treatment. Second, in this dissertation, we only assessed the presence of these resources at the veteran's treating hospital and not the use of these features. Future research could incorporate measures of the acceptability and variations use of these resources amongst physicians. Third, as there is variation in the adoption of these resources, future research could evaluate predictors of adoption of specific resources, especially those that are associated with reduced racial disparities in cancer treatment. Finally, this time period for this dissertation predated the CHOICE and MISSION Acts, which help facilitate the delivery of care in the veteran's community. Future research could assess access to the

resources evaluated in this study, and others, and their association with quality of care measures, particularly among vulnerable veterans such as black veterans, rural residents, black rural veterans, and older rural veterans.

Conclusion

The goal of this dissertation was to describe the distribution of cancer and continuity of care amongst veterans receiving cancer care within the VA and to assess whether they are associated with racial disparities in timely treatment. This goal was accomplished through three Aims that explored how attributes of the site of care (specific resources) and processes of care (continuity of care) are associated with racial disparities in cancer treatment. The first Aim described how resources and continuity of care are distributed throughout the VA The second Aim assessed whether resources and continuity of care are associated with timely cancer treatment. The third Aim used the Oaxaca-Blinder Decomposition method to quantify the effect of these resources and continuity of care on timely cancer treatment. Overall, we found that black veterans are likely to receive treatment at facilities that have the resources that we assessed, except hospital-level tracking. We also found that hospital-level tracking is associated with reduced racial disparities in timely treatment, and that it accounts for a large portion of the disparity observed in this population. Our results can be used to influence policy makers to consider resource allocation to VAs and hospital leaders to consider that adoption of resources that may reduce racial disparities in treatment.

APPENDIX 1: CHAPTER 4 CONSORT DIAGRAM



APPENDIX 2: SEER SITE, HISTOLOGY CODES, CPT CODES, ICD-9 CODES, ICD-9 PROCEDURE CODES USED TO IDENTIFY THE SAMPLE

SEER Site Codes	
Lung, Colon, or Rectal Cancer	21041, 21043, 21044, 21045, 21046, 21047, 21048, 21051, 21052, 22030
Histology Codes	
Non-Small Cell Lung Cancer	80013, 80023, 80033, 80043, 80053, 80102, 80103, 80113, 80123, 80133, 80143, 80153, 80203, 80213, 80223, 80303, 80313, 80323, 80343, 80353, 80463, 80502, 80503, 80513, 80522, 80523, 80702, 80703, 80713, 80723, 80733, 80743, 80753, 80762, 80763, 80783, 80833, 81202, 81203, 81213, 81223, 81233, 81243, 81402, 81403, 81413, 81433, 81473, 82003, 82012, 82013, 82302, 82303, 82313, 82403, 82413, 82423, 82433, 82443, 82453, 82463, 82493, 82503, 82513, 82523, 82533, 82543, 82553, 82603, 83103, 83203, 83233, 84303, 84803, 84813, 84903, 85103, 85503, 85513, 85603, 85623, 85703, 85713, 85723, 85733, 85743, 85753, 85763, 88003, 88013, 88023, 88033, 88043, 88053, 88063, 88103, 88113, 88133, 88143, 88153, 88303, 88903, 88913, 88943, 88953, 88963, 89003, 89013, 89023, 89103, 89123, 89723, 89733, 89803, 89813, 89823, 89903, 8991, 90503, 90513, 90523, 90533, 91203, 91333, 91403, 99713, 99753
Colon/Rectal Adenocarcinoma	81402, 81403, 81413, 81433, 81453, 81473, 82102, 82103, 82113, 8213, 82202, 82203, 82212, 82213, 82453, 82553, 82603, 82612, 82613, 82623, 82632, 82633, 82653, 84403, 84803, 84813, 85513, 85703, 85713, 85723, 85733, 85743, 85753, 85763
Billing Codes	
CPT Codes	32096, 32097, 32098, 32100, 32400, 32405, 32505, 32506, 32507, 32601, 32604, 32606, 32607, 32608, 32609, 32666, 32667, 32668, 32110, 32120, 32140, 32141, 32150, 32151, 32160, 32440, 32442, 32445, 32480, 32482, 32484, 32486, 32488, 32491, 32505, 32506, 32507, 32650, 32651, 32652, 32653, 32654, 32655, 32656, 32658, 32659, 32661, 32662, 32663, 32664, 32665, 32666, 44140, 44141, 44143, 44144, 44145, 44146, 44147, 44150, 44151, 44155, 44156, 44157, 44158, 44160, 44204, 44205, 44206, 44207, 44208, 44210, 44211, 44212, 45110, 45111, 45112, 45113, 45114, 45116, 45119, 45120, 45121, 45123, 45126, 45130, 45135, 45160, 45171, 45172, 45190, 45395, 45397, 45999, 77261, 77262 , 77264, 77265, 77266, 77267, 77268, 77269 , 77270, 77271, 77272, 77273, 77274, 77275, 77276, 77277, 77278, 77279, 77280, 77281, 77282, 77283, 77284, 77285, 77286, 77287, 77288, 77289, 77290, 77291, 77292, 77293, 77294, 77295, 77296, 77297, 77298, 77300, 77301, 77302, 77303, 77304, 77305, 77306, 77307, 77308, 77309, 77310, 77311, 77312,

SEER Site Codes	
	77313, 77314, 77315, 77316, 77317, 77318, 77319, 77320, 77321, 77322, 77323, 77324, 77325, 77326, 77327, 77328, 77329, 77330, 77331, 77332, 77333, 77334, 77335, 77336, 77337, 77338, 77339, 77340 , 77341, 77342, 77343, 77344, 77345, 77346, 77347, 77348, 77349, 77350, 77351, 77352, 77353, 77354, 77355, 77356, 77357, 77358, 77359, 77360, 77361, 77362, 77363, 77364, 77365, 77366, 77367, 77368, 77369, 77370, 77371, 77372, 77373, 77374, 77375, 77376, 77377, 77378, 77379, 77380, 77381, 77382, 77383, 77384, 77385, 77386, 77387, 77388, 77389, 77390, 77391, 77392, 77393, 77394, 77395, 77396, 77397, 77398, 77399, 77400, 77401, 77402, 77403, 77404, 77405, 77406, 77407, 77408, 77409, 77410, 77411, 77412 , 77413, 77414, 77415, 77416, 77417, 77418, 77419, 77420, 77421, 77422, 77423, 77424, 77425, 77426, 77427, 77428, 77429, 77430, 77431, 77432, 77433, 77434, 77435, 77436, 77437, 77438, 77439, 77440, 77441, 77442, 77443, 77444 , 77445, 77446, 77447, 77448, 77449, 77450, 77451, 77452, 77453, 77454, 77455, 77456, 77457, 77458, 77459, 77460, 77461, 77462, 77463, 77464, 77465, 77466, 77467, 77468, 77469, 77470, 77471, 77472, 77473, 77474, 77475, 77476, 77477, 77478 , 77479, 77480, 77481, 77482, 77483, 77484, 77485, 77486, 77487, 77488, 77489, 77490, 77491, 77492, 77493, 77494, 77495, 77496, 77497, 77498, 77499, 77520, 77523, 77750, 77751, 77752, 77753, 77754, 77755, 77756, 77757, 77758, 77759, 77760, 77761, 77762, 77763, 77764, 77765, 77766, 77767, 77768, 77769, 77770, 77771, 77772, 77773, 77774, 77775, 77776, 77777, 77778, 77779, 77780, 77781, 77782, 77783, 77784 , 77785, 77786, 77787, 77788, 77789, 77790, 77791, 77792, 77793, 77794, 77795, 77796, 77797, 77798, 77799, 96365, 96400 , 96401 , 96402 , 96403 , 96404 , 96405, 96406 , 96407 , 96408 , 96409 , 96410 , 96411, 96412, 96413, 96414, 96415, 96416 , 96417, 96418, 96419, 96420, 96421, 96422, 96423, 96424, 96425, 96425, 96247, 96248, 96429, 96430 , 96431, 96432, 96433, 96434, 96435, 96436, 96437, 96438, 96439, 96440, 96441, 96442, 96443, 96444, 96445, 96446, 96447, 96448, 96449, 96450, 96451, 96452, 96453, 96454, 96455, 96456, 96457, 96458, 96459, 96460, 96461, 96462 , 96463, 96464, 96465, 96466, 96467, 96468, 96469, 96470, 96471, 96472, 96473, 96474, 96475, 96476, 96477, 96478, 96479, 96480, 96481, 96482, 96483, 96484, 96485, 96486, 96487, 96488, 96489, 96490, 96491, 96492, 96493, 96494 , 96495, 96496, 96497, 96498, 96499, 96500, 96501, 96502, 96503, 96504, 96505, 96506, 96507, 96508, 96509, 96510, 96511, 96512, 96513, 96514, 96515, 96516, 96517, 96518, 96519,

SEER Site Codes	
	96520, 96521, 96522, 96523, 96524, 96525, 96526, 96527, 96528 , 96529, 96530, 96531, 96532, 96533, 96534, 96535, 96536, 96537, 96538, 96539, 96540, 96541, 96542, 96543, 96544, 96545, 96546, 96547, 96548, 96549, G0261, G0256, G0251, G0339, J9000 – J9990, Q1720 , Q0083, Q0084 , Q0085
ICD-9 Codes	17.31, 17.32, 17.33, 17.34, 17.35, 17.36, 17.37, 17.38, 17.39, 32.2, 32.20, 32.29, 32.3, 32.30, 32.39, 32.4, 32.40, 32.41, 32.49, 32.50, 32.59, 32.60, 32.90, 33.00, 33.10, 45.00, 45.10, 45.11, 45.12, 45.14, 45.15, 45.16, 45.61, 45.62, 45.63, 45.70, 45.71, 45.72, 45.73, 45.74, 45.75, 45.76, 45.77, 45.78, 45.79, 45.80, 45.81, 45.82, 45.83, 48.61, 48.69, 48.00, 48.42, 48.43, 48.49, 48.50, 48.51, 48.52, 48.59, 48.61, 48.62, 48.63, 48.64, 48.69, 48.99, 49.00, 49.10, 49.20, 92.20, 92.21, 92.22, 92.23, 92.24, 92.25, 92.26, 92.27, 92.28, 92.29, 92.30, 92.31, 92.32, 92.33, 92.34, 92.35, 92.36, 92.37, 92.38, 92.39

APPENDIX 3: CHAPTER 4 VARIABLE VALUES AND DEFINITIONS

Variable	Definition	Variable Values
Outcomes		
Continuity of Care		
Modified-Modified Continuity Index (MMCI)	A measure of provider dispersion. Measures the visit dispersion between primary care providers in the two years prior to diagnosis. Ranges from 0 (each visit with a different primary care provider) to 1 (1 all visits made with a single primary care provider). $$\frac{1-\frac{\#\ of\ PCP\ providers}{[\#\ of\ primary\ care\ visits+0.1]}}{1-\frac{1}{\#\ PCP\ visits+0.1}}$$ Low Provider Dispersion = MMCI ≥0.610	High Provider Dispersion = 0 Low Provider Dispersion = 1
Usual Provider of Care (UPC)	A measure of visit concentration. The proportion of visits the patient made to their modal provider in the two years prior to diagnosis. Ranges from 0 (no visits with a regular provider) to 1 (all visits with the regular provider) $$\frac{\#\ of\ visits\ with\ assigned\ PCP}{[\#\ of\ primary\ care\ visits]}$$ High Visit Concentration = UPC≥0.375	Low Visit Concentration = 0 High Visit Concentration = 1
Length of Relationship	A measure of how long the patient has known the provider. Long Relationship = length ≥955 days (about 2.5 years)	Short Relationship = 0 Long Relationship = 1
Oncology-Specific Resources		
On-Site Oncology Staffing		
Medical Oncologist	There is a medical oncologist at the treating hospital.	0 = No 1 = Yes
Social Worker	There is a social worker with a cancer specialty available at the hospital.	
Psychologist	There is a psychologist with a cancer specialty available at the hospital.	
Tumor Board		
Cancer-specific tumor board	The hospital has a lung cancer or colorectal cancer-specific tumor board.	0 = No 1 = Yes
Specialist attendance at tumor board	A palliative care specialist, social worker, nutritionist, and/or cancer registrar regularly attends the cancer-specific tumor board.	

Variable	Definition	Variable Values
Tracking Mechanisms		
Cancer patient tracking	The hospital has a mechanism to track patients from diagnosis through post-treatment care.	0 = No 1 = Yes
Patient navigator	The person who tracks patients from diagnosis through post-treatment care is a patient navigator.	
Hospital timeliness tracking	The hospital has a measurement system that tracks their overall adherence to guideline-based of cancer care.	
Oncology Clinical Trials		
Oncology Clinical Trials	Indicates the availability of an oncology-related clinical trial between 2006 and 2009.	0 = No 1 = Yes
Key Independent Variables		
Race	Self-reported patient race	0 = White 1 = Black
Rurality	Zip-Code approximated 2010 RUCA codes. Census tracts and zip code areas are cross walked to create zip-code approximations of urban (Metropolitan Areas (RUCA Code <4)) and rural (Micropolitan Areas (RUCA Code >=4)) areas.	0 = Urban 1 = Rural

APPENDIX 4: ASSOCIATION OF RACE AND RESIDENCE WITH VISIT DISPERSION, VISIT CONCENTRATION AND LENGTH OF PCP-PATIENT RELATIONSHIP

	Low Provider Dispersion	High Visit Concentration	Long Relationship
	MMCI > 0.610	UPC >0.375	Relationship > 2.5 years
Black *(Ref white)*	1.05	0.99	1.00
	[0.98,1.13]	[0.93,1.07]	[0.93,1.08]]
Rural *(Ref urban)*	**1.21*** **	0.97	0.97
	[1.13,1.29]	[0.91,1.04]	[0.90,1.03]
Means Test Status *(Ref No Copay-Disabled)*			
No Copay-Low income	**1.13***	**1.13***	**1.19****
	[1.01, 1.27]	[1.00,1.27]	[1.06,1.34]
Copay	1.00	**1.18*****	1.03
	[0.92,1.08]	[1.09,1.27]	[0.95,1.11]
Missing	**0.48***	**0.37****	0.79
	[0.24,0.97]	[0.18,0.77]	[0.41,1.54]
Distance Traveled to Treating Hospital Category *(Ref <10.8 miles)*			
10.8 – 32.4 miles	**1.13****	**1.16*****	**0.87*****
	[1.04,1.23]	[1.07,1.26]	[0.80,0.94]
32.5 – 75.9 miles	**1.37*****	**1.40*****	0.95
	[1.25,1.51]	[1.27,1.54]	[0.86,1.04]
>75.9 miles	**1.27*****	**1.22*****	0.96
	[1.15,1.40]	[1.10,1.34]	[0.86,1.06]
Missing	0.98	0.97	**0.88***
	[0.88,1.08]	[0.87,1.07]	[0.80,0.98]
Age Category *(<40 referent)*			
40 – 64	**2.45***	1.51	1.99
	[1.09,5.49]	[0.73,3.10]	[0.88,4.46]
65-79	**3.11****	1.53	**3.74****

	[1.39,6.99]	[0.74,3.14]	[1.67,8.40]
>79	**3.49****	1.36	**4.60***
	[1.55,7.86]	[0.66,2.80]	[2.04,10.34]
Sex *(Ref Male)*			
Female	0.97	**0.65*****	**1.21***
	[0.83,1.15]	[0.55,0.77]	[1.02,1.42]
Marital Status *(Ref Married)*			
Widowed or Divorced	**0.90*****	0.97	0.95
	[0.85,0.95]	[0.92,1.03]	[0.90,1.01]
Never married	**0.83*****	0.95	0.96
	[0.76,0.92]	[0.87,1.05]	[0.88,1.06]
Missing	1.03	1.07	0.920
	[0.71,1.48]	[0.74,1.54]	[0.63,1.33]
NOSOS Categories *(Ref ≤ 1.0)*			
1.1-2.6	**1.14*****	**0.89****	1.06
	[1.06,1.23]	[0.82,0.95]	[0.98,1.14]
2.7 – 5.4	**1.13****	**0.78*****	1.01
	[1.05,1.21]	[0.73,0.84]	[0.94,1.09]
>5.4	**1.10***	**0.62*****	1.06
	[1.02,1.18]	[0.58,0.67]	[0.98,1.14]
History of Cancer *(Ref No)*			
Yes	1.04	**0.89***	**1.82*****
	[0.94,1.15]	[0.80,0.98]	[1.64,2.03]
N	*23,195*	*23,195*	*23,195*

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
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APPENDIX 5: ASSOCIATION OF RACE AND RESIDENCE WITH ONCOLOGY-SPECIFIC STAFFING RESOURCES

	On-Site Medical Oncologist	Cancer Social Worker	Cancer Psychologist
Black *(Ref White)*	0.93	**1.17*** **	**1.71*** **
	[0.70,1.24]	[1.08,1.27]	[1.58,1.85]
Rural *(Ref Urban)*	1.07	**0.81*** **	**0.67*** **
	[0.84,1.37]	[0.75,0.87]	[0.62,0.73]
Means Test Status *(Ref No Copay-Disabled)*			
No Copay-Low Income	1.62	0.92	1.04
	[0.96,2.74]	[0.81,1.05]	[0.91,1.18]
Copay	1.09	0.94	0.92
	[0.82,1.44]	[0.87,1.03]	[0.85,1.01]
Missing	0.43	0.93	0.43
	[0.06,3.28]	[0.42,2.03]	[0.17,1.12]
Distance Traveled to Treating Hospital Category *(Ref <10.8 miles)*			
10.8 – 32.4 miles	**0.65***	**1.10***	**1.69*** **
	[0.46,0.91]	[1.01,1.19]	[1.55,1.84]
32.5 – 75.9 miles	**0.30*** **	**0.82*** **	**1.29*** **
	[0.22,0.41]	[0.75,0.90]	[1.18,1.41]
>75.9 miles	**2.01** **	**1.66*** **	**1.63*** **
	[1.28,3.15]	[1.51,1.83]	[1.49,1.80]
Missing	1.00	**38.66*** **	**72.67*** **
	[1.00,1.00]	[15.93,93.84]	[40.58,130.15]
Age Category *(Ref <40)*			
40-64	2.83	1.26	0.80
	[0.64,12.42]	[0.60,2.61]	[0.38,1.68]
65-79	2.72	1.29	0.82
	[0.62,11.97]	[0.62,2.69]	[0.39,1.73]
>79	3.94	1.39	0.87

	[0.86,18.01]	[0.67,2.91]	[0.41,1.83]
Sex *(Ref Male)*			
Female	0.71	0.91	1.05
	[0.40,1.27]	[0.76,1.09]	[0.87,1.26]
Marital Status *(Ref Married)*			
Widowed or Divorced	**1.36****	**1.21*****	1.03
	[1.10,1.68]	[1.14,1.29]	[0.97,1.10]
Never Married	**2.58*****	**1.32*****	**1.14***
	[1.56,4.27]	[1.19,1.47]	[1.02,1.27]
Missing	0.93	**0.19*****	**0.19*****
	[0.29,2.99]	[0.12,0.31]	[0.10,0.38]
NOSOS Categories *(Ref ≤ 1)*			
1.1 – 2.6	1.20	1.01	1.04
	[0.93,1.55]	[0.93,1.10]	[0.95,1.13]
2.7 – 5.4	**1.76*****	**1.09***	1.08
	[1.33,2.32]	[1.01,1.19]	[0.99,1.18]
> 5.4	**2.51*****	**1.22*****	**1.14****
	[1.82,3.45]	[1.12,1.33]	[1.05,1.25]
History of Cancer *(Ref No)*			
Yes	1.15	1.08	1.08
	[0.76,1.74]	[0.97,1.21]	[0.96,1.21]
N	*20,118*	*20,430*	*20,430*

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001

APPENDIX 6: ASSOCIATION OF RACE AND RESIDENCE WITH CANCER TUMOR BOARD RESOURCES

	Cancer-Specific Tumor Board	Support Staff Attends Cancer-Specific Board
Black *(Ref White)*	**1.38*** **	**1.49*** **
	[1.28,1.49]	[1.38,1.61]
Rural *(Ref Urban)*	**0.86*** **	0.94
	[0.80,0.92]	[0.87,1.01]
Means Test Status *(Ref No Copay-Disabled)*		
No Copay-Low Income	0.97	0.98
	[0.86,1.11]	[0.87,1.11]
Copay	1.02	0.99
	[0.94,1.11]	[0.92,1.08]
Missing	0.55	0.65
	[0.26,1.17]	[0.31,1.38]
Distance Traveled to Treating Hospital Category *(Ref <10.8 miles)*		
10.8 – 32.4 miles	1.07	**1.16*** **
	[0.98,1.16]	[1.07,1.25]
32.5 – 75.9 miles	1.01	1.00
	[0.93,1.10]	[0.92,1.09]
>75.9 miles	**1.39*** **	**1.34*** **
	[1.27,1.53]	[1.23,1.47]
Missing	**0.03*** **	**0.03*** **
	[0.01,0.05]	[0.01,0.05]
Age Category *(Ref <40)*		
40 - 64	2.07	1.57
	[0.99,4.32]	[0.73,3.28]
65 - 79	**2.09***	1.55
	[1.00,4.37]	[0.74,3.24]
>79	2.18*	1.67

	[1.04,4.58]	[0.80,3.51]
Sex *(Ref Male)*		
Female	0.91	0.93
	[0.76,1.09]	[0.78,1.11]
Marital Status *(Ref Married)*		
Widowed or Divorced	1.05	**0.94***
	[0.99,1.11]	[0.88,0.99]
Never Married	1.09	0.99
	[0.98,1.21]	[0.89,1.10]
Missing	1.22	1.25
	[0.81,1.84]	[0.83,1.86]
NOSOS Category *(Ref ≤ 1)*		
1.1 – 2.6	**1.13****	**1.10***
	[1.04,1.22]	[1.02,1.20]
2.7 – 5.4	**1.27*****	**1.25*****
	[1.17,1.37]	[1.15,1.35]
>5.4	**1.35*****	**1.32*****
	[1.25,1.47]	[1.22,1.43]
History of Cancer *(Ref No)*		
Yes	1.11	1.07
	[1.00,1.24]	[0.96,1.19]
N	*20,430*	*20,430*

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
Cancer-specific tumor boards indicate the presence of lung or colorectal cancer-specific tumor boards
Support staff include: palliative care specialists, social workers, nutritionists and cancer registrars.

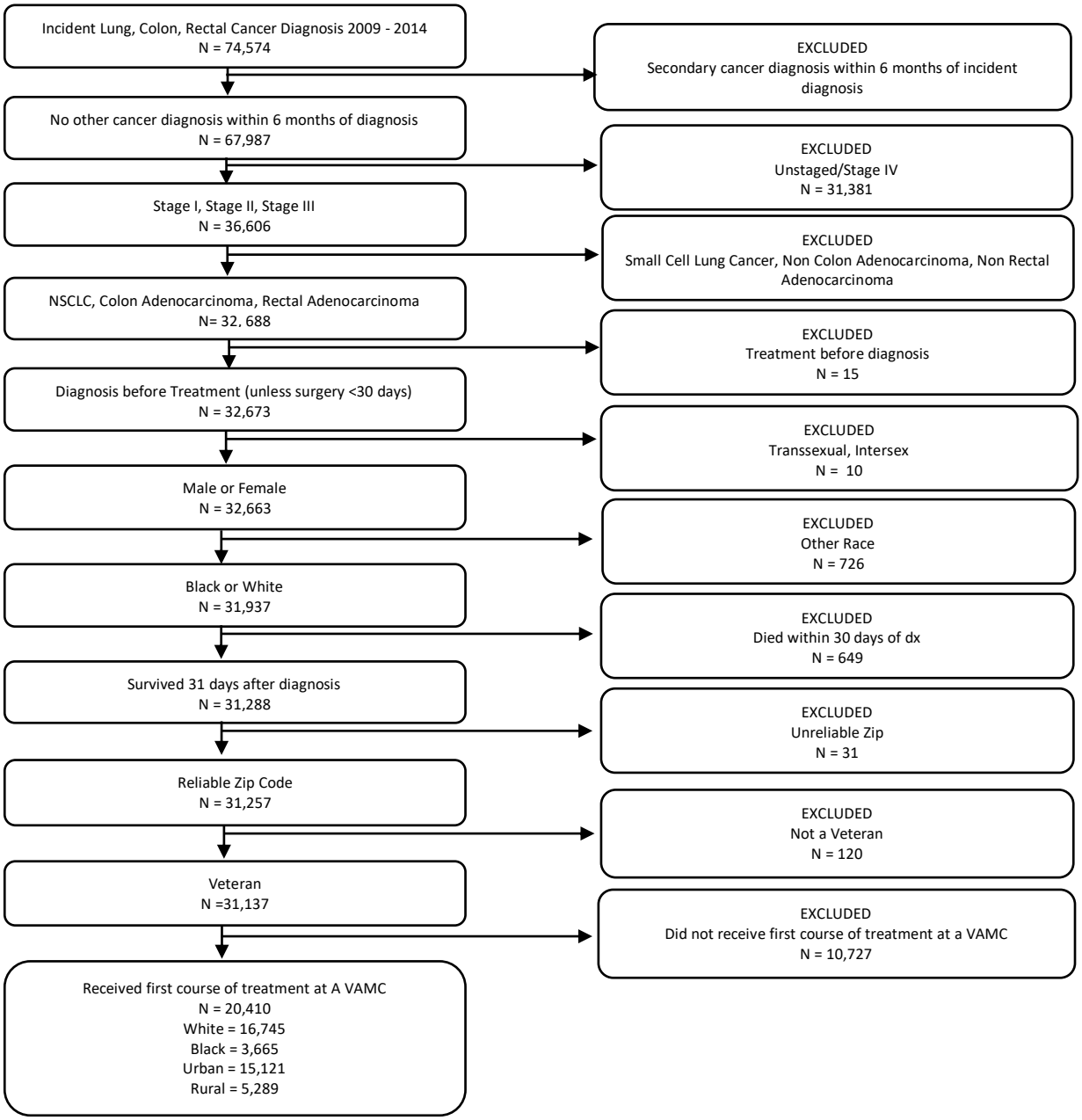
APPENDIX 7: ASSOCIATION OF RACE AND RESIDENCE WITH ONCOLOGY SPECIFIC PATIENT TRACKING AND RESEARCH RESOURCES

	Cancer Patient Tracking	Patient Navigator	Hospital Timeliness Tracking	Oncology Clinical Trial
Black *(Ref White)*	**1.11****	**1.08***	**0.83*****	**1.16****
	[1.03,1.20]	[1.00,1.17]	[0.77,0.90]	[1.06,1.28]
Rural *(Ref Urban)*	1.00	0.99	0.95	**0.69*****
	[0.93,1.08]	[0.92,1.07]	[0.88,1.02]	[0.63,0.75]
Means Test Status *(Ref No Copay-Disabled)*				
No Copay-Low Income	1.00	1.01	0.93	0.91
	[0.88,1.14]	[0.89,1.15]	[0.82,1.05]	[0.78,1.06]
Copay	0.97	1.04	0.92	1.00
	[0.90,1.06]	[0.95,1.12]	[0.85,1.00]	[0.90,1.11]
Missing	0.70	0.65	0.59	1.12
	[0.33,1.48]	[0.29,1.47]	[0.28,1.24]	[0.42,2.99]
Distance Traveled to Treating Hospital Category *(Ref <10.8 miles)*				
10.8 – 32.4 miles	**1.10***	**1.11***	**1.11***	**1.20*****
	[1.02,1.20]	[1.02,1.21]	[1.02,1.20]	[1.09,1.33]
32.5 – 75.9 miles	**1.15****	**1.22*****	**0.91***	**0.78*****
	[1.05,1.26]	[1.12,1.33]	[0.84,1.00]	[0.70,0.86]
>75.9 miles	**1.40*****	**1.11***	0.93	**2.64*****
	[1.28,1.53]	[1.02,1.22]	[0.85,1.02]	[2.34,2.99]
Missing	**31.26*****	**53.29*****	**39.35*****	**31.61*****
	[14.73,66.30]	[28.29,100.39]	[16.22,95.43]	[10.11,98.83]
Age Category *(Ref <40)*				
40 - 64	1.04	1.25	0.84	1.02
	[0.50,2.17]	[0.59,2.68]	[0.40,1.77]	[0.43,2.42]
65 - 79	1.10	1.31	0.87	1.05

	[0.53,2.30]	[0.61,2.80]	[0.41,1.83]	[0.44,2.48]
>79	1.17	1.34	0.88	1.07
	[0.56,2.44]	[0.62,2.87]	[0.42,1.87]	[0.45,2.56]
Sex *(Ref Male)*				
Female	0.88	0.88	0.88	0.98
	[0.74,1.05]	[0.73,1.05]	[0.74,1.05]	[0.79,1.22]
Marital Status *(Ref Married)*				
Widowed or Divorced	0.97	0.95	**0.92****	1.07
	[0.91,1.03]	[0.89,1.01]	[0.87,0.98]	[1.00,1.16]
Never Married	**1.24*****	**1.13***	0.96	1.09
	[1.12,1.38]	[1.02,1.25]	[0.86,1.06]	[0.96,1.24]
Missing	**0.37*****	**0.54****	**0.34*****	1.10
	[0.25,0.56]	[0.35,0.85]	[0.23,0.52]	[0.67,1.80]
NOSOS Category *(Ref ≤ 1)*				
1.1 – 2.6	1.03	1.01	1.02	1.09
	[0.95,1.12]	[0.93,1.09]	[0.94,1.10]	[0.99,1.21]
2.7 – 5.4	0.94	0.94	0.98	**1.26*****
	[0.87,1.02]	[0.87,1.02]	[0.90,1.06]	[1.14,1.39]
>5.4	0.97	0.94	1.04	**1.34*****
	[0.89,1.05]	[0.87,1.02]	[0.96,1.13]	[1.21,1.48]
History of Cancer *(Ref No)*				
Yes	1.04	1.06	1.09	1.08
	[0.93,1.16]	[0.95,1.18]	[0.98,1.21]	[0.94,1.23]
N	*20,430*	*20,430*	*20,430*	*20,430*

Exponentiated coefficients; 95% confidence intervals in brackets
* p<0.05, ** p<0.01, *** p<0.001
Cancer-specific tumor boards indicate the presence of lung or colorectal cancer-specific tumor boards
Support staff include: palliative care specialists, social workers, nutritionists and cancer registrars.

APPENDIX 8: CHAPTERS 5 AND 6 CONSORT DIAGRAM



APPENDIX 9: CHAPTER 5 VARIABLE VALUES AND DEFINITIONS

Variable	Component	Definition	Variable Value
Outcomes			
Time-to-treatment initiation.		A measure of the number of days between diagnosis and treatment initiation (first evidence of surgery, chemo, radiation or chemoradiation).	
Late treatment initiation.		A measure of whether the Veteran received their first course of treatment within 10 weeks of diagnosis.	0 = No 1 = Yes
Key Independent Variables			
Race		Self-reported patient race	0 = White 1 = Black
Oncology Specific Resources			
On-site cancer social worker		There is a social worker with a cancer specialty available at the hospital.	0 = No support staff 1 = on-site cancer social worker or on-site cancer psychologist 2 = On-site cancer social worker and on-site cancer psychologist
Cancer-specific tumor board		A measure of whether the hospital has a lung cancer or colorectal cancer-specific tumor board, and whether a palliative care specialist, social worker, nutritionist, and/or cancer registrar regularly attends the cancer-specific tumor board.	0 = No cancer-specific tumor board 1 = Cancer-specific tumor board without regular support staff attendance 2 = Cancer-specific tumor board with regular support staff attendance
Guideline Concordance and Timeliness Tracking		The hospital has a measurement system that tracks their overall adherence to guideline-based of cancer care.	0 = No hospital timelines tracking 1 = Hospital timelines tracking
Oncology Clinial Trials		Indicates the availability of an oncology-related clinical trial between 2006 and 2009.	0 = No Oncology clinical trial 1 = Oncology Clinical Trial

Continuity of Care			
Summary Continuity of Care	Modified-Modified Continuity Index (MMCI)	A measure of visit dispersion between primary care providers in the two years prior to diagnosis. Ranges from 0 (each visit with a different primary care provider) to 1 (1 all visits made with a single primary care provider). High Dispersion = 0 Low Dispersion = MMCI ≥0.610 = 1	0 = high dispersion and low concentration 1 =low dispersion or high concentration 2 = low dispersion and high concentration
	Usual Provider of Care (UPC)	A measure of visit concentration. UPC measures the proportion of visits the patient made to their modal provider in the two years prior to diagnosis. Ranges from 0 (no visits with a regular provider) to 1 (all visits with the regular provider) Low Concentration = 0 High Concentration = UPC≥0.375 = 1	
Covariates			
Age at diagnosis		The patient's age at diagnosis.	0 = < 64 1 =65-79 2 = ≥79
Rurality		Zip-Code approximated 2010 RUCA codes. Census tracts and zip code areas were cross walked to create zip-code approximations of urban (Metropolitan Areas (RUCA Code <4)) and rural (Micropolitan Areas (RUCA Code >=4)) areas.	0 = Urban 1 = Rural
Sex		Self-reported sex	0 = Male 1 = Female

VA Copayment Status		Copay status is determined by the Veteran's service-connected disability status and their socioeconomic status.	0 = No copay – service connected disability 1 = No copay – low income 2 = Copay required 3 = Missing
Distance to Treating Hospital		The distance between the centroid of the patient's zip code and the treating hospital's zip code, in miles.	0 = < 10.8 Miles 1 = 10.8 – 32.4 Miles 2 = 32.5 – 75.9 Miles 4 = ≥75.9 Miles
Nosos Risk Score		A risk score recalibrated from the Centers for Medicare and Medicaid Services (CMS) V21 risk score, calculated every fiscal year. Uses the patient's age, gender, pharmacy records, priority status and VA computed costs to adjust for risk when making comparisons in research.	0 = ≤ 1 1 = 1.1 – 2.6 2 = 2.7 – 5.4 3 = ≥5.4
History of Cancer		An indication that the patient has had a previous cancer (treated within or outside the VA) documented in the VACCR.	0 = No 1 = Yes
First Course of Treatment		First course of treatment type.	0 = Surgery 1 = Chemotherapy 2= Radiation 3= Chemoradiation
Cancer Type			0 = Lung Cancer 1 = Colon Cancer 2 = Rectal Cancer
First Course of Treatment		First evidence of surgical resection, chemotherapy, radiation therapy, chemoradiation	0 = Surgical Resection 1 = Chemotherapy 2 = Radiation Therapy 4 = Chemoradiation

APPENDIX 10: CHAPTER 6 VARIABLE VALUES AND DEFINITIONS

Variable	Component	Definition	Variable Value
Outcomes			
Time-to-treatment initiation.		A measure of the number of days between diagnosis and treatment initiation (first evidence of surgery, chemo, radiation or chemoradiation).	
Late treatment initiation.		A measure of whether the Veteran received their first course of treatment within 10 weeks of diagnosis.	0 = No 1 = Yes
Key Independent Variables			
Race		Self-reported patient race	0 = White 1 = Black
Oncology Specific Resources			
On-site cancer social worker		There is a social worker with a cancer specialty available at the hospital.	0 = No support staff 1 = on-site cancer social worker or on-site cancer psychologist 2 = On-site cancer social worker and on-site cancer psychologist
Cancer-specific tumor board		A measure of whether the hospital has a lung cancer or colorectal cancer-specific tumor board, and whether a palliative care specialist, social worker, nutritionist, and/or cancer registrar regularly attends the cancer-specific tumor board.	0 = No cancer-specific tumor board 1 = Cancer-specific tumor board without regular support staff attendance 2 = Cancer-specific tumor board with regular support staff attendance
Guideline Concordance and Timeliness Tracking		The hospital has a measurement system that tracks their overall adherence to guideline-based of cancer care.	0 = No hospital timelines tracking 1 = Hospital timelines tracking
Oncology Clinical Trials		Indicates the availability of an oncology-related clinical trial between 2006 and 2009.	0 = No Oncology clinical trial 1 = Oncology Clinical Trial

Variable	Component	Definition	Variable Value
Continuity of Care			
Summary Continuity of Care	Modified-Modified Continuity Index (MMCI)	A measure of visit dispersion between primary care providers in the two years prior to diagnosis. Ranges from 0 (each visit with a different primary care provider) to 1 (1 all visits made with a single primary care provider). High Dispersion = 0 Low Dispersion = MMCI ≥0.610 = 1	0 = high dispersion and low concentration 1 =low dispersion or high concentration 2 = low dispersion and high concentration
	Usual Provider of Care (UPC)	A measure of visit concentration. UPC measures the proportion of visits the patient made to their modal provider in the two years prior to diagnosis. Ranges from 0 (no visits with a regular provider) to 1 (all visits with the regular provider) Low Concentration = 0 High Concentration = UPC≥0.375 = 1	
Covariates			
Age at diagnosis		The patient's age at diagnosis.	0 = < 64 1 =65-79 2 = ≥79
Rurality		Zip-Code approximated 2010 RUCA codes. Census tracts and zip code areas were cross walked to create zip-code approximations of urban (Metropolitan Areas (RUCA Code <4)) and rural (Micropolitan Areas (RUCA Code >=4)) areas.	0 = Urban 1 = Rural
Sex		Self-reported sex	0 = Male 1 = Female

Variable	Component	Definition	Variable Value
VA Copayment Status		Copay status is determined by the Veteran's service-connected disability status and their socioeconomic status.	0 = No copay – service connected disability 1 = No copay – low income 2 = Copay required 3 = Missing
Distance to Treating Hospital		The distance between the centroid of the patient's zip code and the treating hospital's zip code, in miles.	0 = < 10.8 Miles 1 = 10.8 – 32.4 Miles 2 = 32.5 – 75.9 Miles 4 = ≥75.9 Miles
Nosos Risk Score		A risk score recalibrated from the Centers for Medicare and Medicaid Services (CMS) V21 risk score, calculated every fiscal year. Uses the patient's age, gender, pharmacy records, priority status and VA computed costs to adjust for risk when making comparisons in research.	0 = ≤ 1 1 = 1.1 – 2.6 2 = 2.7 – 5.4 3 = ≥5.4
History of Cancer		An indication that the patient has had a previous cancer (treated within or outside the VA) documented in the VACCR.	0 = No 1 = Yes
First Course of Treatment		First course of treatment type.	0 = Surgery 1 = Chemotherapy 2= Radiation 3= Chemoradiation
Cancer Type			0 = Lung Cancer 1 = Colon Cancer 2 = Rectal Cancer
First Course of Treatment		First evidence of surgical resection, chemotherapy, radiation therapy, chemoradiation	0 = Surgical Resection 1 = Chemotherapy 2 = Radiation Therapy 4 = Chemoradiation

APPENDIX 11: ASSOCIATION OF CLINICAL, HOSPITAL AND CONTINUITY OF CARE VARIABLES AND TIMELY TREATMENT (TREATMENT RECEIPT WITHIN 10 WEEKS) – POOLED LOGIT MODEL INCLUDING THE FULL SAMPLE

	Logit Point Estimate [95%CI]	Adjusted Odds Ratio [95% CI]
Black *(ref: White)*	**-0.25*** **	**0.78*** **
	[-0.034,-0.16]	[0.71,0.85]
	[-0.14,0.06]	[0.87,1.06]
NOSOS *(ref: ≤ 1)*		
1.1 – 2.6	0.08	1.08
	[-0.02,0.18]	[0.98,01.19]
2.7 – 5.4	**0.23*** **	**1.26*** **
	[0.14,0.33]	[1.15,1.39]
>5.4	**0.20*** **	**1.22*** **
	[0.10,0.30]	[1.11,1.35]
Stage at Diagnosis *(ref: 1)*		
2	0.03	1.03
	[-0.06,0.12]	[0.94,1.13]
3	**0.33*** **	**1.40*** **
	[0.24,0.43]	[1.27,1.53]
Treatment Type *(ref: Surgical Resection)*		
Chemotherapy	**-0.30*** **	**0.74*** **
	[-0.40,-0.19]	[0.67,0.83]
Radiation Therapy	**-0.36*** **	**0.70*** **
	[-0.47,-0.26]	[0.63,0.77]
Chemoradiation	**-.05***	**0.58***
	[-1.03,-0.06]	[0.36,0.94]
Low Provider Dispersion *(ref: High Provider Dispersion)*		
	-0.00	1.00
	[-0.07,0.07]	[0.93,1.07]
High Visit Concentration *(ref: Low Visit Concentration)*		
	0.02	1.02
	[-0.05,0.09]	[0.95,1.09]
Social Worker		
	-0.02	0.98
	[-0.11,0.08]	[0.90,1.08]
Psychologist		
	-0.26* **	**0.77*** **
	[-0.35,-0.18]	[0.71,0.84]
Cancer-Specific Tumor Board without Support Staff Attendance *(ref: No Cancer-Specific Tumor Board)*		
	-0.17*	**0.85***
	[-0.31,-0.03]	[0.73,0.97]

	Logit Point Estimate [95%CI]	Adjusted Odds Ratio [95% CI]
Cancer-Specific Tumor Board with Support Staff Attendance *(ref: No Cancer-Specific Tumor Board)*		
	-0.02	0.98
	[-0.11,0.06]	[0.90,1.06]
Timeliness Tracking		
	0.04	1.04
	[-0.04,0.11]	[0.96,1.12]
Oncology Clinical Trial		
	-0.01	0.99
	[-0.34,-0.16]	[0.90,1.09]
N	*20,430*	*20,430*

* p<0.05, ** p<0.01, *** p<0.001

Low Dispersion = MMCI ≥0.610 = 1

High Concentration = UPC≥0.375 = 1

Support staff includes palliative care specialists, social workers, nutritionists, or cancer registrars

Other covariates included cancer type (lung, colon, rectal); age at diagnosis (≤64, 65-79, >79); sex (male, female); marital status at diagnosis (married, single, widowed or divorced, missing); straight-line distance between the centroid of the patient's zip code to the centroid of the treating hospital's zip code, in miles (<10.8 miles, 10.8 – 32.4 miles, 32.5-75.9 miles, >75.9 miles, missing); rurality (urban, rural) based on patient's residential zip code; a binary indicator of prior history of cancer; VA copayment status (no copay due to service-connected disability, no copay due to low income status, copay required, missing)

APPENDIX 12: RELATIVE CONTRIBUTION OF CLINICAL, HOSPITAL AND CONTINUITY OF CARE VARIABLES TO THE OBSERVED GAP IN TIMELY TREATMENT (E.G. TREATMENT INITIATED WITHIN 10 WEEKS OF DIAGNOSIS) – RESULTS OF AN OAXACA-BLINDER DECOMPOSITION

	Explained Percentage Point (pp) [95% Confidence Interval (CI)]	**Unexplained PP 95% CI**
Nosos Risk Score < 1.1	**-0.06***	0.51
	[-0.11,-0.01]	[-0.28,1.30]
1.1 – 2.6	0.00	0.40
	[-0.01,0.01]	[-0.44,1.25]
2.7 – 5.4	-0.02	**-1.08***
	[-0.05,0.00]	[-2.07,-0.10]
>5.4	-0.03	-0.03
	[-0.05,0.00]	[-0.95,0.89]
Stage 1	-0.02	-0.93
	[-0.05,0.01]	[-2.15,0.29]
Stage 2	**-0.03***	**0.79***
	[-0.06,0.00]	[0.00,1.58]
Stage 3	**-0.11****	-0.41
	[-0.19,-0.03]	[-1.70,0.87]
Surgical resection	**0.11****	-3.21
	[0.03,0.19]	[-8.71,2.29]
Chemotherapy	0.00	-1.00
	[-0.00,0.00]	[-2.59,5.95]
Radiation Therapy	0.02	0.07
	[-0.03,0.07]	[-1.11,1.25]
Chemoradiation	0.00	0.04
	[-0.02,0.01]	[-0.05,0.12]
No Cancer-Specific Tumor Board	0.06	**-2.54****
	[-0.01,0.12]	[-4.28,-0.80]
Cancer-Specific Tumor Board without Support Staff Attendance	-0.02	**0.37***
	[-0.04,0.00]	[0.01,0.74]
Cancer-Specific Tumor Board with Support Staff Attendance	-0.04	0.54
	[-0.11,0.02]	[-1.47,2.55]
High Provider Dispersion	0.00	-0.29
	[-0.01,0.01]	[-1.36 ,0.78]
Low Provider Dispersion	0.00	0.28
	[-0.01,0.01]	[-0.74,1.30]
Low Provider Concentration	0.00	-0.12

	Explained Percentage Point (pp) [95% Confidence Interval (CI)]	**Unexplained PP 95% CI**
	[-0.01,0.01]	[-1.18,0.93]
High Provider Concentration	0.00	0.12
	[-0.01,0.01]	[-0.91,1.16]
No Cancer Social Worker	0.00	0.04
	[-0.02,0.02]	[-0.90,0.98]
Cancer Social Worker	0.00	-0.10
	[-0.02,0.02]	[-2.01,1.82]
No Cancer Psychologist	**0.16*** **	1.12
	[0.07,0.24]	[-0.35,2.59]
Cancer Psychologist	**0.16*** **	-0.80
	[0.07,0.24]	[-1.85 ,0.24]
No hospital guideline concordance or timeliness tracking	0.01	**1.14***
	[-0.01,0.03]	[0.17,2.11]
Hospital guideline concordance or timeliness tracking	0.02	**-1.55***
	[-0.02,0.03]	[-2.87,-0.23]
No Oncology Clinical Trial	0.00	0.51
	[-0.01,0.01]	[-0.04,2.06]
Oncology Clinical Trial	0.00	-2.21
	[-0.01,0.01]	[-4.60,0.19]
Portion of the difference explained	-0.39	**4.34*** **
	[-1.01,0.24]	[2.78,5.90]
N	*20,430*	*20,430*

Oaxaca-Blinder Decomposition, using a "pooled" logit where the coefficients from a pooled model, including both black and white veterans are the counterfactual. Categorical variables were normalized and not sensitive to the choice of base category.

Black veterans were the reference category: a positive estimate indicates that white veterans benefit from the covariate distribution (explained) and/or the effect of the covariate on the outcome (unexplained) relative to black veterans. A negative point estimate indicates the opposite.

* p<0.05, ** p<0.01, *** p<0.001

Low Dispersion = MMCI ≥0.610 = 1

High Concentration = UPC≥0.375 = 1

Support staff includes palliative care specialists, social workers, nutritionists, or cancer registrars

Other covariates included cancer type (lung, colon, rectal); age at diagnosis (≤64, 65-79, >79); sex (male, female); marital status at diagnosis (married, single, widowed or divorced, missing); straight-line distance between the centroid of the patient's zip code to the centroid of the treating hospital's zip code, in miles (<10.8 miles, 10.8 – 32.4 miles, 32.5-75.9 miles, >75.9 miles, missing); rurality (urban, rural) based on patient's residential zip code; a binary indicator of prior history of cancer; VA copayment status (no copay due to service-connected disability, no copay due to low income status, copay required, missing)

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