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Burden of Breast Cancer and Associated Health and Economic Outcomes in Elderly Women in West Virginia: Comparison with National Estimates

Ami Maulik Vyas

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“Burden of Breast Cancer and Associated Health and Economic Outcomes in Elderly Women in West Virginia: Comparison with National Estimates”

Ami Maulik Vyas ¹

**Dissertation submitted to the School of Pharmacy
at West Virginia University
in partial fulfillment of the requirements
for the degree of**

**Doctor of Philosophy
in
Health Outcomes Research**

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Keywords: Breast Cancer; Surveillance, Epidemiology, and End Results (SEER); West Virginia Cancer Registry; Medicare; Mammography Screening; Persistence; Timeliness of Care; Blinder-Oaxaca Linear Decomposition; Generalized Linear Modeling; Logistic Regression

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ABSTRACT

“Burden of Breast Cancer and Associated Health and Economic Outcomes in Elderly Women in West Virginia: Comparison with National Estimates”

Ami Maulik Vyas

West Virginia (WV) which is the only state which lies entirely in Appalachia and which is predominantly rural and medically underserved region, has lower incidence of breast cancer (BC) but a higher BC-related mortality as compared to the national averages in elderly women age 65 and above. This may be due to lower mammography utilization in these rural elderly women, limited physical access to services, shortage of healthcare professionals and services, and untimely and/or inappropriate care. This is dearth of epidemiological studies that have focused on understanding the factors associated with these disparities among these rural and underserved population such as WV. The purpose of this project was to do a detailed evaluation of burden of BC and its associated health and economic outcomes in elderly women in WV, and to compare these estimates with the national estimates. Three retrospective observational studies were conducted using West Virginia Cancer Registry-Medicare and Surveillance, Epidemiology, and End Results (SEER)-Medicare linked datasets for the years 2002-2007. In the first study, persistence with mammography screening and its effect on stage at BC diagnosis was investigated for the elderly rural WV women and was compared to the national estimates from SEER-Medicare data. The study found no significant differences in the representation of disease between WV-Medicare and SEER-Medicare cohorts even after controlling for persistence with mammography screening. In the second study, timeliness of BC care in regards to diagnosis and treatment as per the published opinion-based recommendations and its effect on chances of being alive at the follow-up period was determined for the WV-Medicare cohort and then was compared to the SEER-Medicare cohort. The study found that the WV-Medicare cohort was significantly less likely to receive timely diagnosis of BC as per recommendations when compared to the SEER-Medicare cohort. However, there were no significant differences between these cohorts for the timely treatment of BC. Also, delayed diagnosis was not associated with poorer prognosis in the WV-Medicare cohort. In the third study, average total healthcare costs in the initial phase of 12-months following BC diagnosis and costs by types of specific services were estimated for the WV-Medicare cohort and these were compared to the national estimates derived from the SEER-Medicare cohort. This study reported that average total healthcare costs, inpatient costs and physician services costs were significantly lower for the WV-Medicare cohort as compared to the SEER-Medicare cohort. Also, the decomposition analyses only explained total 16% of the differences in the average costs due to the cohorts' characteristics. Overall, the findings of this project highlight the importance of persistence with mammography screening and timely BC care in the elderly, rural and underserved women diagnosed with BC. Moreover, these studies can serve as a foundation for larger studies aimed at decreasing BC disparities in a rural and geographically challenged state such as WV, through the development of strategies and interventions to foster early detection and timely treatment of BC among rural populations.

DEDICATION

I dedicate this dissertation to my husband, Maulik, my mom, Kanta, my dad, Prabhudas, my two sisters, Pinky and Bansary, for their continued love and support.

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CHAPTER 1

CHAPTER 1

INTRODUCTION

BACKGROUND

Breast Cancer Overview

Breast cancer (BC) is a malignant tumor that starts in the cells of the breast. A malignant tumor is a group of cancer cells that invade surrounding tissues of the breast or metastasize to distant areas of the body. BC is the most common cancer in women and is the second leading cause of cancer death in women in the United States (US). About 1 in 8 (12%) women in the US will develop invasive BC during their lifetime. According to the 2014 statistics by American Cancer Society, it is estimated that about 232,670 new cases of invasive BC, and about 62,570 new cases of carcinoma in situ (CIS) will be diagnosed, and 40,000 women will die from BC in the US ¹.

Risk factors for Breast Cancer ²

There are various modifiable and non-modifiable factors which affect a woman's chance of developing BC. Some of the non-modifiable risk factors increasing a woman's risk of developing BC are gender (female), advanced age, family history of BC, personal history of BC, early menarche and late menopause, inherited genetic mutations (BRCA1/BRCA2 or others), having dense breast tissue, some benign breast conditions, previous chest radiation for other malignancies, and diethylstilbestrol exposure. Modifiable risk factors associated with the development of BC in women include nulliparity, delayed child bearing, no full-term pregnancies, never breastfed, oral contraceptive use, post-menopausal hormone therapy, obesity, decreased physical activity, and alcohol consumption.

Breast Cancer Epidemiology

BC incidence and mortality rates vary significantly by age. Based on 2005-2009 Surveillance, Epidemiology and End Results (SEER) statistics, the median age at diagnosis and mortality due to BC is 61 and 68 years, respectively ³. Also, 41% of the new BC cases and 57.4% of the BC deaths occur in women age 65 and above ³. The overall incidence of BC in women below 65 years of age is 82.97 per 100,000 and is 421.30 per 100,000 women in those above age 65 ³. The overall mortality from BC is 11.15 per 100,000 women for those less than 65 years of age and is 98.64 per 100,000 women in those above age 65 ³. Furthermore, older women age 65 and above have a greater burden of BC as they are diagnosed at advanced stages and with larger tumors impacting their survival ⁴.

Mammography Screening

Screening tests can find cancers in early stages before they start to cause symptoms and hence help in reducing cancer-related mortality. Mammography screening is considered to be the 'gold standard' for women at average risk and it enables BC detection at an early stage, when the treatment is most effective and tends to require less intense systemic and local therapies ^{5,6}. Several clinical trials have shown that mammography screening reduces BC-related mortality by 20-35% in women age 40-69 years of age ⁶⁻¹⁰. Also, a recent Cochrane review reported that mammography screening reduces relative risk in BC mortality by 15% with 0.05% reduction in absolute risk ¹¹.

Women diagnosed with BC who have had a screening mammogram within the previous two years are significantly less likely to have late-stage disease ¹². However, in 2010, only 64% of women age 65 and above had a mammography screening within the previous two years as

compared to 73% of women age 50-64 years ² even though annual screening mammograms are recommended and covered by both Medicare and Medicaid.

Breast Cancer and Mammography Screening in West Virginia

West Virginia (WV) is the only state that lies entirely in Appalachia, a region which is predominantly rural and medically underserved, characterized by high poverty rates, low levels of education, an aging population, high rates of chronic disease, and poor health behaviors ¹³⁻¹⁶. For 2009, WV was reported to have a lower incidence of BC (112.6 vs. 122.9 nationally) but a higher BC-related mortality (23.3 vs. 22.2 nationally) ^{17,18}. Also, WV is reported to have higher rates of advanced and unstaged BC ¹⁹⁻²³, which has been attributed to lower mammography screening rates of women in WV ²⁰⁻²⁴. In 2010, WV was ranked 48th among US states for women having mammography screening within the past two years ²⁵. In 2008, WV was ranked sixth nationally in BC deaths ^{26,27}.

In WV women age 65 years and above, BC accounted for 12% of all the incident cancer cases ²⁸ and 5.3% of all cancer deaths ²⁹. For 2009 among women age 65 and older, WV had lower incidence of BC (372.8 per 100,000 vs. 411.7 per 100,000) but higher BC-related mortality (110.4 per 100,000 vs. 98.6 per 100,000) ^{17,18} as compared to the national estimates. This may be attributed to numerous factors such as lower mammography screening rates in these elderly women ^{21-23,30}, limited physical access to services, shortage of healthcare professionals and services ³¹, and untimely BC care. These disparities also indicate that elderly women diagnosed with BC in WV may have higher healthcare costs after cancer diagnosis.

NEED FOR STUDY

Persistence with Mammography Screening and Stage at Breast Cancer Diagnosis

Though mammography screening has been shown to reduce BC mortality by 20-35% in the average-risk women age 40-69 years⁶⁻¹⁰, it is not clearly evident whether or not mammography screening is beneficial in older women. This is because very few screening trials assessing the benefits of mammography screening have included women aged 70 and above³². Moreover, there is a deficit of evidence-based guidelines for mammography screening in elderly women. Current US-based guidelines about screening mammography³³⁻³⁵ have no upper age limit set for the procedure and suggest woman should have mammography screening as long as she is in good health. Elderly women age 65 and above have a greater burden of BC as cancer tends to be found at advanced stages with larger tumor sizes, and thereby leading to poorer survival⁴. Additionally, the literature has also reported that these women are less likely to utilize mammography screening as compared to their younger counterparts^{33,36,37}. In 2010, 64% of women age 65 and above had a mammography screening within the previous two years as compared to 73% among women age 50-64 years³³. Various studies have demonstrated the benefits of mammography screening utilization in women age 65 and above on stage at BC diagnosis, an important predictor of survival³⁸⁻⁴¹. Yet, these studies have limitations in terms of only including younger women, utilizing data from fewer cancer registries or utilizing data from limited time period before BC diagnosis, and not effectively distinguishing screening and diagnostic mammography claims, an inherent problem with Medicare claims data.

Very limited information is available about the effect of mammography screening and stage at BC diagnosis among elderly Medicare beneficiaries diagnosed with BC from rural settings and non-SEER Medicare states. With lower incidence of BC but higher BC-related

mortality in elderly WV women and lower mammography screening rates in these women, there is a vital need to determine the association between persistence with mammography screening and stage at BC diagnosis.

Timeliness of Care among Elderly Women Diagnosed with Breast Cancer

Though BC is a major health issue and the second cause of cancer-related deaths in women in the US, measuring quality of care delivered to women diagnosed with BC is extremely challenging. Timeliness of care i.e. prompt diagnosis after detecting an abnormality in the breast and prompt initiation of the treatment after BC diagnosis is an important component of high-quality BC treatment. Providing timely care to BC patients is significant to both patients and primary providers in order to reduce BC-related mortality^{42,43}. Despite the widely accepted benefit of timely care in BC patients, the US-based guidelines have yet to define an appropriate time frame from presentation of abnormality in a breast to confirmed BC diagnosis and from BC diagnosis to the initiation of the treatment. However, other international oncology organizations such as European Society of Breast Cancer Specialists (EUSOMA) and National Health Service of United Kingdom have published professional opinion-based recommendations. Each group provides recommendations on time intervals between events such as presentation of abnormality to diagnosis of BC⁴⁴ and between BC diagnosis to the initiation of the treatment⁴⁵, respectively.

Various studies regarding timeliness of BC care have been conducted in the last decade in the US⁴⁶⁻⁵⁴, but no consensus exists regarding an appropriate time from diagnosis and to treatment. Also, none of these studies have followed any published opinion-based recommendations to appropriately define timely diagnosis and treatment.

As elderly women age 65 years and above have higher BC incidence and mortality and are more likely to have advanced stage disease at diagnosis^{3,4}, it is highly likely that delayed

diagnosis and/or delayed treatment may negatively affect the prognosis of the disease, and hence their survival. Previous literature has also reported that delay in diagnosis is a major factor contributing to the poor survival in elderly women diagnosed with BC⁴. Hence, it is exceedingly important to determine timeliness of BC care based on the published opinion-based recommendations among elderly women with BC in the US. In addition, as WV had a lower incidence of BC among women age 65 and above but higher BC-related mortality^{17,18} as compared to the national estimates, it is possible that the timeliness of care may be one of the important contributors to these disparities. Therefore, a study comparing the timeliness of BC care among elderly WV women diagnosed with BC to the national estimates may help begin to understand these disparities.

Total Healthcare Costs of Breast Cancer in the Initial Phase (12-months) After Diagnosis

The lifetime per-patient direct medical care cost estimates of BC ranged from \$20,000 to \$100,000 for the base cost year from 1984 to 2003⁵⁵. The direct medical costs of initial and terminal care for women with BC are reported to be significantly higher than that of the continuing care on a per unit time basis⁵⁵. This is because the costs of BC care are substantial during the initial care (12-months) period encompassing the time from diagnosis to surgery, radiation and adjuvant systemic therapy which constitute the major cost components in cancer therapy⁵⁶⁻⁵⁹.

To date, a majority of the studies estimating total healthcare costs during the initial period after BC diagnosis in elderly women are either outdated or have utilized SEER-Medicare data from fewer cancer registries and states/regions or have not stratified the results by stage at diagnosis, comorbidity and type of initial treatment. Besides, very limited information is available about the healthcare costs in elderly women diagnosed with BC from rural settings and

from non-SEER states, such as WV. As WV has a lower incidence of BC but a higher BC-related mortality among women age 65 and older^{17,18} as compared to the national estimates and with the increasing median age of the population and higher BC cases at advanced stages, it may be likely that healthcare costs during the initial period among elderly WV women diagnosed with BC may be higher as compared to the national estimates. Thus, a study comparing the healthcare costs during the initial period of 12-months among elderly WV women diagnosed with BC with that of the national estimates is essential to understand any such disparities. This data may aid in planning for healthcare costs and may facilitate resource allocation in the future.

SPECIFIC AIMS AND OBJECTIVES

The specific aims and objectives of the project are:

Specific Aim 1: To determine the association between persistence with mammography screening and stage at BC diagnosis among Medicare fee-for-service (FFS) beneficiaries in WV and compare it with national estimates from the SEER-Medicare data

Objective 1: To determine the proportion of Medicare FFS women beneficiaries with incident BC persistent with mammography screening in WV and compare it with national estimates from the SEER-Medicare data

Objective 2: To determine the stage at BC diagnosis among women Medicare FFS beneficiaries in WV by mammography screening persistence and compare it with the national estimates from the SEER-Medicare data

Objective 3: To determine the association between persistence with mammography screening and stage at BC diagnosis among women Medicare FFS beneficiaries in WV, after controlling for predisposing factors (age), enabling factors (median household income, education level), need factors (co-occurring chronic conditions), healthcare use (number of primary care physicians

(PCP) visits in five years before BC diagnosis) and external healthcare environmental factors (location of residence and number of hospitals offering BC screening/mammography services in the area of residence), and compare it with the national estimates from the SEER-Medicare data

Specific Aim 2: To determine the timeliness of BC care based on published recommendations among Medicare FFS beneficiaries in WV and compare it with the national estimates from the SEER-Medicare data

Objective 1: To determine time to diagnosis and treatment among WV women Medicare FFS beneficiaries and compare them with the national estimates from the SEER-Medicare data

Objective 2: To determine the proportion of WV women Medicare FFS beneficiaries receiving timely BC care based on published recommendations and compare it with the national estimates from the SEER-Medicare data

Objective 3: To identify the factors associated with receipt of timely BC care based on published recommendations among WV women Medicare FFS beneficiaries and compare them with the national estimates from the SEER-Medicare data

Objective 4: To determine the association between receipt of timely BC care based on published recommendations and survival among WV women Medicare FFS beneficiaries, and compare it with the national estimates from SEER-Medicare data

Specific Aim 3: To determine average total healthcare costs and costs by type of specific services during the initial phase of 12 months following an incident diagnosis of BC among Medicare FFS beneficiaries in WV and compare it with the national estimates from SEER-Medicare data

Objective 1: To determine average total healthcare costs in initial phase among Medicare FFS beneficiaries in WV, and compare it with the national estimates from the SEER-Medicare data

Objective 2: To determine average total healthcare costs by types of specific services in the initial phase among Medicare FFS beneficiaries in WV, and compare them with the national estimates from the SEER-Medicare data

Objective 3: To determine the predictors of average total healthcare costs in the initial phase among Medicare FFS beneficiaries in WV and compare them with the estimates from SEER-Medicare data

Objective 4: To determine the magnitude of differences in the average total healthcare costs in the initial phase between Medicare FFS beneficiaries in WV and those from the SEER-Medicare using decomposition analysis

CONCEPTUAL FRAMEWORK

The Andersen Behavioral Model for Health Services Utilization (Andersen model) was utilized as the conceptual model in these studies^{60,61}. This model that has been used for decades in predicting health services utilization in population-based studies postulates that healthcare services utilization is the function of the predisposition of individuals to use services, factors which enable or impede use, the need for care, healthcare use, and external environmental. This model is one of the most frequently used conceptual frameworks for analyzing individual's utilization of health care services (**Figure 1.1**).

Predisposing factors such as age, race, and enabling factors such as census tract annual household income and census tract education level were included in the model. Need-related factors included in the model were comorbidities, mental conditions, stage at diagnosis, grade of tumor, estrogen-receptor status, and size of tumor. The later four variables were included only in Aims 2 and 3. Healthcare use consisted of persistence with mammography screening, primary care physicians visits, type of initial treatment, and inpatient use. The later two variables were

included only in Aims 2 and 3. External health care environment factors included in the model were location of residence and number of hospitals offering BC screening and oncology related services. Using this Andersen Behavioral model of healthcare services utilization provides a strong theoretical framework to identify the factors which influence stage at BC diagnosis (Aim 1), timeliness of BC care (Aim 2), and total healthcare costs in the initial period of one year (Aim 3).

SIGNIFICANCE

Aim 1 results from this study will help understand the disparities in stage at the time of BC diagnosis by persistence with mammography screening among Medicare FFS beneficiaries from rural setting, such as WV, and how this association varies from national estimates. Aim 2 results will help to identify disparities in the timeliness of BC care and the factors contributing to timely diagnosis and treatment and how timely care affect survival among elderly Medicare FFS beneficiaries diagnosed with BC from a rural setting such as WV, and compare them with the national sample estimates. Aim 3 results will help to understand average total healthcare costs in the initial phase, and to what extent age, race, location of residence, type of treatment, comorbidity burden and clinical variables affect these costs in elderly Medicare FFS beneficiaries in WV diagnosed with BC and variation from the national estimates will also be obtained. In addition, comparing average total healthcare costs among elderly Medicare beneficiaries in WV with incident BC to the national sample will help to determine whether or not these costs were higher in a rural setting such as WV with higher median age and where the majority of the elderly women are diagnosed at advanced stages of BC. Overall, this project laid the foundation for larger studies aimed at decreasing BC disparities in a rural and geographically

challenged state such as WV, through the development of strategies and interventions to foster early detection and timely treatment of BC among elderly women.

LIMITATIONS

Since the study utilized administrative claims data, the limitations of these studies include selection bias, misclassification and coding errors. Data on beneficiaries from the Medicare managed care program, and uninsured population was not be used, thus the study results may be generalizable only to FFS beneficiaries. Since information on each patient's socio-economic status is not available with SEER-Medicare, the county level census tract median household income and education level were utilized ⁶². Medicaid claims for dual-eligible Medicare beneficiaries in the SEER-Medicare data are not available; therefore, we limited our comparisons of costs to those incurred only by Medicare for beneficiaries diagnosed with cancer in WV and in SEER-Medicare. Any screening mammograms obtained outside the Medicare program such as from free mammography screening programs are not captured by Medicare and hence may affect the precision of the estimates. This may not be a significant limitation as Medicare is the primary health insurer for the older adult population. Any genetic factors, family history of BC, and psychosocial factors such as perceived risk and knowledge about mammography screening and BC, affecting the screening behavior and incidence of BC are not captured by this database and hence may affect the precision of the estimates. As per the literature, the FFS beneficiaries tend to be sicker than those in managed care, thus the costs may be skewed for the beneficiaries. The costs reported do not include out-of-pocket costs, and hence do not represent total cost of care during initial one year period. Moreover, costs associated with lost productivity and other non-medical costs which constitutes important economic burden are not captured by Medicare and hence are not included. As Medicare data on prescription drugs is not available before 2007,

the costs associated with adjuvant therapies with prescription drugs such as Tamoxifen were not be captured and hence not included in the studies.

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*Variables used for Aim 2 and Aim 3 only

#Key independent variable for Aim 1 only

Figure 1.1: The Andersen Behavioral Model for Health Care Utilization

CHAPTER 2

CHAPTER 2

ASSOCIATION BETWEEN PERSISTENCE WITH MAMMOGRAPHY SCREENING AND STAGE AT DIAGNOSIS AMONG ELDERLY WOMEN DIAGNOSED WITH BREAST CANCER

INTRODUCTION

Breast Cancer

Breast cancer (BC) is the most common cancer and the second leading cause of cancer death in women in the United States (US). For year 2014, about 232,670 new cases of invasive BC, and about 62,570 new cases of carcinoma in situ (CIS) will be diagnosed, and 40,000 women will die from BC in the US ¹.

BC incidence and mortality rates vary significantly by age. Based on Surveillance, Epidemiology and End Results (SEER) statistics for 2005-2009, the median age at diagnosis and mortality due to BC was 61 and 68 years, respectively ². Also 41% of the new cases of BC were diagnosed, and 57.4% of the BC deaths occurred in women age 65 and above ². More than half of incident BC diagnoses occur in women age 65 and above ³. The overall incidence of BC for 2005-2009 was 82.97 per 100,000 in women age below 65 years and was 421.30 per 100,000 in women age 65 and above. The overall mortality from BC for 2005-2009 was 11.15 per 100,000 in women below 65 years of age and was 98.64 per 100,000 in women age 65 and above ². Moreover, elderly women age 65 and above have a greater burden of BC as tumor in these women may be found at more advanced stages and with larger sizes thereby leading to poorer survival ⁴.

Mammography Screening

Mammography screening is considered the ‘gold standard’ for women at an average risk to detect BC at an early stage, when the treatment is less aggressive and most effective ^{5,6}. Mammography screening has demonstrated a reduction in BC-related mortality by 20-35% in average-risk women age 40-69 years of age ⁶⁻¹⁰. Also, women diagnosed with BC who have had a mammography screening within the previous two years are significantly less likely to have late-stage disease ¹¹. However, in 2010 only 64% of women age 65 and above have had mammography screening within the past two years as compared to 73% among women age 50-64 years ¹² even though annual screening mammograms are covered by both Medicare and Medicaid. This lower percentage may be partly due to the uncertainty regarding the frequency and upper age limit to avail mammography screening as reflected in the BC screening guidelines. The US Preventive Service Task Force recommends biennial mammography screening for women in age group 69 to 74 years, but reported insufficient evidence for mammography screening for women age above 74 years ¹³. In contrast, the American Cancer Society recommends annual mammography screening with no set upper age limit for women till her life expectancy is at least five years ¹⁴. In absence of no direct evidence of beneficial effects of mammography screening and with suggested potential and immediate harms of mammography screening in elderly women age 75 and older, this group encounters contrasting recommendations and guidelines for mammography screening which may affect their screening behavior thereby leading to poorer breast cancer outcomes.

Breast Cancer and Mammography Screening in West Virginia

West Virginia (WV), the only state that lies completely in Appalachia is a largely rural and medically underserved region in the US characterized by high poverty rates, low levels of

education, aging population, high rates of chronic diseases, and poor health behaviors¹⁵⁻¹⁸. WV is reported to have higher rates of advanced and unstaged BC¹⁹⁻²³, which has been attributed to lower mammography screening rates in women in WV^{20,21,24,25}. Additionally, WV was ranked sixth nationally in BC deaths in 2008^{26,27}.

In WV women age 65 years and above, BC accounted for 12% of all the incident cancer cases²⁵ and 5.3% of all cancer deaths²⁸. For 2009 among women age 65 and older, WV had lower incidence of BC (372.8 per 100,000 vs. 411.7 per 100,000 nationally) but higher mortality (110.4 per 100,000 vs. 98.6 per 100,000 nationally)^{29,30} as compared to the national estimates. The authors of various studies have argued that low mammography screening rates in WV women may be one of the significant factors responsible for this disparity^{21,25,31}.

Persistence with Mammography Screening and Stage at Breast Cancer Diagnosis

Although mammography screening has been reported to reduce BC mortality by 20-35% in women age 40-69 years⁶⁻¹⁰, it is not yet clear whether or not mammography screening is beneficial in older women. This is because very few screening trials evaluating the benefits of mammography screening in women have included women aged 70 and above³². Elderly women age 65 and above have a greater burden of BC since it is found at more advanced stages and with larger tumor sizes thereby leading to poorer survival⁴. Also, though these women are more vulnerable to BC, they are less likely to utilize mammography screening^{33,34}. In 2010, 64% of women age 65 and above have had mammography screening within the previous 2 years as compared to 73% among women age 50-64 years¹². Without clear scientific evidence of benefits of mammography screening in older women, physicians are left with the decision whether or not to recommend mammography screening to these elderly women. Physicians have

several mammography screening guidelines from which to choose for this expanding aging population, when most of the current US-based guidelines have no upper age limit set up.

Even though reducing BC-related mortality is the ultimate goal of mammography screening, intermediate measures such as stage at diagnosis are useful to evaluate the utility of screening^{35,36}. In elderly women age 65 and above, various studies have demonstrated the benefits of mammography screening utilization on an important predictor of survival, stage at BC diagnosis. Two studies which used Surveillance Epidemiology and End Results (SEER)-Medicare database reported that mammography use decreased with advancing age at diagnosis, and older women who undergo regular mammography were diagnosed with an earlier stage of disease^{37,38}. However, these studies utilized the mammography screening data from only two years before BC diagnosis, which may have failed to capture the effect of persistence with mammography screening on the stage at BC diagnosis. Also, a study by McCarthy et al. utilized SEER data from only three registries which may limit the generalizability of the study findings³⁷. A study which utilized 5-years mammography utilization data from all the SEER registries reported that regular mammography screening was associated with earlier stage at BC diagnosis, though it focused only on women age 80 and above³⁹. A systematic review of routine mammography screening demonstrated that regular mammography screening was associated with earlier-stage disease and lower BC mortality, but it focused only on women over 74 years of age⁴⁰.

Thus, most of the studies evaluating the association between mammography screening utilization and stage at BC diagnosis have been conducted using data from either a few SEER-Medicare registries, or data for limited time period of two years before BC diagnosis, or among women age 80 and above. Moreover, the major limitation with all these previous studies is that

the authors did not use any model or technique to distinguish screening from diagnostic mammograms which is one of the key concerns with Medicare or any administrative claims data. A study by Freeman et al.⁴¹ reported that challenges persist in distinguishing screening mammograms from the diagnostic ones with the Medicare claims data as many screening procedures may be billed as diagnostic procedures as the later are reimbursed at higher level. The authors of a recently published study have developed and suggested a 3-step algorithm with higher sensitivity (99.7%) and higher positive predictive value (97.4%) to distinguish between screening and diagnostic mammograms using Medicare data linked to a cancer registry⁴². In the absence of strong evidence supporting beneficial effects of mammography screening and hence no current guidelines supporting mammography screening in older women and in absence of proper studies focusing on this crucial issue, overall there is a vital need to determine the association between mammography screening and stage at BC diagnosis among elderly women age 65 and above, that clearly distinguishes between screening and diagnostic mammograms, from a large number of SEER-Medicare registries, with a longer follow-up time period of at least five years before BC diagnosis to capture persistence to mammography screening.

In addition, SEER-Medicare data represents only 17 cancer registries and states/regions and reflects a population more likely to be residing in urban setting⁴³. Very limited information is available about the use of mammography screening and stage at BC diagnosis among elderly Medicare beneficiaries diagnosed with BC from rural settings and from non-SEER Medicare states. In contrast to population characteristics prevalent in SEER-Medicare areas, a large majority of the population in WV is white and a significant proportion resides in rural areas. For 2009, WV had a lower incidence of BC among women age 65 and older (372.8 per 100,000 vs. 410.6 per 100,000) but higher mortality (110.4 per 100,000 vs. 98.6 per 100,000)^{29,30} as

compared to the national estimates. The proportion of WV women who have had a mammogram in the past two years increased with increase in age until 64 years, but the trend reversed for those who were age 65 and above ²⁴. Moreover, the overall mammography screening rates in WV women was also lower than the national estimates ²⁴. Due to higher BC mortality in women age 65 years and above in WV as compared to national estimates, there is a need to determine the association between persistence with mammography screening and stage at BC diagnosis in elderly WV women and compare this with the national estimates.

Hence, the purpose of the study is to determine the persistence with mammography screening in WV Medicare fee-for-service (FFS) women beneficiaries diagnosed with first incident BC and compare it with national estimates using SEER-Medicare data and to determine the association between persistence with mammography screening and stage at BC diagnosis in these WV women and compare it with the national estimates, after controlling for predisposing factors (age), enabling factors (median household income, education level), need factors (co-occurring chronic conditions), healthcare use (number of primary care physicians (PCP) visits in five years before BC diagnosis) and external healthcare environmental factors (location of residence and number of hospitals offering BC screening/mammography services in the area of residence).

METHODS

Data Source

West Virginia Cancer Registry-Medicare-Area Resource File linked dataset

Established by the West Virginia Department of Health and Human Resources in 1993, the West Virginia Cancer Registry (WVCR) is a state-level cancer registry which provides information on cancer incidence and mortality in West Virginia (WV) ⁴⁴. The registry collects

and provides data on the primary site of cancer, tumor grade, date and stage of diagnosis, date and cause of mortality, and demographics such as age, gender, race, and also zip code information (for location of residence). The de-identified linked WVCR-Medicare dataset was established at West Virginia University (WVU) in full compliance with the WVU Institutional Review Board and HIPPA requirements⁴⁵. The WVCR file served as the case source file, and individuals who were aged ≥ 65 years and diagnosed with cancer between the January 1, 2002 and December 31, 2007 were extracted from this file. The Social security numbers (SSN) for these individuals was then provided to the CMS by the WVCR, using which the CMS identified the corresponding Health Insurance Claim (HIC) number. To extract information on the individuals as Medicare beneficiaries, a “crosswalk” file is created using the HIC which allows for linkage across the WVCR and the Medicare. Individuals with a missing SSN were excluded from the linkage. The Area Resource File (ARF) was linked to the WVCR-Medicare dataset using the state and county FIPS codes for each beneficiary to extract the county level information on the availability of healthcare facilities, healthcare providers, and socioeconomic characteristics of the region’s population.

SEER-Medicare-Area Resource File linked dataset

The SEER-Medicare linked dataset provides population-based information on cancer-related epidemiologic and health services research. The SEER-Medicare program collects information on newly diagnosed cases of cancer from 17 population-based tumor registries which in turn collect information from several sources including hospitals, outpatient clinics, laboratories, private practitioners, laboratories, hospices, autopsy reports and death certificates. The SEER-Medicare data represents approximately 26% of the US population. The SEER part of the SEER-Medicare data is in the form of a tailored file known as the Patient Entitlement and

Diagnosis Summary File (PEDSF). PEDSF contains one record per person for individuals in the SEER database who have been matched with Medicare enrollment records. These files provide diagnostic information for up to 10 diagnosed cancer cases (including date of cancer diagnosis, cancer sub-site, cancer stage at diagnosis, tumor size, histology, grade), and information on the first course of cancer related treatment (surgery and radiation provided in the first 4 months after diagnosis) for each individual. The PEDSF additionally includes information on the median household income and education level for each individual based on their census tract and zip code data.

The Medicare files that are a part of the SEER-Medicare linked dataset provide information about any health care utilized by individuals age 65 and above who are enrolled in and are covered under the Medicare program. These files have claims from the inpatient, outpatient, physician, home health, and hospice care utilized by individuals enrolled in the program. The linkage of the SEER data with the Medicare data, and formation of the SEER case number involves matching individuals across the two files using an algorithm based on a match of SSN, name, sex, and date of birth. The linkage process is described elsewhere⁴³. The Area Resource File (ARF) was linked to the SEER-Medicare dataset using the state and county Federal Information Processing Standards (FIPS) code for each beneficiary to extract the county level information on the availability of healthcare facilities and healthcare providers.

Study Design

This study utilized a retrospective observational cohort design to assess the association between persistence with mammography screening and stage at diagnosis among Medicare FFS beneficiaries diagnosed with BC.

Study Cohorts

The two study cohorts consisted of all women from WVCR-Medicare-ARF linked dataset and SEER-Medicare-ARF linked dataset, age 70 and above at the first primary diagnosis of incident BC between January 1, 2007 and December 31, 2007. Since mammography screening persistence during the period of five years before BC diagnosis was to be determined, women age 70 and above who were continuously enrolled in Medicare parts A and B for at least 60 months before BC diagnosis and till the month of BC diagnosis, and who were not enrolled in health maintenance organizations (HMOs) at any time during the study period were included in the study. Women with a previous cancer diagnosis, unknown or missing BC stage information, and who were diagnosed via death certificate or autopsy were excluded from the study. BC diagnosis codes were based on the primary site and International Classification of Diseases, 9th edition Clinical Modification (ICD-9-CM) codes 174.xx, 233.0x, 238.3x, and 239.3x.

According to the WVCR-Medicare-ARF linked dataset, 661 women were diagnosed with BC from January 1, 2007 to December 31, 2007. The following women were excluded from the final study population: 168 women who were younger than 70 years at diagnosis, 99 women with any previous cancer diagnosis, 7 women who were diagnosed with BC during death or autopsy, 56 women for whom BC stage information was unknown or missing, 32 women who were not continuously enrolled in Medicare parts A and B for 5 years before diagnosis, and 72 women who were members of HMO any time during the study follow-up period. From the remaining 227 women, only 6 women (2.6%) belonged to 'other' race which resulted in very small cell-size for stage at diagnosis categories, and hence were removed from the analyses. Hence, the cohort of 221 WV women was included in the final analyses.

According to the SEER-Medicare-ARF linked dataset, 27,781 women were diagnosed with BC from January 1, 2007 and December 31, 2007. The following women were excluded from the final study population: 14,175 women who were younger than 70 years at diagnosis, 721 women with any previous cancer diagnosis, 171 women who were diagnosed with BC during death or autopsy, 383 women for whom BC stage information was unknown or missing, 770 women who were not continuously enrolled in Medicare parts A and B for 5 years before diagnosis, and 3,616 women who were members of HMO any time during the study follow-up period. The remaining 7,945 SEER-Medicare women were eligible to be included in all further analyses to derive national estimates.

Measures

Dependent Variable: Stage at diagnosis: BC stage at diagnosis was determined according to the SEER summary staging system which is a combination of the most accurate clinical and pathological documentation of the extent of disease⁴⁶ and which uses all the data in the medical record. The variable was categorized as an ‘early stage’ consisting of carcinoma insitu and localized cancers, and the ‘late stage’ consisting of regional and distant cancers as defined in a previous study⁴⁷.

Key Independent Variable: Persistence with mammography screening: There is ambiguity regarding the ability of Medicare claims data to distinguish screening from diagnostic mammograms. Appropriately distinguishing screening mammograms from diagnostic mammograms is very crucial when assessing screening utilization using claims-based database⁴⁸. No clear distinction between screening and diagnostic mammograms may affect measurement of the effect of mammography screening on BC-related outcomes using Medicare claims. A recently published 3-step algorithm with high sensitivity (99.7%) and high positive

predictive value (97.4%) of a screening designation was utilized to classify screening mammograms from diagnostic mammograms ⁴².

After capturing the claims for all the mammograms, this 3-step algorithm was applied ⁴².

It had the following sequential steps:

Step 1: To identify if women had a mammogram in the previous 9 months (≤ 270 days): If a woman had a mammogram within 9 months then those mammograms were removed. If a woman did not a mammogram within 9 months then those mammograms led to step 2.

Step 2: To identify if the Healthcare Common Procedure Coding System (HCPCS) code for a mammogram was for 'screening' or 'diagnostic' purpose: If the HCPCS code for a mammogram was for 'screening' purpose then those mammograms were considered to be screening mammograms and were utilized to determine persistence with mammography screening. If the HCPCS code for a mammogram was for 'diagnostic' purpose then those mammograms led to step 3.

Step 3: If identify if a woman had any BC-related symptom 349 days prior to 'diagnostic' mammogram: If a woman had a BC-related symptom within 349 days prior to diagnostic mammogram then those mammograms were removed. While, if a women had a BC-related symptom beyond 349 days prior to diagnostic mammogram were utilized to determine persistence with mammography screening.

All the mammograms which had HCPCS codes for 'screening' in step 2 and those for which prior BC-related symptom was beyond 349 days in step 3 were considered to be actual screening mammograms and were utilized to determine persistence with mammography screening for each woman in the study cohorts. Using this algorithm improved the precision of estimates for this study.

The key independent variable for this study was persistence with mammography screening defined in the literature as having had at least three consecutive mammograms as per the screening guidelines ⁴⁹. Based on the number of screening mammograms a woman had during the five years period before BC diagnosis, women were categorized as Non-persistent users (with 0-2 screening mammograms), and Persistent users (with three or more screening mammograms). As per the recently published study, older women above 65 years of age have similar risk of advanced stage of BC with biennial screening mammography as compared to annual screening mammography ⁵⁰. Hence, persistent users represented a population who have had annual to biennial screening mammography before BC diagnosis.

Other Independent Variables: To identify the factors that contributed to an early stage at BC diagnosis associated with persistence with mammography screening, the Andersen behavioral healthcare services utilization model was used ^{51,52}. Based on this model, the independent variables were grouped into predisposing factors, enabling factors, need-related factors, factors associated with healthcare use, and external healthcare environmental factors (Figure 2.1).

Predisposing factors consisted of age at BC diagnosis (70-74, 75-79, 80 and older), race (white, other), while enabling factors included census tract median household income of their zip code of residence ($\leq \$35,000$; $> \$35,000$), and census tract percentage of people age ≥ 25 years with at least 4 years of college education ($< 15\%$, $\geq 15\%$). As individual level information on household income and education level were not available with both SEER-Medicare and WV-Cancer Registry, census tract information for these two variables were utilized in this study. Need-related factor comprised of co-occurring chronic conditions during the twelve months before BC diagnosis which were identified from the Medicare files using the ICD-9 diagnosis codes. Comorbidity scores were calculated using Charlson comorbidity index with macros

provided by the National Cancer Institute⁵³⁻⁵⁵ and were categorizedized as 0 (no comorbidity), 1, and 2+. Healthcare use factors comprised of number of primary care physicians (PCP) visits in the five years before BC diagnosis. Similar to previous research, PCP visits were derived from National Claims History (NCH) files using the Medicare provider specialty field found in NCH claims and the PCP included those in general practice (01), family practice (08), internal medicine (11), geriatric medicine (38), and multi-specialty group practice (70)⁵⁶. The PCP visits were categorized into two groups (high, low) based on the median value. External healthcare environmental factors included location of residence based on US Department of Agriculture rural-urban continuum codes (metro, urban, rural) and the number of hospitals with BC screening/mammography services in the area of residence for each woman derived from ARF file.

Statistical Analyses

Chi-square statistics for categorical variables and t-test test for continuous variables were used to determine significant differences in persistence to mammography screening categories across all the independent variables, for both the study cohorts. The percentage of women with each stage of disease according to persistence with mammography screening was also calculated for both the study cohorts. For each cohort, logistic regression was performed to determine the association between screening mammography persistence and an early stage of disease, after controlling for predisposing, enabling, need, healthcare use and external healthcare environmental factors. In both the regressions, “late stage” was used as the reference group for the dependent variable. As the sample size for the WV-Medicare cohort was very small as compared to the SEER-Medicare cohort and consisted of only white women, 10% of non-Hispanic white women from each SEER-Medicare registry were randomly selected to make the

national cohort comparable to WV cohort. This randomly selected sample had similar distribution of characteristics as the entire SEER-Medicare non-Hispanic white population (data not shown). Hence, 708 women comprised of the SEER-Medicare cohort who were included for further analyses to determine the relationship between type of cohort (WV-Medicare and SEER-Medicare) and an early stage of disease, after controlling for all the independent variables. Logistic regression was performed using “late stage” as the reference group for the dependent variable. The fit of the regression models were tested by Pearson chi-square and likelihood ratio chi-square (deviance statistics) and Hosmer-Lemeshow goodness-of-fit statistic⁵⁷. From the logistic regressions, the parameter estimates were transformed to odds ratios and their corresponding 95% confidence intervals were examined and the findings that were significant with p-values less than 0.05 levels are discussed. All analyses were conducted within statistical analysis systems software SAS 9.3 (SAS[®] version 9.3, SAS Institute Inc., Cary, NC, USA).

RESULTS

Description of the Study Cohorts by Persistence with Mammography Screening

Table 2.1 characterizes WV-Medicare and SEER-Medicare cohorts by persistence with mammography screening in women age 70 and above, diagnosed with first primary incident BC in 2007. For the WV-Medicare cohort, younger age at diagnosis was associated with screening mammography persistence. However for SEER-Medicare cohort, younger age at diagnosis, being white, higher household income, residence in an area with higher proportion of the population with higher education, no or one co-occurring condition, and low PCP visits were associated with screening mammography persistence.

Stage at Breast Cancer Diagnosis by Persistence with Mammography Screening

Approximately, 51% of women in WV-Medicare cohort were persistent with mammography screening (Figure 2.2) as compared to 45.4% in the SEER-Medicare cohort (Figure 2.3). Figure 2.4 describes disease stage according to persistence with mammography screening during five years before diagnosis for WV-Medicare cohort. Among women who were not persistent with mammography screening, 31% were diagnosed with the late stage disease. Among women who were persistent with mammography screening, only 12% were diagnosed with late stage disease. Figure 2.5 describes disease stage by persistence with mammography screening during five years before diagnosis for the SEER-Medicare cohort. Among women who were not persistent with mammography screening, 39% were diagnosed with late stage disease. Among women who were persistent with mammography screening, 17% were diagnosed with late stage disease. This indicates that the WV-Medicare cohort had a larger proportion of women diagnosed at an early stage BC if they were persistent with mammography screening as compared to the SEER-Medicare cohort.

Association between Persistence with Mammography Screening and Stage at Breast Cancer Diagnosis

Table 2.2 describes the results of separate multivariate logistic regressions for the probability of an early stage disease for both the study cohorts. For the WV-Medicare cohort, women who were persistent with mammography screening were four times more likely of being diagnosed at an early stage BC (Adjusted odds ratio (AOR) = 4.18, 95% confidence interval (CI) = 1.94-8.98) as compared to those who were not persistent with mammography screening. No other factors significantly affected the probability of being diagnosed at an early stage in this sample. For the SEER-Medicare cohort, women who were persistent with mammography

screening were significantly more likely to be diagnosed at an early stage BC (AOR = 1.44, 95% CI = 1.31-1.58) as compared to those who were not persistent with screening mammography. Among enabling factors, higher household income was significantly associated with more likelihood of women being diagnosed at an early stage disease (AOR = 1.19, 95% CI = 1.04-1.35) as compared to those with lower household income. Women who had higher PCP visits during five years before BC diagnosis were significantly more likely to be diagnosed at an early stage BC (AOR = 1.17, 95% CI= 1.06-1.28) as compared to those who had lower PCP visits.

Description of the Study Cohorts

Table 2.3 characterizes the significant differences in WV-Medicare and SEER-Medicare cohorts. The two cohorts were significantly different from each other in terms of enabling factors such as census tract household income and census tract education level, and external healthcare environmental factors such as location of residence and number of hospitals with BC screening services in the area of residence. Elderly women in WV diagnosed with BC were more likely to reside in rural areas, had lower census tract annual household income, had lower education levels, and had less access to BC screening centers as compared to those from the SEER-Medicare cohort.

Differences in Stage at Breast Cancer Diagnosis between Study Cohorts in a Multivariate Framework

Table 2.4 lists the results of the multivariate logistic regression for the probability of an early stage disease after combining both WV-Medicare and SEER-Medicare cohorts and controlling for the type of setting (WV-Medicare vs. SEER-Medicare) and other independent variables. Women in WV-Medicare cohort were more likely to be diagnosed at an early stage

disease as compared to women in the SEER-Medicare cohort, however the association was not significant (AOR = 1.57, 95% CI = 0.97-2.55).

DISCUSSION

As per the literature to date, this is the first study which after appropriately identifying screening mammograms from the Medicare claims using a recently published algorithm, evaluated the association between persistence with mammography screening and stage at BC diagnosis in a rural state such as WV and compared it with the national estimates derived from the SEER-Medicare data. In the absence of data on persistence with mammography screening from a rural setting and from non-SEER-Medicare states, this study has filled a significant literature gap by addressing these issues and improving the precision of the estimates by appropriately identifying screening mammograms from the Medicare claims. The findings of this study are consistent to the previous studies which reported that regular mammography screening or having had a mammography screening in one to two years before BC diagnosis was associated with earlier disease stage^{37,39,40,48}.

Approximately 51% of elderly WV women diagnosed with BC were persistent with mammography screening as compared to 45% from those in the SEER-Medicare cohort. Also in WV-Medicare cohort, approximately 89% of women with BC were diagnosed with an early disease if they were persistent with mammography screening as compared to 83% from the SEER-Medicare cohort. Thus, the arguments made by the authors of the previous studies about lower mammography screening utilization in WV women as one of the contributing factors to late stage BC diagnosis^{20,24,31} are conflicting with the findings of this study. There may be other factors such as poor health status, family history of BC, BRCA gene mutation, untimely

and inappropriate care, that may be responsible for higher rates of late stage BC in elderly women in WV.

Even though WV women were more likely to reside in rural regions, had lower income and education levels, and had lower access to BC screening centers as compared to women from the SEER-Medicare regions, the likelihood of being diagnosed with an earlier stage BC was higher for WV women who were persistent with mammography screening (AOR=4.18) as compared to women belonging to the SEER-Medicare cohort (AOR=1.44). This indicates that enabling factors and external healthcare environmental factors had no negative impact on persistence with mammography screening in WV women diagnosed with BC, and they were diagnosed at earlier stages when the treatments are usually less aggressive, and survival is significantly better. Among all the independent variables controlled in the model, only persistence with mammography screening was significantly associated with an earlier stage of disease in elderly WV women which indicates that persistence with mammography screening is extremely beneficial in these women to get diagnosed at an earlier stage of BC. However, for the SEER-Medicare cohort, along with persistence with mammography screening, enabling factor such as higher census tract household income and healthcare use in terms of higher PCP visits significantly increased the likelihood of earlier representation of BC. This indicates that women who have higher PCP visits are more likely to be consulted for healthy preventive behaviors such as mammography screening, and are more likely to get screening at regular intervals thereby being able to get diagnosed at an earlier stage of BC.

When controlled for the type of setting (WV-Medicare vs SEER-Medicare) along with persistence with mammography screening and other independent variables, WV-Medicare cohort was more likely to be diagnosed at an earlier stage BC as compared to the SEER-Medicare

sample, but the association was not significant. This indicates that elderly women in WV are equally likely to be diagnosed at an early stage BC as women in the SEER-Medicare sample.

A major strength of this study is it helps in understanding the benefits of persistence with mammography screening for elderly women age 70 and above in a rural setting such as WV and how it differs from the national estimates obtained from the SEER-Medicare regions. Utilization of the recently published algorithm with very high sensitivity (99.7%) and high predictive value (97.4%) to identify the screening mammograms from the Medicare claims files ⁴² may have improved the precision of the estimates and hence must also be considered a major strength of the study. Though it is very crucial in appropriately distinguishing screening from diagnostic mammograms when evaluating screening utilization from claims-based data ⁴⁸, difficulty in this distinction has been reported as a major limitation by several previous studies which have evaluated the association between utilization of mammography screening and stage at BC diagnosis ^{37,39,40,48}.

There are several limitations worth noting when interpreting the results of this study. Some of the study women may have been recipients of free screening mammograms which will not be captured in the Medicare data and hence may underestimate persistence with mammography screening. However, this may not be considered a major limitation as Medicare is the primary health insurer for all of the older adult population. Since the study utilized cancer registries-Medicare linked databases, certain patient characteristics such as annual household income, education level, access to total of BC screening centers at patient level are not available and hence census tract information for these variables has been utilized ⁵⁸. The findings of the study are generalizable only to elderly women age 70 and above, and to other rural areas having same characteristics as that of WV.

CONCLUSION

The findings of the study indicate that persistence with mammography screening is significantly associated with earlier stage at BC diagnosis in elderly women in WV, and the likelihood of earlier representation of disease was similar in WV as compared to the national cohort derived from the SEER-Medicare registries.

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*Key Independent Variable

Figure 2.1: The Andersen Behavioral Model for Health Care Utilization (For Aim 1)

Figure 2.2: WV-Medicare Cohort by Persistence with Mammography Screening

Figure 2.3: SEER-Medicare Cohort by Persistence with Mammography Screening

Figure 2.4: Stage at Breast Cancer Diagnosis by Persistence with Mammography Screening for the WV-Medicare Cohort

Figure 2.5: Stage at Breast Cancer Diagnosis by Persistence with Mammography Screening for the SEER-Medicare Cohort

Table 2.1
Description of the Study Cohorts by Persistence with Mammography Screening
2007

Variables	WV-Medicare (N=221)					SEER-Medicare (N=7,945)				
	Non-Persistent	%	Persistent	%	Sig	Non-Persistent	%	Persistent	%	Sig
	108 (48.9%)		113 (51.1%)			4341 (54.6%)		3604 (45.4%)		
Stage at BC Diagnosis					***					***
Early	75	69.4	100	88.5		2653	61.1	3000	83.2	
Late	33	30.6	13	11.5		1688	38.9	604	16.8	
Age at Diagnosis					*					***
70-74	34	31.5	38	33.6		1183	27.3	1325	36.8	
75-79	23	21.3	38	33.6		1141	26.3	1094	30.4	
80,+	51	47.2	37	32.7		2017	46.5	1185	32.9	
Race/Ethnicity										***
White	NA	NA	NA	NA		3753	86.5	3242	90.0	
Other	NA	NA	NA	NA		588	13.5	362	10.0	
Location of Residence										
Metro	65	60.2	55	48.7		3609	83.1	3018	83.7	
Urban	23	21.3	40	35.4		633	14.6	530	14.7	
Rural	20	18.5	18	15.9		99	2.3	56	1.6	
Census Tract Household Income										***
LE \$35,000	95	88.0	102	90.3		1200	27.6	783	21.7	
GT \$35,000	13	12.0	11	9.7		3141	72.4	2821	78.3	
Census Tract Education										***
LT 15% pop. with CE	44	40.7	57	50.4		1462	33.7	943	26.2	
GE 15% pop. with CE	64	59.3	56	49.6		2879	66.3	2661	73.8	
Comorbidity										***
0	45	41.7	60	53.1		2143	49.4	1959	54.4	
1	33	30.6	30	26.5		1235	28.4	1048	29.1	
2,+	30	27.8	23	20.4		963	22.2	597	16.6	
PCP visits										***
High	54	50.0	55	48.7		2275	52.4	1650	45.8	
Low	54	50.0	58	51.3		2066	47.6	1954	54.2	
Total BC Screening Centers										
Mean	1.5		1.6			7.0		6.6		

Note: Based on 221 elderly WV-Medicare women and 7,945 elderly SEER-Medicare women, age 70 and above diagnosed with primary incident breast cancer in 2007. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; PCP, Primary Care Physicians, BC, Breast Cancer; pop., population; LE, Less than or equal to; GT, Greater than; LT, Less than; GE, Greater than or equal to; CE, College education; Sig, Significance; NA, Not Applicable. For WV-Medicare cohort, χ^2 test for race/ethnicity variable was not performed due to 0 sample size in one of the persistent groups. Asterisks represent statistically significant group differences based on χ^2 tests and t-tests separately for two study cohorts: *** $P < 0.001$; ** $0.01 \leq P < 0.05$; * $0.05 \leq P < 0.10$.

Table 2.2
Association between Persistence with Mammography Screening and Stage at Breast Cancer Diagnosis,
Separately for WV-Medicare and SEER-Medicare
Adjusted Odds Ratios and 95% Confidence Intervals from Logistic Regressions
2007

Variables	WV-Medicare (N=221)			SEER-Medicare (N=7,945)		
	AOR	95% CI	Sig	AOR	95% CI	Sig
Persistence with Mammography Screening						
Persistent	4.18	[1.94,8.98]	***	1.44	[1.31,1.58]	***
Non-Persistent	1			1		
Age at Diagnosis						
70-74	1			1		
75-79	0.75	[0.31,1.79]		1.04	[0.92,1.16]	
80,+	1.72	[0.73,4.07]		1.11	[1.00,1.23]	
Race/Ethnicity						
White	NA	NA		1.1	[0.95,1.26]	
Other	NA	NA		1		
Location of Residence						
Metro	1			1		
Urban	1.13	[0.44,2.87]		1.07	[0.93,1.23]	
Rural	1.00	[0.31,3.15]		1	[0.72,1.39]	
Census Tract Household Income						
LE \$35,000	1			1		
GT \$35,000	0.77	[0.21,2.85]		1.19	[1.04,1.35]	**
Census Tract Education						
LT 15% pop. with CE	1			1		
GE 15% pop. with CE	2.3	[0.90,5.86]		1.1	[0.98,1.24]	
Comorbidity						
0	1			1		
1	0.72	[0.31,1.65]		0.97	[0.87,1.08]	
2,+	0.89	[0.36,2.24]		1.04	[0.92,1.18]	
PCP visits						
High	1.24	[0.60,2.56]		1.17	[1.06,1.28]	**
Low	1			1		
Total BC Screening Centers	0.85	[0.52,1.38]		1.00	[1.00,1.01]	

Note: Based on 221 elderly WV-Medicare women and 7,945 elderly SEER-Medicare women, age 70 and above diagnosed with primary incident breast cancer in 2007. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; PCP, Primary Care Physicians; BC, Breast Cancer; CE, College Education; pop., population; LE, Less than or equal to; GT, Greater than; LT, Less than; GE, Greater than or equal to; AOR, Adjusted odds ratio; CI, Confidence Interval; Sig, Significance; NA, Not Applicable. The regressions also include intercept terms and parameter estimates for other variable controlled are not presented. "Late Stage at Breast Cancer Diagnosis" is the reference group for the dependent variable for both the study cohorts. For WV-Medicare cohort, logistic regression did not include race/ethnicity as one of the controlled variables due to 0 sample size in one of the persistent groups. Asterisks represent statistically significant group differences compared with the reference group: ***P<0.001; **001<=P<.01; *.01<=P<.05.

Table 2.3
Description of WV-Medicare and SEER-Medicare (randomly selected non-Hispanic white SEER-Medicare) cohorts
2007

Variables	WV-Medicare (N=221)		SEER-Medicare (N=708)		Sig
	N	%	N	%	
Stage at BC Diagnosis					
Early	175	79.2	514	72.6	
Late	46	20.8	194	27.4	
Persistence with Mammography Screening					
Persistent	113	51.1	339	47.9	
Non-Persistent	108	48.9	369	52.1	
Age at Diagnosis					
70-74	72	32.6	242	34.2	
75-79	61	27.6	179	25.3	
80,+	88	39.8	287	40.5	
Location of Residence					***
Metro	120	54.3	580	81.9	
Urban	63	28.5	120	16.9	
Rural	38	17.2	8	1.1	
Census Tract Household Income					***
LE \$35,000	197	89.1	147	20.8	
GT \$35,000	24	10.9	561	79.2	
Census Tract Education					***
LT 15% pop. with CE	101	45.7	192	27.1	
GE 15% pop. with CE	120	54.3	516	72.9	
Comorbidity					
0	105	47.5	374	52.8	
1	63	28.5	193	27.3	
2,+	53	24.0	141	19.9	
PCP visits					
High	112	50.7	325	45.9	
Low	109	49.3	383	54.1	
Total BC Screening Centers					
Mean	1.5		6.5		***

Note: Based on 221 elderly WV-Medicare women and randomly selected non-Hispanic white 708 elderly SEER-Medicare women, age 70 and above diagnosed with primary incident breast cancer in 2007. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; PCP, Primary Care Physicians; BC, Breast Cancer; pop., population; CE, College Education; LE, Less than or equal to; GT, Greater than; LT, Less than; GE, Greater than or equal to; Sig, Significance. Asterisks represent statistically significant group differences based on χ^2 tests and t-tests: ***P<0.001; **001<=P<.01; *.01<=P<.05.

Table 2.4
Differences in Stage at Breast Cancer Diagnosis between Study Cohorts
In a Multivariate Framework
Adjusted Odds Ratio and 95% Confidence Intervals from Logistic Regression
2007

Variables	Early Stage at Diagnosis		
	AOR	95% CI	Sig
Type of Setting			
WV-Medicare	1.57	[0.97,2.55]	
SEER-Medicare	1		
Persistence with Mammography Screening			
Persistent	2.87	[2.08,3.97]	***
Non-Persistent	1		
Age at Diagnosis			
70-74	1		
75-79	0.63	[0.42,0.93]	*
80,+	0.94	[0.65,1.36]	
Location of Residence			
Metro	1		
Urban	0.99	[0.65,1.50]	
Rural	1.12	[0.51,2.47]	
Census Tract Household Income			
LE \$35,000	1		
GT \$35,000	1.05	[0.66,1.67]	
Census Tract Education			
LT 15% pop. with CE	1		
GE 15% pop. with CE	1.60	[1.07,2.40]	*
Comorbidity			
0	1		
1	0.82	[0.57,1.18]	
2,+	1.06	[0.70,1.61]	
PCP visits			
High	1.24	[0.89,1.71]	
Low	1		
Total BC Screening Centers	1.00	[0.98,1.02]	

Note: Based on 221 elderly WV women and 708 randomly selected non-Hispanic elderly women from SEER-Medicare, age 70 and above diagnosed with primary incident breast cancer in 2007. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; PCP, Primary Care Physicians, BC, Breast Cancer; CE, College Education; pop., population; LE, Less than or equal to; GT, Greater than; LT, Less than; GE, Greater than or equal to; AOR, Adjusted odds ratio; CI, Confidence Interval; Sig, Significance. The regressions also include intercept terms and parameter estimates for other variable controlled are not presented. "Late Stage at Breast Cancer Diagnosis" is the reference group for the dependent variable. Asterisks represent statistically significant group differences compared with the reference group: ***P<0.001; **001<=P<.01 ; *.01<=P<.05.

CHAPTER 3

CHAPTER 3

TIMELY DIAGNOSIS AND TREATMENT OF BREAST CANCER IN ELDERLY WOMEN

INTRODUCTION

Breast Cancer

Breast cancer (BC) is the most common occurring cancer in women and is the second leading cause of cancer death in women in the United States (US). As per the Surveillance, Epidemiology and End Results (SEER) statistics for 2005-2009, the overall incidence of BC was 82.97 per 100,000 women in those below 65 years of age and was 421.30 per 100,000 women in those age 65 and above ¹ and the overall mortality from BC was 11.15 per 100,000 women in those below 65 years of age and was 98.64 per 100,000 women in those age 65 and above ¹. Moreover, older women age 65 and above have a greater burden of BC as cancer in these women may be found at more advanced stages and with larger tumor sizes thereby leading to poorer survival ². However, BC has 5-years survival of 88.5% in elderly women age 65 and above which is only a little lower as compared to 89.7% for women below 65 years of age ³.

Timely Diagnosis and Treatment of Breast Cancer in Elderly Women

BC is a major and complex health issue among women and the second cause of cancer-related deaths among women in the US, as such, measuring quality of care delivered to BC patients is challenging. Timeliness of care, i.e., rapid diagnosis after noticing abnormality in the breast and rapid initiation of treatment after diagnosis, is one of the key components of high-quality cancer treatment. Determining timeliness of care provided to BC patients is extremely important as both patients and referring care providers expect rapid access to care for breast problems ^{4,5}. Also, emotional distress may occur during the wait time for the patient's diagnostic

evaluation and subsequent treatment⁶⁻⁸. Most research in this area has demonstrated a possible relationship between delay and survival because of a complex interaction of clinical and socio-cultural factors⁹.

To our knowledge, despite the widely accepted benefit of timely care in BC patients, US-based agencies such as the National Initiative for Cancer Care Quality, National Comprehensive Cancer Network Quality, American Society of Clinical Oncology, National Quality Forum are yet to define guidelines for an appropriate time frame from presentation of abnormality to confirmed diagnosis and from diagnosis to the initiation of the treatment¹⁰. As per a quality review of the timeliness of BC diagnosis and treatment¹¹, the European Society of Breast Cancer Specialists (EUSOMA) has published professional opinion-based guidelines on time intervals between various events from presentation of abnormality to diagnosis of BC^{12,13}. Moreover, the National Health Service of United Kingdom has published professional opinion-based guidelines on appropriate time interval from BC diagnosis to the initiation of the treatment¹⁴. The US-based National Initiative of Cancer Care Quality (NICCCQ) has suggested time intervals for few events which occur between presentation of abnormality to initiation of treatment, however it does not define the appropriate time from presentation of abnormality to confirmed diagnosis and from diagnosis to the initiation of the treatment¹⁵.

Despite numerous studies about timeliness of BC care have been conducted in the last decade in the US¹⁶⁻²⁴, no consensus exists regarding the time intervals for diagnosis and treatment delays. Among the studies about delay in diagnosis, only three studies included women age 65 and above in their analyses^{16,19,20}. One study did not assess the effect of important clinical covariates such as tumor size, grade of tumor, ER- and PR-status, socio-economic variables such as income and education, and access factors, which affect timely

diagnosis and care ²⁰. While other two studies were conducted in a smaller geographic location which may affect the generalizability of the findings to other populations ^{16,19}. Among studies about delay of treatment, only four studies included women age 65 years and above in their analyses ²¹⁻²⁴. One study restricted women till 72 years of age and did not adjust for any clinical covariates which affect treatment delays ²¹. Another study was limited to North Carolina-Medicaid population only which may affect the generalizability of the findings to the other populations ²². Only two studies were conducted using SEER-Medicare dataset of which one study did not include patients with distant or stage IV disease and did not adjust for clinical covariates and access factors in the analyses ²⁴, and the other study reported treatment delay in terms of months (whole numbers), which was not consistent with any of the studies estimating delay in care ²³. Finally, none of the above studies followed the published opinion-based EUSOMA, National Health Service of United Kingdom or any guidelines to define timeliness of diagnosis and treatment in women with BC.

As older women age 65 years and above have higher BC incidence and mortality and are more likely to have advanced stage disease with larger tumors ^{1,2}, it is highly likely that diagnosis delay and/or treatment delay may negatively affect the prognosis of the disease and hence the survival. Hence, it is extremely important to determine timeliness of care based on the published opinion-based guidelines among elderly BC patients in the US.

WV is the only state that lies entirely in Appalachia, a region which is a predominantly rural and medically underserved in the United States characterized by high poverty rates, low levels of education, aging population, high rates of chronic disease, and poor health behaviors ²⁵⁻²⁸. With lower incidence of BC among WV women age 65 and older (372.8 per 100,000 vs. 410.6 per 100,000) but higher mortality (110.4 per 100,000 vs. 98.6 per 100,000) ^{29,30} as

compared to the national estimates, and with higher rates of advanced and unstaged BC in these women³¹⁻³⁵, it is likely that timeliness of care may be one of the significant contributors to these disparities. Therefore, a study comparing the timeliness of care among elderly BC patients from WV to the national estimates may help understand these disparities.

Hence, the purpose of the study is to determine timeliness of BC care based on published recommendations and its effect on survival in elderly women with BC among WV Medicare fee-for-service (FFS) women beneficiaries and compare it with the national estimates derived from SEER-Medicare data, and to determine the factors associated with timeliness of BC care in WV women and compare it with the national estimates, after controlling for predisposing factors (age, race), enabling factors (median household income, education level), need-related factors (stage at diagnosis, grade of tumor, estrogen-receptor (ER) status, co-occurring chronic conditions), factors associated with healthcare use (number of primary care physicians (PCP) visits in year prior to BC diagnosis, type of initial cancer-related treatment) and external healthcare environmental factors (location of residence and number of hospitals offering oncology services in the area of residence).

METHODS

Data Source

West Virginia Cancer Registry-Medicare-Area Resource File linked dataset

Established in 1993 by the West Virginia Department of Health and Human Resources, the West Virginia Cancer Registry (WVCR) provides information on cancer incidence and mortality in the state³⁶. The registry provides information on clinical characteristics of cancer such as primary cancer site, tumor grade, date and stage of diagnosis, date and cause of mortality, and demographic data on age, gender, race, and zip code. In the full compliance with

the WVU Institutional Review Board and HIPPA requirements, the de-identified linked WVCR-Medicare dataset was established at West Virginia University which provided information about WV individuals who are age ≥ 65 years and diagnosed with cancer between the January 1, 2002 and December 31, 2007³⁷. The Social security numbers (SSN) for individuals in WVCR were then provided to the CMS by the WVCR, using which the CMS identified the corresponding Health Insurance Claim (HIC) number. A “crosswalk” file created using the HIC allowed for linkage across the WVCR and the Medicare for extracting information on these individuals as Medicare beneficiaries. Individuals with a missing SSN were excluded from the linkage. To extract the county level information on the availability of healthcare facilities, and socioeconomic characteristics of the region’s population, the Area Resource File (ARF) was linked to the WVCR-Medicare dataset using the state and county FIPS codes for each beneficiary.

SEER-Medicare-Area Resource File linked dataset

The SEER-Medicare linked dataset provides important data useful for population-level cancer-related epidemiologic and health outcomes studies. The SEER-Medicare program collects information on newly diagnosed cases of cancer from 17 population-based tumor registries which ultimately collect information from hospitals, outpatient clinics, laboratories, private practitioners, laboratories, hospices, autopsy reports and death certificates and it represents 26% of the US population. Patient Entitlement and Diagnosis Summary File (PEDSF) is a customized file which contains one record per person for individuals in the SEER part of the SEER-Medicare database who have been matched with Medicare enrollment records. PEDSF provides diagnostic information for up to 10 diagnosed cancer cases (including date of cancer diagnosis, cancer sub-site, cancer stage at diagnosis), and information on the first course of

cancer related treatment (surgery and radiation provided in the first 4 months after diagnosis) for each individual. Additionally it includes information on the median household income and education level for each individual based on their census tract and zip code data.

The Medicare files of the SEER-Medicare linked dataset provide data about health care utilization inpatient, outpatient, physician, home health, and hospice care by individuals age 65 and above who are enrolled in the Medicare program. These files have information about dates of healthcare service and codes for specific diagnosis and procedures using the International Classification of Disease, Ninth Edition (ICD-9) codes or Common Procedure Terminology codes. The linkage process of the SEER data with the Medicare data is described elsewhere³⁸. The Area Resource File (ARF) was linked to the SEER-Medicare dataset using the state and county Federal Information Processing Standards (FIPS) code for each beneficiary to extract the county level information on the availability of healthcare facilities and healthcare providers.

Study Design

This study utilized a retrospective observational cohort design to assess time to diagnosis and time to treatment and its effect on chances of being alive among Medicare FFS beneficiaries diagnosed with BC.

Study Cohorts

The two cohorts for this study consisted of women from WVCR-Medicare-ARF linked dataset and SEER-Medicare-ARF linked dataset, age 66 and older at the first primary pathologically confirmed diagnosis of incident BC from January 1, 2003 to December 31, 2006. These women were required to be continuously enrolled in Medicare parts A and B at least 12 months prior to the BC diagnosis to identify comorbidities and timeliness of care from the initial consultation to BC diagnosis, and till the follow-up period of 12 months after BC diagnosis to

determine timeliness of care from diagnosis to treatment. Women who died during the study period and who were enrolled in health maintenance organizations (HMOs) at any time during the study period were excluded from the study. Also, women with any previous cancer diagnosis, with unknown or missing stage of BC, and who were diagnosed through death certificate or autopsy were excluded from the study. To determine the effect of timeliness of care on the probability of being alive, women diagnosed with first primary pathologically confirmed incident BC from January 1, 2003 to December 31, 2004 and who followed all the inclusion and exclusion criteria as described above were identified from both the datasets and were followed for three years. BC diagnosis codes were based on the primary site and International Classification of Diseases, 9th edition Clinical Modification (ICD-9-CM) codes 174.xx, 233.0x, 238.3x, and 239.3x.

The WVCR-Medicare-ARF linked dataset identified 2,814 women diagnosed with BC from January 1, 2003 to December 31, 2006. The following women were excluded from the final study population: 152 women who were below 66 years at diagnosis, 527 women with any previous cancer diagnosis, 24 women who were diagnosed with BC during death or autopsy, 246 women with unknown or missing BC stage, 245 women who were not continuously enrolled in Medicare parts A and B in the 12 months before and 12 months after diagnosis, and 232 women who were members of a HMO any time during the study period. Thus, a final sample of 1,388 women who had claims for breast biopsy was included in the final analyses.

The SEER-Medicare-ARF linked dataset had 112,719 women diagnosed with BC from January 1, 2003 to December 31, 2006. The following women were excluded from the final study population: 45,198 women who were below 66 years at diagnosis, 3,385 women with any previous cancer diagnosis, 815 women who were diagnosed with BC during death or autopsy,

1,947 women with unknown or missing BC stage, 5,714 women who were not continuously enrolled in Medicare parts A and B in 12 months before and 12 months after diagnosis, 14,671 women who were members of a HMO any time during the study period, and 7 women from all the remaining women who died during the 12 months after BC diagnosis. From the remaining 40,982 women, 4,706 women did not have claims for breast biopsy which were used to ascertain biopsy-proved diagnosis and hence were removed from the analyses. Thus, a final sample of 36,276 women was included in the final analyses.

Measures

Timely Care Intervals

Based on previous studies^{16,17}, two intervals were created for both the study cohorts: timely diagnosis, timely treatment and timely clinical care.

Timely Diagnosis: Timely diagnosis was defined as the period (in days) between the initial consultation for abnormality and biopsy-proved BC diagnosis as per the published opinion-based guidelines. Breast biopsies (fine-needle aspiration, core biopsy, incision, or excision) were identified using Current Procedural Terminology (CPT) and International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes. The initial consultation date for abnormality was defined as the date of a consultation for breast symptoms or date of diagnostic mammography or diagnostic magnetic resonance imaging (MRI) or diagnostic ultrasonography. Breast symptoms were identified using International Classification of Diseases, Ninth Revision, Clinical Modification diagnostic codes 611.7x and 611.9 occurring within one year before the breast biopsy proved diagnosis date. Diagnostic mammograms were identified using CPT codes 76090, 76091, 77055, 77056, G0204, G0206. Diagnostic MRI was identified using CPT codes 76093, 76094, 77058, 77059, C8903-C8908 and diagnostic

ultrasonography was identified using CPT code 76645. According to the published guidelines of the EUSOMA on quality assurance in the diagnosis of breast disease^{12,13}, the number of days from abnormality in the form of breast symptom or diagnostic procedure to the confirmed BC diagnosis range from 21 days (3 weeks) to 35 days (5 weeks). This range is calculated based on the guideline recommended time interval for each event and the typical sequence of events leading to diagnosis of BC depending on the type of abnormality. Hence, diagnosis delay was categorized into two groups based on the number of days from initial consultation for abnormality to biopsy-proved BC diagnosis (timely diagnosis - 35 days or less, and delayed diagnosis - greater than 35 days).

Timely Treatment: Timely treatment was defined as the period (in days) between biopsy-proven BC diagnosis and the initiation of treatment as per the published opinion-based guidelines.

Treatment was defined as definitive surgery, neoadjuvant chemotherapy or radiation, whichever came first. The use of prescription drug was not included in the analysis as data pertaining to prescription drugs was not available for these study cohorts. According to the only published BC care guidelines by National Health Service of United Kingdom on timeliness to BC treatment, the initiation of treatment should occur within less than or equal to 4 weeks (28 days) after BC diagnosis¹⁴. Based on this guideline, timely treatment was categorized into two groups based on number of days from biopsy-proved BC diagnosis to initiation of the treatment (timely treatment - 28 days or less, and delayed treatment - greater than 28 days).

Independent Variables: To identify the factors associated with timely BC care in elderly Medicare FFS with first primary incident BC, the Andersen behavioral healthcare services utilization model was utilized^{39,40}. Based on this model, the independent variables were grouped

into predisposing factors, enabling factors, need-related factors, healthcare use factors and external healthcare environmental factors (Figure 3.1).

Predisposing factors included age at diagnosis (66-69, 70-74, 75-79, 80 and older), and race (white, other), and enabling factors included census tract median household income ($\leq \$35,000$; $> \$35,000$), and census tract percentage of people age ≥ 25 years with at least 4 years of college education ($< 15\%$, $\geq 15\%$). As individual level information on household income and education level are not available with both SEER-Medicare and WVCR-Medicare datasets, census tract information for these two variables was used. Need-related factors consisted of clinical covariates such as stage at diagnosis (insitu, local, regional, distant), grade of tumor (well-differentiated, moderately differentiated, poorly differentiated, undifferentiated/unknown), estrogen-receptor status (positive, negative, borderline/unknown), tumor size (< 1 cm, 1-2 cm, 2-3 cm, > 3 cm), and comorbidity scores obtained from co-occurring chronic conditions during the 12 months prior to BC diagnosis identified from the Medicare files using the ICD-9-CM diagnosis codes. As stage at BC diagnosis is considered as a predictor or outcome of delay and as chemotherapy treatment choices are determined by stage, and tumor size, grade of tumor, estrogen receptor status⁴¹, these variables were included in the analyses. BC stage at diagnosis was determined according to the SEER Summary staging system that uses all information available in the medical record. It is a combination of the most precise clinical and pathological documentation of the extent of disease⁴². Comorbidity scores were calculated using Charlson comorbidity index to account for possible misclassification using codes from physician claims with macros provided by the National Cancer Institute⁴³⁻⁴⁵. The comorbidity scores were categorized as 0 (no comorbidity), 1, 2+. The number of primary care physicians (PCP) visits 12 months prior to BC diagnosis was included as a healthcare use factor in the

model and its median value was utilized to categorize as low or high. External healthcare environmental factors included location of residence (metro, non-metro) and ARF-derived number of hospitals offering oncology-related services and number of hospitals offering BC screening and mammography services in the area of residence, both categorized as low or high based on their respective median values.

Statistical Analyses

Descriptive statistics and chi-square statistics were used to describe the characteristics and the significant differences in characteristics between the two study cohorts. Unadjusted median time to diagnosis (in days) in women who had any initial consultation and median time to treatment (in days) in women who had any BC treatment, with their respective 25% and 75% inter quartile range (IQR) were estimated for both the study cohorts. These time periods (median days with IQR) were also estimated for all the groups within each independent variable. In addition, a non-parametric test, Kruskal-Wallis test, was performed to assess statistical significant differences in time period for diagnosis and treatment within each group. Bar charts were used to exhibit timely diagnosis and timely treatment based on published opinion-based recommendations for both the Medicare study cohorts. Separate logistic regression models were used to characterize timely diagnosis and timely treatment based on published opinion-based recommendations for both the study populations to identify the predictors of timely care, after controlling for all the independent variables. Logistic regressions were also conducted on timely diagnosis and timely treatment to determine significant differences in timely care between WV-Medicare and SEER-Medicare cohorts. In all models, “delayed care” for diagnosis and treatment were used as the reference group for the dependent variables. Another set of logistic regressions to model the association between timely diagnosis and timely treatment and survival,

were performed to determine significant differences in survival between WV-Medicare and SEER-Medicare cohorts. In these regressions, “death” was used as the reference group for the dependent variable. From all the logistic regressions, the parameter estimates were transformed to odds ratios, and their corresponding 95% confidence intervals were examined. The findings that were significant with p-values less than 0.05 levels are discussed. All analyses were conducted within statistical analysis system software SAS 9.3 (SAS[®] version 9.3, SAS Institute Inc., Cary, NC, USA).

RESULTS

Description of the Study Cohorts

Table 3.1 describes the WV-Medicare and SEER-Medicare women age 66 and above, diagnosed with first primary incident BC in 2003-2006. Twenty-five percent of women in WV cohort were age 80 and above as compared to 29% in SEER-Medicare. Approximately 98% of the WV-Medicare women were white as compared to 89% in the SEER-Medicare cohort. A higher proportion of WV-Medicare cohort had household income below \$35,000 (91%), resided in areas with less than 15% population with some college education (51%), and resided in areas with lower number of hospitals with oncology services (60%) and BC screening centers (58%). However, a majority of SEER-Medicare women resided in metro areas (84%), had household income above \$35,000 (75%), resided in areas with greater than 15% of population with some college education (70%), and resided in areas with lower number of hospitals with oncology services (56%) and BC screening centers (51%).

Median Days for Diagnosis and Treatment for the Study Cohorts

Table 3.2 describes median time period in days with IQR for diagnosis and treatment in the WV-Medicare and SEER-Medicare cohorts. The median days from initial consultation for

abnormality to BC diagnosis was 26 (IQR=12-50 days) for the WV-Medicare cohort as compared to 20 (IQR=8 to 41 days) for the SEER-Medicare cohort. The overall median days from BC diagnosis to any BC treatment was 8 (IQR=0-28 days) for the WV-Medicare cohort as compared to 15 (IQR=0-29 days) for the SEER-Medicare cohort. Among women who had their first BC treatment as surgery, the median days from BC diagnosis to surgery was 0 (IQR=0-25 days) for the WV-Medicare cohort as compared to 14 (IQR=0-29 days) for the SEER-Medicare cohort. Women who had their first BC treatment as chemotherapy, the median days from BC diagnosis to chemotherapy was 20 (IQR=15-29 days) for the WV-Medicare cohort as compared to 25 (IQR=14-45 days) for the SEER-Medicare cohort. However, women who had their first BC treatment as radiation therapy, the median days from BC diagnosis to radiation therapy was 27 (IQR=16-48 days) for the WV-Medicare cohort as compared to 28 (IQR=15-49 days) for the SEER-Medicare cohort.

Median Days for Type of Initial Treatment by Stage at Diagnosis for the Study Cohorts

Table 3.3 describes median time period in days with IQR for type of initial treatment by stage at BC diagnosis in the WV-Medicare and SEER-Medicare cohorts. The median days from BC diagnosis to surgery as the first treatment increased with advancing stage of tumor for the WV-Medicare cohort. It was 0 days for insitu tumor and 10 days for distant tumor. However, the median days from BC diagnosis to surgery as the first treatment did not vary much by stage at diagnosis for the SEER-Medicare cohort. It was 11 days for insitu tumor and 14 days for distant tumor. The median days from BC diagnosis to first treatment with chemotherapy ranged from 17 (distant tumor) to 178 (insitu tumor) for the WV-Medicare cohort. While the median days from BC diagnosis to first treatment with chemotherapy were 21 for insitu, 29 for local, 25 for regional and 24 for distant tumors for women in the SEER-Medicare cohort. The median

days from BC diagnosis to radiation therapy as the first treatment were 31 for insitu, 27 for local, 17 for regional and 25 for distant tumors for women in the WV-Medicare cohort. However, the median days from BC diagnosis to radiation therapy as the first treatment were 28 for insitu, 30 for local, 29 for regional and 13 for distant tumors for women in the SEER-Medicare cohort.

Median Days for Diagnosis and Treatment within Independent Variables for the Study Cohorts

Table 3.4 describes the significant differences in time period in median days with respective IQR for diagnosis and treatment within each independent variable for both the study cohorts. For the WV-Medicare cohort, median time period for diagnosis was significantly different for stage at diagnosis, grade of tumor and tumor size. While for the SEER-Medicare cohort, median time period for diagnosis was significantly different for all the independent variables except census tract income and education. For the WV-Medicare cohort, median time period for treatment was significantly different for age at diagnosis, census tract income, stage at diagnosis, ER status, and the number of hospitals with oncology services in the area of residence. However, for the SEER-Medicare cohort, median time period for treatment was significantly different for all the variables except mental health condition and number of hospitals with oncology services in the area of residence.

Proportion of Study Cohorts Receiving Timely Diagnosis and Treatment as Per the Published Recommendations

Figure 3.2 summarizes the proportion of the study cohorts who received timely BC diagnosis of BC as per the published opinion-based recommendations. Approximately only 63% of women in the WV-Medicare cohort received timely diagnosis of BC as compared to 71% of the SEER-Medicare cohort. Figure 3.3 summarizes the proportion of the study cohorts who

received timely treatment of BC as per the published opinion-based recommendations. Seventy-six percent of the WV-Medicare cohort received timely BC treatment as compared to 73% of the SEER-Medicare cohort.

Factors Associated with Timely Diagnosis and Timely Treatment

Table 3.5 describes the factors associated with timely diagnosis and timely treatment as per the published opinion-based recommendations for both the study cohorts. For the WV-Medicare cohort, higher census tract household income above \$35,000 (AOR=3.33, 95% CI=1.41-7.83) and tumor size > 3 cm was significantly associated with timely diagnosis of BC. While for the SEER-Medicare cohort, age 80 and above, white race (AOR=1.21, 95% CI=1.12-1.30), non-metro residence (AOR=1.30, 95% CI=1.20-1.40), higher census tract education (AOR=1.07, 95% CI=1.01-1.14), distant stage of BC, moderately (AOR=1.09, 95% CI=1.02-1.16) and poorly (AOR=1.26, 95% CI=1.17-1.36) differentiated grade of tumor, tumor size > 3 cm, no comorbidity and low PCP visits were significantly associated with timely diagnosis of BC. Surprisingly, no factors were significantly associated with timely treatment of BC for the WV-Medicare cohort. However, for the SEER-Medicare cohort, age 66 to 74 years, white race (AOR=1.36, 95% CI=1.26-1.47), non-metro residence (AOR=1.28, 95% CI=1.18-1.39), earlier stages of BC, tumor size < 3 cm, no comorbidity, high PCP visits (AOR=1.06, 95% CI=1.01-1.12), and low hospitals with oncology services in the area of residence were significantly associated with timely treatment of BC.

Differences in Timely Diagnosis and Treatment between Study Cohorts in a Multivariate Framework

Table 3.6 summarizes the results for timely diagnosis and timely treatment, to identify any significant differences in timeliness between WV-Medicare and SEER-Medicare study

cohorts. As compared to the SEER-Medicare cohort, the WV-Medicare cohort was significantly less likely to receive timely diagnosis of BC (AOR=0.76, 95% CI=0.64-0.90), but it was equally likely as the SEER-Medicare cohort to receive timely treatment of BC (AOR=1.00, 95% CI=0.83-1.23).

Differences in Survival between Study Cohorts with Receipt of Timely Diagnosis and Timely Treatment in a Multivariate Framework

Table 3.7 summarizes the results on probabilities of survival with receipt of timely clinical BC care, to identify any significant differences between WV-Medicare and SEER-Medicare study cohorts. As compared to the SEER-Medicare cohort, the WV-Medicare cohort was significantly more likely to be alive at the follow-up period of three years.

DISCUSSION

In the Institute of Medicine's report *Crossing the Quality Chasm*, six constructs of healthcare quality are defined^{46,47}, out of which timeliness of care is one of the most important aspects of measuring quality of cancer care⁴⁸. Delays in diagnosis and treatment in BC patients lead to high emotional distress in patients^{6-8,49}, and also poor health outcomes in terms of compromised survival⁹. Previous studies which evaluated timeliness of BC care in elderly BC patients using nationally representative populations did not use any published recommendations to define timely BC care¹⁶⁻²⁴. This is the first study to identify differences in timeliness of BC care (diagnosis, treatment) as per the published opinion-based recommendations from EUSOMA and NICE in elderly women with BC in a rural state such as WV and a nationally representative population from the SEER-Medicare data, and to determine the factors associated with timely BC care in these study cohorts. The study findings indicate that the two study cohorts were statistically different in terms of most of their characteristics. The median number of days for

BC diagnosis was higher in WV-Medicare cohort as compared to that from the SEER-Medicare cohort. In addition, WV-Medicare cohort was significantly less likely to receive timely diagnosis of BC as compared to the SEER-Medicare cohort after controlling for all the factors. This difference of timely BC diagnosis between the WV-Medicare and SEER-Medicare cohorts may be a reflection of WV women's social and cultural barriers in form of psychosocial factors such as fear, sense of fatalism, knowledge and beliefs, perceived risk, social norms, physicians' characteristics, and health system factors such as cultural variations in BC detection and follow-up, or preferences in cancer detection ^{19,50-56} which are not measured in this study. Future studies may assess the effects of these factors that may contribute to diagnosis delays in this rural state. Efforts to expedite diagnostic evaluations after any breast abnormality and abnormality in screenings may help reduce untimely BC diagnosis in elderly WV women.

Among the predictors of timely BC diagnosis, higher annual household income was significantly associated with timely diagnosis of BC in the WV-Medicare cohort. This finding was consistent with the previous studies which identified association between lower income and delayed BC diagnosis ⁵⁷⁻⁵⁹. Again consistent with previous studies, WV women with tumor size less than 1 cm was associated with delayed BC diagnosis as compared to women with tumor size greater than 3 cm, thereby emphasizing the prompt evaluation of women with large volume of tumors ^{16,60-62}.

The median days for initiation of BC treatment after diagnosis was lower in WV women as compared to those from the SEER-Medicare data. This finding is consistent with previous studies ^{16,63} in which the authors argued that rural women who may have to travel longer distances for evaluations and treatments might well be referred for treatment on that same day to minimize travel ⁶³. Also, the median days from initiation of surgery, chemotherapy or radiation

therapy did not vary much by stage at BC diagnosis for both the study cohorts. Within women who have had surgery as their first BC treatment, those with regional and local stage cancers had higher median days of treatment for the WV-Medicare cohort. Within those who had chemotherapy as their first BC treatment, women with distant cancer had lowest median days for the WV-Medicare cohort. Furthermore, there were no significant differences in timely treatment of BC between WV-Medicare and SEER-Medicare cohorts after controlling for all the factors. This indicates that rural and low income population in a state such as WV is equally likely to receive timely BC treatment as the SEER-Medicare population. This finding is remarkable since rural settings are less likely to have specialized equipment or trained healthcare professionals ⁶⁴. An interesting finding of this study is that there were no significant predictors of timely BC treatment in the WV-Medicare cohort thereby indicating that several unmeasured factors such as health status, body mass index (BMI), psychosocial factors such as fear, fatalism, knowledge and beliefs, and health system factors may be affecting timely BC treatment in these rural WV women.

Finally, it was found that WV-Medicare cohort had surprisingly higher probability of being alive at the end of the follow-up period of three years after controlling for timeliness of BC care. Given the prognosis of the disease and higher five-years survival in women with BC ³, the follow-up period of three years to model probability of being alive in elderly women who receive timely BC care may not generate robust statistical estimates for this association to make any conclusions in this regards. Future studies to assess the effect of timely BC care in elderly women with BC on survival and how it varies between the rural setting and the national population, may require a longer follow-up period of at least five to ten years to generate robust conclusions.

This study's interpretation is limited by the nature of the cancer registry-Medicare linked dataset. Since administrative claims were utilized for the analyses of timeliness of BC care, any healthcare services received outside of the Medicare settings may not be captured which may affect the precision of the estimates. Also, these data could only identify procedures and diagnoses that healthcare providers include on billings on the dates of services and hence could not determine types of BC symptoms or the sequence of procedures occurred on the same date. For instance, if the diagnostic mammography and MRI had the same claim date for a particular woman then it was not possible to identify which procedure occurred first. In addition, the typical sequence of events which leads to BC diagnosis depends on whether the abnormality in the breast was first detected by the patient, or the clinician, or through the screening mammogram¹⁹. Since this study utilized administrative claims data, whether diagnosis of BC was affected by patient-related factors (patient delay) or system-related factors (structural delay) was not identified and hence was not controlled in the analyses. Adjuvant therapy with prescription drugs was not captured in the analyses as these were not covered by Medicare prior to 2007. Several important variables such as annual household income, education level, access to BC screening centers and hospitals offering oncology services are not available in the cancer registries-Medicare linked databases and hence census tract information for these variables were utilized⁶⁵. Data on some important variables which may affect timeliness of BC care such as health status, severity of comorbidities, and patient preferences were not available. This study included individuals who received BC treatment in the form of surgery, radiation, and chemotherapy within one year after diagnosis and hence the findings cannot be generalized to individuals who do not receive any treatment. As this study is based on observational data, the study findings cannot establish causality. In addition, the findings of this study are only

generalizable to elderly BC patients covered only by Medicare. Also, the findings are not generalizable to other rural populations. Despite these limitations, this study provides important inputs on the timeliness of BC care and associated health outcomes in a BC population that is aged, belongs to a lower socio-economic status, and from a rural state such as WV.

CONCLUSION

Timely BC diagnosis is a critical concern in a rural state such as WV as women in this state are less likely to get timely BC diagnosis when compared to their national counterparts, however the chances of their survival are higher. Interventions that address patient, provider and health system factors which contribute to delay in BC diagnosis in WV are needed to be developed and implemented to achieve timely BC diagnosis.

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Figure 3.1: The Andersen Behavioral Model for Health Care Utilization (For Aim 2)

Figure 3.2: Proportion of Study Cohorts Receiving Timely Breast Cancer Diagnosis as Per the Published Recommendations

Figure 3.3: Proportion of Study Cohorts Receiving Timely Breast Cancer Treatment as Per the Published Recommendations

Table 3.1
Description of the Study Cohorts
2003-2006

Variables	WV-Medicare (N=1,388)		SEER-Medicare (N=36,276)		Sig
	N	%	N	%	
Age at Diagnosis					***
66-69	275	19.8	7,975	22.0	
70-74	385	27.7	9,079	25.0	
75-79	379	27.3	8,624	23.8	
80,+	349	25.1	10,598	29.2	
Race					***
White	1,355	97.6	32,124	88.6	
Other	33	2.4	4,152	11.4	
Location of Residence					***
Metro	762	54.9	30,349	83.7	
Non-metro	626	45.1	5,927	16.3	
Census Tract Household Income					***
LE \$35,000	1,268	91.4	8,949	24.7	
GT \$35,000	120	8.6	27,327	75.3	
Census Tract Education					***
LT 15% pop. with CE	704	50.7	11,005	30.3	
GE 15% pop. with CE	684	49.3	25,271	69.7	
Stage at Diagnosis					*
Insitu	209	15.1	5,982	16.5	
Local	866	62.4	20,982	57.8	
Regional	274	19.8	8,166	22.5	
Distant	38	2.7	1,146	3.2	
Grade of Tumor					***
Well Differentiated	325	23.4	7,762	21.4	
Moderately Differentiated	473	34.1	14,258	39.3	
Poorly Differentiated	306	22.0	9,252	25.5	
Undifferentiated/Unknown	284	20.5	5,004	13.8	
ER Status					***
Positive	628	45.2	25,018	69.0	
Negative	126	9.1	5,114	14.1	
Borderline/Unknown	634	45.7	6,144	16.9	
Tumor Size					***
<1 cm	290	29.5	7,992	22.6	
1-2 cm	409	41.6	13,809	39.1	
2-3 cm	158	16.1	5,485	15.5	
>3 cm	126	12.8	7,999	22.7	
Comorbidity					***
0	716	51.6	20,890	57.6	
1	416	30.0	9,796	27.0	
2,+	256	18.4	5,590	15.4	
Mental Condition					***
Yes	134	9.7	2,256	6.2	
No	1,254	90.3	34,020	93.8	
PCP visits					
High	689	49.6	17,851	49.2	
Low	699	50.4	18,425	50.8	

(Continued)...

Table 3.1
Description of the Study Cohorts
2003-2006

Variables	WV-Medicare (N=1,388)		SEER-Medicare (N=36,276)		Sig
	N	%	N	%	
Total BC Screening Centers					***
High	587	42.3	17,714	48.8	
Low	801	57.7	18,562	51.2	
Total Hospitals with Oncology Services					***
High	551	39.7	16,157	44.5	
Low	837	60.3	20,119	55.5	

Note: Based on 1,388 elderly WV-Medicare women and 36,276 elderly SEER-Medicare women, age 66 and above diagnosed with primary incident breast cancer from 2003 to 2006. FFS, Fee-for-service; WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; ER, Estrogen-receptor; PCP, Primary Care Physicians, BC, Breast Cancer; CE, College Education; pop., population; LE, Less than or equal to; GT, Greater than; LT, Less than; GE, Greater than or equal to; Sig, Significance. Asterisks represent statistically significant group differences based on χ^2 tests: ***P<0.001; **0.01<P<0.05; *.01<=P<0.05.

Table 3.2
Median Days in Diagnosis and Treatment for the Study Cohorts
2003-2006

Type of Delay	WV-Medicare (N=1,388)			SEER-Medicare (N=36,276)		
	N	Median (Days)	25-75% IQR (Days)	N	Median (Days)	25-75% IQR (Days)
Initial Consultation to Diagnosis	892	26	12 to 50	35,717	20	8 to 41
Diagnosis to Treatment	851	8	0 to 28	34,695	15	0 to 29
Diagnosis to Surgery	738	0	0 to 25	31,779	14	0 to 28
Diagnosis to Chemotherapy	39	20	15 to 29	1,329	25	14 to 45
Diagnosis to Radiation	74	27	16 to 48	1,587	28	15 to 49

Note: Based on 1,388 elderly WV-Medicare women and 36,276 elderly SEER-Medicare women, age 66 and above diagnosed with primary incident breast cancer from 2003 to 2006. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; IQR, Inter Quartile Range.

Table 3.3
Median Days (IQR) for Type of Initial Treatment by Stage at Diagnosis
For the Study Cohorts
2003-2006

	WV-Medicare	SEER-Medicare	WV-Medicare	SEER-Medicare	WV-Medicare	SEER-Medicare
Stage at Diagnosis	Diagnosis to Surgery	Diagnosis to Surgery	Diagnosis to Chemotherapy	Diagnosis to Chemotherapy	Diagnosis to Radiation	Diagnosis to Radiation
Insitu	0 (0 to 20)	11 (0 to 28)	178 (178 to 178)	21 (8 to 34)	31 (24 to 64)	28 (19 to 46)
Local	0 (0 to 26)	14 (0 to 28)	20 (15 to 51)	29 (15 to 50)	27 (16 to 48)	30 (17 to 49)
Regional	9 (0 to 25)	15 (0 to 29)	21 (11 to 27)	25 (14 to 42)	17 (14 to 55)	29 (15 to 54)
Distant	10 (0 to 24)	14 (0 to 29)	17 (15 to 31)	24 (14 to 49)	25 (4 to 44)	13 (4 to 42)

Note: Based on 1,388 elderly WV-Medicare women and 36,276 elderly SEER-Medicare women, age 66 and above diagnosed with primary incident breast cancer from 2003 to 2006. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; IQR, Inter Quartile Range.

Table 3.4
Median Days in Diagnosis and Treatment within Independent Variables for the Study Cohorts
2003-2006

Variables	Initial Consultation to Diagnosis				Diagnosis to Treatment			
	WV-Medicare		SEER-Medicare		WV-Medicare		SEER-Medicare	
	N	Median (IQR)	N	Median (IQR)	N	Median (IQR)	N	Median (IQR)
	892		35,717		851		34,695	
Age at Diagnosis			***		**		***	
66-69	167	27 (13 to 50)	7,827	21 (9 to 43)	170	8 (0 to 28)	7,825	14 (0 to 28)
70-74	245	27 (12 to 55)	8,961	21 (9 to 42)	239	0 (0 to 23)	8,863	15 (0 to 29)
75-79	238	26 (13 to 49)	8,496	21 (9 to 41)	226	10 (0 to 31)	8,337	15 (0 to 30)
80,+	242	22 (8 to 44)	10,433	18 (7 to 37)	216	14 (0 to 32)	9,670	16 (0 to 32)
Race			***				***	
White	876	26 (12 to 49)	31,639	20 (8 to 41)	835	8 (0 to 28)	30,796	15 (0 to 29)
Other	16	20 (8 to 53)	4,078	22 (9 to 47)	16	16 (0 to 34)	3,899	19 (0 to 36)
Location of Residence			***				***	
Metro	469	27 (13 to 51)	29,901	21 (8 to 42)	444	9 (0 to 28)	29,045	16 (0 to 31)
Non-metro	423	24 (11 to 48)	5,816	18 (8 to 36)	407	7 (0 to 28)	5,650	12 (0 to 25)
Census Tract Household Income					**		**	
LE \$35,000	817	26 (12 to 51)	8,775	20 (8 to 41)	779	6 (0 to 27)	8,447	14 (0 to 29)
GT \$35,000	75	24 (10 to 38)	26,942	20 (8 to 41)	72	17 (0 to 36)	26,248	15 (0 to 30)
Census Tract Education							***	
LT 15% pop. with CE	456	26 (12 to 52)	10,822	20 (9 to 42)	441	10 (0 to 30)	10,463	14 (0 to 29)
GE 15% pop. with CE	436	27 (11 to 48)	24,895	20 (8 to 41)	410	6 (0 to 25)	24,232	16 (0 to 30)
Stage at Diagnosis	***		***		*		***	
Insitu	151	35 (20 to 64)	5,904	28 (14 to 58)	144	0 (0 to 27)	5,705	12 (0 to 28)
Local	553	27 (13 to 51)	20,797	21 (9 to 41)	525	9 (0 to 29)	20,209	15 (0 to 29)
Regional	164	17 (8 to 37)	8,029	16 (6 to 34)	162	11 (0 to 26)	7,883	17 (0 to 31)
Distant	23	7 (4 to 17)	987	7 (1 to 21)	19	17 (4 to 41)	898	18 (6 to 37)
Grade of Tumor	**		***				***	
Well D	204	29 (15 to 54)	7,695	22 (10 to 44)	194	0 (0 to 29)	7,505	15 (0 to 29)
Moderately D	302	24 (11 to 50)	14,074	20 (8 to 40)	295	9 (0 to 29)	13,735	15 (0 to 30)
Poorly D	191	20 (8 to 43)	9,098	17 (7 to 35)	189	10 (0 to 26)	8,993	16 (0 to 29)
Undifferentiated /Unknown	195	28 (15 to 55)	4,850	23 (10 to 51)	173	11 (0 to 31)	4,462	14 (0 to 29)
ER Status			***		*		***	
Positive	389	24 (10 to 48)	24,664	20 (8 to 40)	365	13 (0 to 30)	24,080	15 (0 to 30)
Negative	78	23 (10 to 41)	5,022	17 (7 to 36)	77	9 (0 to 22)	4,996	16 (0 to 30)
Borderline/Unknown	425	27 (13 to 52)	6,031	25 (11 to 50)	409	0 (0 to 28)	5,619	13 (0 to 29)

(Continued)...

Table 3.4
Median Days in Diagnosis and Treatment within Independent Variables for the Study Cohorts
2003-2006

Variables	Initial Consultation to Diagnosis				Diagnosis to Treatment			
	WV-Medicare		SEER-Medicare		WV-Medicare		SEER-Medicare	
	N	Median (IQR)	N	Median (IQR)	N	Median (IQR)	N	Median (IQR)
	892		35,717		851		34,695	
Tumor Size	***		***				***	
<1 cm	191	29 (17 to 49)	7,921	26 (12 to 52)	185	0 (0 to 31)	7,824	13 (0 to 28)
1-2 cm	255	26 (10 to 48)	13,675	20 (8 to 39)	240	14 (0 to 29)	13,379	14 (0 to 29)
2-3 cm	99	19 (8 to 44)	5,430	16 (7 to 34)	90	12 (0 to 28)	5,279	16 (0 to 30)
>3 cm	75	13 (4 to 29)	7,753	17 (6 to 38)	72	12 (0 to 25)	7,341	17 (0 to 32)
Comorbidity			***				***	
0	458	24 (12 to 47)	20,550	20 (8 to 40)	438	5 (0 to 28)	20,111	15 (0 to 29)
1	268	27 (10 to 49)	9,650	21 (9 to 42)	265	10 (0 to 29)	9,361	15 (0 to 29)
2,+	166	29 (13 to 60)	5,517	22 (9 to 45)	148	9 (0 to 29)	5,223	17 (0 to 33)
Mental Condition			*					
Yes	87	23 (11 to 49)	2,227	21 (9 to 42)	83	9 (0 to 28)	2,104	14 (0 to 29)
No	805	26 (12 to 50)	33,490	20 (8 to 41)	768	7 (0 to 28)	32,591	15 (0 to 29)
PCP visits			***				***	
High	455	27 (12 to 53)	17,635	22 (10 to 45)	430	7 (0 to 28)	17,004	15 (0 to 29)
Low	437	25 (11 to 48)	18,082	19 (7 to 37)	421	9 (0 to 28)	17,691	15 (0 to 30)
Total BC Screening Centers					**		***	
High	374	27 (13 to 52)	17,449	21 (8 to 42)	353	2 (0 to 22)	16,929	18 (0 to 33)
Low	518	26 (11 to 48)	18,268	20 (8 to 40)	498	13 (0 to 32)	17,766	13 (0 to 27)
Total Hospitals with Oncology Services			***		**			
High	351	27 (12 to 51)	15,924	21 (8 to 43)	330	1 (0 to 23)	15,427	19 (0 to 33)
Low	541	26 (12 to 48)	19,793	20 (8 to 40)	521	13 (0 to 31)	19,268	13 (0 to 27)

Note: Based on 1,388 elderly WV-Medicare women and 36,276 elderly SEER-Medicare women, age 66 and above diagnosed with primary incident breast cancer from 2003 to 2006. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; CE, College Education; pop., population; D, Differentiated; ER, Estrogen-receptor; PCP, Primary Care Physicians, BC, Breast Cancer; LE, Less than or equal to; GT, Greater than; LT, Less than; GE, Greater than or equal to; IQR, Inter Quartile Range; Sig, Significance. Asterisks represent statistically significant group differences based on Kruskal-Wallis tests: ***P<0.001; **001<=P<.01 ; *.01<=P<.05.

Table 3.5
Factors Associated with Timely Diagnosis and Timely Treatment Separately for the Study Cohorts
Adjusted Odds Ratios and 95% Confidence Intervals from Logistic Regressions
2003-2006

Variables	WV-Medicare			SEER-Medicare			WV-Medicare			SEER-Medicare		
	Timely Diagnosis			Timely Diagnosis			Timely Treatment			Timely Treatment		
	Model 1			Model 2			Model 3			Model 4		
	AOR	95% CI	Sig	AOR	95% CI	Sig	AOR	95% CI	Sig	AOR	95% CI	Sig
Age at Diagnosis												
66-69	0.98	[0.59,1.64]		0.81	[0.76,0.87]	***	1.55	[0.87,2.77]		1.23	[1.14,1.32]	***
70-74	0.79	[0.49,1.28]		0.83	[0.78,0.89]	***	1.72	[0.99,3.01]		1.17	[1.09,1.25]	***
75-79	0.88	[0.54,1.42]		0.87	[0.81,0.93]	***	1.07	[0.63,1.80]		1.07	[1.00,1.14]	*
80,+	1			1			1			1		
Race												
White	1.31	[0.25,6.75]		1.21	[1.12,1.30]	***	0.91	[0.09,8.84]		1.36	[1.26,1.47]	***
Other	1			1			1			1		
Location of Residence												
Metro	1			1			1			1		
Non-metro	1.40	[0.91,2.17]		1.30	[1.20,1.40]	***	1.47	[0.90,2.40]		1.28	[1.18,1.39]	***
Census Tract Household Income												
LE \$35,000	1			1			1			1		
GT \$35,000	3.33	[1.41,7.83]	**	1.03	[0.96,1.10]		0.77	[0.33,1.80]		1.07	[1.00,1.15]	
Census Tract Education												
LT 15% pop. with CE	1			1			1			1		
GE 15% pop. with CE	0.77	[0.48,1.22]		1.07	[1.01,1.14]	*	1.45	[0.84,2.52]		0.94	[0.88,1.00]	*
Stage at Diagnosis												
Insitu	0.19	[0.02,1.57]		0.33	[0.27,0.39]	***	0.74	[0.14,4.02]		1.37	[1.17,1.61]	***
Local	0.23	[0.03,1.86]		0.51	[0.42,0.61]	***	0.76	[0.15,3.77]		1.23	[1.05,1.43]	**
Regional	0.28	[0.03,2.28]		0.60	[0.50,0.73]	***	0.91	[0.18,4.71]		1.19	[1.02,1.38]	*
Distant	1			1			1			1		
<i>(Continued)...</i>												

Table 3.5
Factors Associated with Timely Diagnosis and Timely Treatment Separately for the Study Cohorts
Adjusted Odds Ratios and 95% Confidence Intervals from Logistic Regressions
2003-2006

	WV-Medicare			SEER-Medicare			WV-Medicare			SEER-Medicare		
	Timely Diagnosis			Timely Diagnosis			Timely Treatment			Timely Treatment		
Variables	Model 1			Model 2			Model 3			Model 4		
	AOR	95% CI	Sig	AOR	95% CI	Sig	AOR	95% CI	Sig	AOR	95% CI	Sig
Grade of Tumor												
Well D	1			1			1			1		
Moderately D	1.34	[0.85,2.11]		1.09	[1.02,1.16]	**	1.07	[0.64,1.78]		0.98	[0.92,1.05]	
Poorly D	1.32	[0.77,2.26]		1.26	[1.17,1.36]	***	1.33	[0.71,2.49]		1.04	[0.96,1.12]	
Undifferentiated/Unknown	0.94	[0.54,1.65]		0.93	[0.85,1.01]		1.18	[0.62,2.23]		1.00	[0.91,1.10]	
ER Status												
Positive	1			1			1			1		
Negative	0.97	[0.52,1.78]		1.01	[0.94,1.09]		1.95	[0.88,4.32]		1.02	[0.95,1.10]	
Borderline/Unknown	1.22	[0.80,1.87]		0.85	[0.79,0.91]	***	1.11	[0.70,1.78]		1.07	[0.99,1.16]	
Tumor Size												
<1 cm	0.48	[0.23,0.97]	*	0.66	[0.61,0.71]	***	0.59	[0.27,1.31]		1.22	[1.13,1.32]	***
1-2 cm	0.58	[0.30,1.12]		0.90	[0.84,0.96]	**	0.63	[0.30,1.34]		1.20	[1.12,1.29]	***
2-3 cm	0.60	[0.29,1.24]		1.06	[0.98,1.16]		0.66	[0.29,1.51]		1.12	[1.03,1.21]	**
>3 cm	1			1			1			1		
Comorbidity												
0	1			1			1			1		
1	0.72	[0.48,1.08]		0.93	[0.88,0.98]	**	0.67	[0.43,1.05]		0.96	[0.90,1.02]	
2,+	0.65	[0.41,1.04]		0.84	[0.78,0.90]	***	0.92	[0.53,1.60]		0.81	[0.76,0.88]	***
Mental Condition												
Yes	1.16	[0.65,2.08]		0.99	[0.90,1.10]		1.05	[0.54,2.02]		1.07	[0.96,1.19]	
No	1			1			1			1		
<i>(Continued)...</i>												

Table 3.5
Factors Associated with Timely Diagnosis and Timely Treatment Separately for the Study Cohorts
Adjusted Odds Ratios and 95% Confidence Intervals from Logistic Regressions
2003-2006

	WV-Medicare			SEER-Medicare			WV-Medicare			SEER-Medicare		
	Timely Diagnosis			Timely Diagnosis			Timely Treatment			Timely Treatment		
Variables	Model 1			Model 2			Model 3			Model 4		
	AOR	95% CI	Sig	AOR	95% CI	Sig	AOR	95% CI	Sig	AOR	95% CI	Sig
PCP visits												
High	0.84	[0.59,1.21]		0.77	[0.73,0.81]	***	1.05	[0.70,1.57]		1.06	[1.01,1.12]	*
Low	1			1			1			1		
Total BC Screening Centers												
High	0.93	[0.58,1.50]		0.98	[0.93,1.03]		NA	NA		NA	NA	
Low	1			1			NA	NA		NA	NA	
Total Hospitals with Oncology Services												
High	NA	NA		NA	NA		1.50	[0.84,2.68]		0.71	[0.67,0.75]	***
Low	NA	NA		NA	NA		1			1		

Note: Based on 1,388 elderly WV-Medicare women and 36,276 elderly SEER-Medicare women, age 66 and above diagnosed with primary incident breast cancer from 2003 to 2006. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; CE, College Education; pop., population; D, Differentiated; ER, Estrogen-receptor; PCP, Primary Care Physicians, BC, Breast Cancer; LE, Less than or equal to; GT, Greater than; LT, Less than; GE, Greater than or equal to; AOR, Adjusted Odds Ratio; CI, Confidence Interval; Sig, Significance; NA, Not Applicable. The regressions also include intercept terms and parameter estimates for other variable controlled are not presented. Model 1 represents Timely Care from Initial Consultation to Diagnosis for WV-Medicare cohort; Model 2 represents Timely Care from Initial Consultation to Diagnosis for SEER-Medicare cohort; Model 3 represents Timely Care from Diagnosis to Treatment for WV-Medicare cohort; Model 4 represents Timely Care from Diagnosis to Treatment for SEER-Medicare cohort. "Non-timely care for Diagnosis", was the reference group for Models 1 and 2 for respective cohorts for the dependent variable, and "Non-timely care for Treatment" was the reference group for Models 3 and 4 for respective cohorts for the dependent variable. Asterisks represent statistically significant group differences compared with the reference group: ***P<0.001; **001<=P<.01 ; *.01<=P<.05.

Table 3.6
Differences in Timely Diagnosis and Treatment between Study Cohorts
In a Multivariate Framework
Adjusted Odds Ratios and 95% Confidence Intervals from Logistic Regressions
2003-2006

WV-Medicare						
Variables	Timely Diagnosis			Timely Treatment		
	Model 1			Model 2		
	AOR	95% CI	Sig	AOR	95% CI	Sig
Type of Setting						
WV-Medicare	0.76	[0.64,0.90]	**	1.00	[0.82,1.22]	
SEER-Medicare	1			1		
Age at Diagnosis						
66-69	0.82	[0.76,0.87]	***	1.23	[1.15,1.32]	***
70-74	0.83	[0.78,0.89]	***	1.18	[1.10,1.26]	***
75-79	0.87	[0.81,0.93]	***	1.07	[1.00,1.14]	
80,+	1			1		
Race						
White	1.21	[1.12,1.30]	***	1.37	[1.27,1.48]	***
Other	1			1		
Location of Residence						
Metro	1			1		
Non-metro	1.31	[1.21,1.41]	***	1.27	[1.18,1.38]	***
Census Tract Household Income						
LE \$35,000	1			1		
GT \$35,000	1.05	[0.98,1.12]		1.05	[0.98,1.13]	
Census Tract Education						
LT 15% pop. with CE	1			1		
GE 15% pop. with CE	1.06	[1.00,1.13]		0.95	[0.90,1.01]	
Stage at Diagnosis						
Insitu	0.32	[0.27,0.39]	***	1.36	[1.16,1.60]	***
Local	0.50	[0.42,0.60]	***	1.22	[1.05,1.42]	*
Regional	0.60	[0.50,0.72]	***	1.18	[1.02,1.38]	*
Distant	1			1		
Grade of Tumor						
Well Differentiated	1			1		
Moderately Differentiated	1.09	[1.03,1.16]	**	0.99	[0.92,1.05]	
Poorly Differentiated	1.26	[1.17,1.36]	***	1.04	[0.96,1.12]	
Undifferentiated/Unknown	0.92	[0.85,1.01]		1.00	[0.91,1.10]	

(Continued)...

Table 3.6
Differences in Timely Diagnosis and Treatment between Study Cohorts
In a Multivariate Framework
Adjusted Odds Ratios and 95% Confidence Intervals from Logistic Regressions
2003-2006

WV-Medicare						
Variables	Timely Diagnosis			Timely Treatment		
	Model 1			Model 2		
	AOR	95% CI	Sig	AOR	95% CI	Sig
ER Status						
Positive	1			1		
Negative	1.01	[0.94,1.09]		1.03	[0.95,1.11]	
Borderline/Unknown	0.86	[0.81,0.92]	***	1.07	[0.99,1.15]	
Tumor Size						
<1 cm	0.66	[0.62,0.71]	***	1.21	[1.12,1.31]	***
1-2 cm	0.90	[0.84,0.96]	**	1.19	[1.11,1.28]	***
2-3 cm	1.06	[0.97,1.15]		1.11	[1.02,1.20]	*
>3 cm	1			1		
Comorbidity						
0	1			1		
1	0.92	[0.88,0.98]	**	0.96	[0.90,1.01]	
2,+	0.83	[0.78,0.89]	***	0.82	[0.76,0.88]	***
Mental Condition						
Yes	1.00	[0.91,1.10]		1.07	[0.96,1.18]	
No	1			1		
PCP visits						
High	0.77	[0.74,0.81]	***	1.06	[1.01,1.12]	*
Low	1			1		
Total BC Screening Centers						
High	0.97	[0.92,1.02]	**	NA	NA	
Low	1			NA	NA	
Total Hospitals with Oncology Services						
High	NA	NA		0.72	[0.68,0.76]	***
Low	NA	NA		1		

Note: Based on 1,388 elderly WV-Medicare women and 36,276 elderly SEER-Medicare women, age 66 and above diagnosed with primary incident breast cancer from 2003 to 2006. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; CE, College Education; pop., population; D, Differentiated; ER, Estrogen-receptor; PCP, Primary Care Physicians, BC, Breast Cancer; LE, Less than or equal to; GT, Greater than; LT, Less than; GE, Greater than or equal to; AOR, Adjusted Odds Ratio; CI, Confidence Interval; Sig, Significance; NA, Not Applicable. The regressions also include intercept terms and parameter estimates for other variable controlled are not presented. Model 1 represents Timely Care from Initial Consultation to Diagnosis; Model 2 represents Timely Care from Diagnosis to Treatment. "Non-timely care for Diagnosis" and "Non-timely care for Treatment" are the reference groups for Model 1 and Model 2, respectively for the dependent variables. Asterisks represent statistically significant group differences compared with the reference group: ***P<0.001; **0.01<=P<.01; *.01<=P<.05

Table 3.7
Differences in Survival between Study Cohorts with Receipt of Timely Diagnosis and Timely Treatment in a Multivariate Framework
Adjusted Odds Ratios and 95% Confidence Intervals from Logistic Regressions
2003-2006

Variables	WV-Medicare					
	Model 1			Model 2		
	AOR	95% CI	Sig	AOR	95% CI	Sig
Type of Setting						
WV-Medicare	7.79	[3.33,18.20]	***	6.82	[2.89,16.1]	***
SEER-Medicare	1			1		
Timely Diagnosis						
Yes	0.91	[0.81,1.02]		NA	NA	
No	1			NA	NA	
Timely Treatment						
Yes	NA	NA		1.17	[1.04,1.31]	*
No	NA	NA		1		
Age at Diagnosis						
66-69	5.06	[4.27,6.00]	***	4.55	[3.83,5.40]	***
70-74	3.10	[2.70,3.56]	***	2.87	[2.49,3.31]	***
75-79	2.45	[2.15,2.80]	***	2.29	[2.00,2.62]	***
80,+	1			1		
Race						
White	0.95	[0.81,1.12]		0.95	[0.80,1.12]	
Other	1			1		
Location of Residence						
Metro	1			1		
Non-metro	0.99	[0.85,1.16]		1.01	[0.86,1.19]	
Census Tract Household Income						
LE \$35,000	1			1		
GT \$35,000	1.07	[0.93,1.22]		1.07	[0.92,1.23]	

(Continued)...

Table 3.7
Differences in Survival between Study Cohorts with Receipt of Timely Diagnosis and Timely Treatment in a Multivariate Framework
Adjusted Odds Ratios and 95% Confidence Intervals from Logistic Regressions
2003-2006

WV-Medicare						
Variables	Model 1			Model 2		
	AOR	95% CI	Sig	AOR	95% CI	Sig
Census Tract Education						
LT 15% pop. with CE	1			1		
GE 15% pop. with CE	1.20	[1.06,1.35]	**	1.19	[1.05,1.36]	*
Stage at Diagnosis						
Insitu	34.91	[25.5,47.6]	***	34.75	[25.0,48.1]	***
Local	11.07	[8.72,14.0]	***	11.13	[8.72,14.2]	***
Regional	6.56	[5.18,8.31]	***	6.20	[4.87,7.89]	***
Distant	1			1		
Grade of Tumor						
Well D	1			1		
Moderately D	0.87	[0.74,1.02]		0.84	[0.71,0.99]	*
Poorly D	0.61	[0.51,0.72]	***	0.58	[0.48,0.69]	***
Undifferentiated/Unknown	0.73	[0.60,0.89]	**	0.80	[0.65,1.00]	*
ER Status						
Positive	1			1		
Negative	0.49	[0.43,0.57]	***	0.49	[0.43,0.57]	***
Borderline/Unknown	0.74	[0.64,0.86]	***	0.81	[0.69,0.94]	**
Tumor Size						
<1 cm	2.85	[2.38,3.42]	***	2.67	[2.22,3.22]	***
1-2 cm	2.30	[2.01,2.63]	***	2.35	[2.04,2.70]	***
2-3 cm	1.50	[1.30,1.74]	***	1.49	[1.29,1.73]	***
>3 cm	1			1		

(Continued)...

Table 3.7
Differences in Survival between Study Cohorts with Receipt of Timely Diagnosis and Timely Treatment in a Multivariate Framework
Adjusted Odds Ratios and 95% Confidence Intervals from Logistic Regressions
2003-2006

Variables	WV-Medicare					
	Model 1			Model 2		
	AOR	95% CI	Sig	AOR	95% CI	Sig
Comorbidity						
0	1			1		
1	0.64	[0.57,0.72]	***	0.64	[0.56,0.73]	***
2,+	0.36	[0.32,0.41]	***	0.37	[0.32,0.42]	***
Mental Condition						
Yes	0.64	[0.53,0.77]	***	0.70	[0.58,0.85]	***
No	1			1		
PCP visits						
High	0.84	[0.75,0.93]	**	0.87	[0.78,0.97]	**
Low	1			1		
Total Hospitals with BC Screening Services						
High	1.03	[0.92,1.16]		NA	NA	
Low	1			NA	NA	
Total Hospitals with Oncology Services						
High	NA	NA		1.12	[1.00,1.26]	
Low	NA	NA		1		

Note: Based on 1,388 elderly WV-Medicare women and 36,276 elderly SEER-Medicare women, age 66 and above diagnosed with primary incident breast cancer from 2003 to 2006. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; CE, College Education; pop., population; D, Differentiated; ER, Estrogen-receptor; PCP, Primary Care Physicians; BC, Breast Cancer; LE, Less than or equal to; GT, Greater than; LT, Less than; GE, Greater than or equal to; NA, Not Applicable; AOR, Adjusted Odds Ratio; CI, Confidence Interval; Sig, Significance. The regressions also include intercept terms and parameter estimates for other variable controlled are not presented. Model 1 represents Survival After Controlling for Timely Diagnosis; Model 2 represents Survival after Controlling for Timely Treatment. "Death" is the reference group for the dependent variables for both the models. Asterisks represent statistically significant group differences compared with the reference group: ***P<0.001; **0.01<=P<.01 ; *.01<=P<.05.

CHAPTER 4

CHAPTER 4

TOTAL HEALTHCARE COSTS AMONG ELDERLY WOMEN WITH BREAST CANCER IN THE INITIAL PERIOD OF ONE YEAR AFTER DIAGNOSIS: AN APPLICATION OF DECOMPOSITION TECHNIQUE

INTRODUCTION

Breast Cancer

Breast cancer (BC), the most common type of cancer, is the second leading cause of cancer death in women in the United States (US). It is estimated that approximately 232,670 new cases of invasive BC, and about 62,570 new cases of carcinoma in situ (CIS) will be diagnosed, and 40,000 women will die from BC in the US in 2014 ¹. Based on Surveillance, Epidemiology and End Results (SEER) statistics for 2005-2009, the overall incidence of BC from 2005-2009 was 82.97 per 100,000 in women age below 65 years and was 421.30 per 100,000 in women age 65 and above ². The overall mortality from BC from 2005-2009 was 11.15 per 100,000 in women below 65 years of age and was 98.64 per 100,000 in women age 65 and above ².

Total Healthcare Costs in the Initial Phase of One Year after Breast Cancer Diagnosis

Due to rapid scientific and technological advances in the field of oncology and with increased adoption and utilization of more expensive cancer treatments as the standards of care, and due to an increasing aging population, the costs of cancer care is expected to increase enormously in the future. Based on a recent study, the national costs of cancer care in 2010 was estimated to be \$124.6 billion, out of which female BC comprised the highest proportion of 13% (\$16.5 billion), which may increase by 32% in 2020 ³. In addition, BC had the highest expenditures in the initial phase of care (one year after diagnosis) among all other cancers ³.

From \$16.5 billion, 37% of the BC costs were for the initial phase of care, 41% were for the continuing phase of care and 22% were for the last year of life.

A descriptive review on the costs of cancer care in the US reported that studies vary widely with regards to study settings, methodology, cost perspective, stage at diagnosis, populations, measurements of costs, types of services included, time horizons, and databases ⁴. Moreover, none of the studies included in the review followed any published standards of reporting costs analyses and hence called for future studies to follow these standards ⁴. A systematic review of costs associated with BC in the US reported that the lifetime per-patient direct medical care cost estimates of BC ranged from \$20,000 to \$100,000 for a base cost year from 1984 to 2003 ⁵. Yet the authors of this review suggested that the majority of the studies included in the review were outdated, and hence the findings of the study did not reflect the changes in patterns of care due to technological advances and innovations in BC treatment ⁵. Also, most of the studies included in the review focused on women with BC stages disease I or II ⁵.

The costs to Medicare of BC care are substantially higher during the initial phase of care due to surgery, radiation and adjuvant therapy ⁵⁻⁹. Despite the extensive cost to Medicare during the initial phase of care, there is inadequate information on costs incurred by types of specific services, and average costs by stage at diagnosis, type of treatment, and number of comorbidities, and the factors associated with higher costs of BC care. Recent studies on costs of cancer care in the initial phase of care for elderly BC patients in the US have been based on old data (2003), from fewer cancer registries, or for fewer disease stages ^{3,6,7,10}. In addition, the average costs by type of specific services, stage at diagnosis, type of initial treatment, and comorbidities have not been reported ^{7,10}. One study which determined the initial phase of care costs for Medicare

beneficiaries in Virginia reported lower costs associated with BC care as compared to that from the SEER-Medicare data, and that comorbidity, hospital stay, and type of treatment were significant contributors of costs due to BC ¹¹. However, there is limited information available about the costs associated with BC care from rural settings and from non-SEER states. The costs estimates from the previous studies may not be representative of Medicare reimbursements for other geographic areas and across other populations in the US.

The population in WV is predominantly white and a considerable proportion reside in rural areas. WV also has high poverty rates, low levels of education, aging population, high rates of chronic diseases, and poor health behaviors ¹²⁻¹⁵. With lower incidence of BC among WV women age 65 and older (372.8 per 100,000 vs. 410.6 per 100,000) but higher mortality (110.4 per 100,000 vs. 98.6 per 100,000) ^{16,17} than national estimates, and with higher rates of advanced and unstaged BC in these women ¹⁸⁻²², it is likely that costs of BC care during the initial phase of care may be higher. These findings will help to determine the extent to which costs are higher in rural, underserved states such as WV with increasing median age.

Thus, the purpose of the study is to determine the average costs in the initial phase of care among WV-Medicare fee-for-service (FFS) women beneficiaries and compare it with national estimates derived from SEER-Medicare data, and to determine the factors associated with higher costs in WV-Medicare women and compare it with the national estimates, after controlling for predisposing factors (age, race), enabling factors (median household income, education level), need-related factors (stage at diagnosis, grade of tumor, estrogen-receptor (ER) status, co-occurring physical and mental chronic conditions), healthcare use factors (number of primary care physicians (PCP) visits in the year prior to BC diagnosis, type of initial cancer-related treatment, inpatient stay) and external healthcare environmental factors (location of residence

and number of hospitals offering oncology services in the area of residence). The post hoc objective of the study is to utilize linear decomposition technique^{23,24} to determine the magnitude of differences in the average costs in the initial phase of care between WV-Medicare and the SEER-Medicare, and to understand extent to which the predisposing, enabling, need, healthcare use, and external healthcare environmental factors explain the differences in the average costs between WV-Medicare and the SEER-Medicare cohorts.

METHODS

Data Source

West Virginia Cancer Registry-Medicare-Area Resource File linked dataset

The West Virginia Cancer Registry (WVCR) was established by the West Virginia Department of Health and Human Resources in 1993 and it is a state-level cancer registry which provides information on cancer incidence and mortality in West Virginia (WV)²⁵. The WVCR collects and provides data on primary site of cancer, tumor grade, date and stage of diagnosis, date and cause of mortality, and demographics such as age, gender, race, and also zip code (for location of residence). The de-identified linked WVCR-Medicare dataset was developed at West Virginia University (WVU) in full compliance with the WVU Institutional Review Board and HIPPA requirements²⁶. The WVCR file served as the case source file from which the information about individuals aged ≥ 65 years and diagnosed with cancer between the January 1, 2002 and December 31, 2007 was obtained. The Social security numbers (SSN) for these individuals were provided to the CMS by the WVCR, using which the CMS identified the corresponding Health Insurance Claim (HIC) number. A “crosswalk” file created using the HIC allowed for linkage across the WVCR and the Medicare for extracting information on these individuals as Medicare beneficiaries. Individuals with a missing SSN were excluded from the

linkage. The Area Resource File (ARF) was linked to the WVCR-Medicare dataset using the state and county FIPS codes for each beneficiary to extract the county level information on the availability of healthcare facilities, healthcare providers, and socioeconomic characteristics of the region's population.

SEER-Medicare-Area Resource File linked dataset

The SEER-Medicare linked dataset provides population-based information on cancer-related epidemiologic and health services research. The SEER-Medicare program collects information on newly diagnosed cases of cancer from 17 population-based tumor registries which collect information from several sources including hospitals, outpatient clinics, laboratories, private practitioners, hospices, autopsy reports and death certificates. The SEER-Medicare data represents approximately 26% of the US population. It is in the form of a customized file known as the Patient Entitlement and Diagnosis Summary File (PEDSF) which contains one record per person for individuals in the SEER database who have been matched with Medicare enrollment records. It provides diagnostic information for up to 10 diagnosed cancer cases (including date of cancer diagnosis, cancer sub-site, cancer stage at diagnosis, tumor size, histology, grade), and information on the first course of cancer related treatment (surgery and radiation provided in the first 4 months after diagnosis) for each individual. The PEDSF additionally includes information on the median household income and education level for each individual based on their census tract and zip code data.

The Medicare files that are a part of the SEER-Medicare linked dataset provide information about any health care utilized in the inpatient, outpatient, physician, home health, and hospice care by individuals age 65 and above who are enrolled in and are covered under the Medicare program. All Medicare files include specific dates of service and codes for specific

diagnosis and procedures using the International Classification of Disease, Ninth Edition (ICD-9) codes or Common Procedure Terminology codes. The linkage of the SEER data with the Medicare data, and formation of the SEER case number involves matching individuals across the two files using an algorithm based on a match of SSN, name, sex, and date of birth. The linkage process is described elsewhere²⁷. The Area Resource File (ARF) was linked to the SEER-Medicare dataset using the state and county Federal Information Processing Standards (FIPS) code for each beneficiary to get the county level information on the availability of healthcare facilities and healthcare providers.

Study Design

This study utilized a retrospective observational cohort design to assess healthcare costs during initial phase of care in Medicare FFS beneficiaries diagnosed with BC.

Study Cohorts

The two study cohorts comprised of women from WVCR-Medicare-ARF linked dataset and SEER-Medicare-ARF linked dataset, age 66 and above at the first primary diagnosis of incident BC between January 1, 2003 to December 31, 2006. These women were required to be continuously enrolled in Medicare parts A and B at least 12 months prior to the BC diagnosis to identify chronic conditions to measure comorbidity and till the follow up period of 12 months after BC diagnosis to determine average total costs, and not enrolled in health maintenance organizations (HMOs) at any time during this period. Women with a previous cancer diagnosis, having an unknown or missing BC stage information, and who were diagnosed via death certificate or autopsy were excluded from the study. Also women who died during the first 12 months after BC diagnosis were excluded from the study as these women may have dramatically higher total average costs which may affect the estimates^{9,11}. Each beneficiary was followed for

up to 12 months after BC diagnosis, to determine healthcare costs during the initial phase of care. BC diagnosis codes were based on the primary site and International Classification of Diseases, 9th edition Clinical Modification (ICD-9-CM) codes 174.xx, 233.0x, 238.3x, and 239.3x.

The WVCR-Medicare-ARF linked dataset identified 2,814 women diagnosed with BC from January 1, 2003 to December 31, 2006. The following women were excluded from the final study cohort: 152 women who were below 66 years at diagnosis, 13 women who died during the first 12 months after BC diagnosis, 526 women with any previous cancer diagnosis, 24 women who were diagnosed with BC during death or autopsy, 245 women with unknown or missing BC stage, 234 women who were not continuously enrolled in Medicare parts A and B in the 12 months before and 12 months after diagnosis, and 232 women who were members of a HMO at any time during the study period. From the remaining 1,388 women, only 1 woman (0.07%) had zero total expenditure in the initial period after BC diagnosis and hence was removed from the analyses. Thus, a sample of 1,387 women was included in the final analyses.

The SEER-Medicare-ARF linked dataset had 112,719 women diagnosed with BC from January 1, 2003 to December 31, 2006. The following women were excluded from the final study cohort: 44,869 women who were below 66 years at diagnosis, 6,137 women who died during the first 12 months after BC diagnosis, 3,123 women with any previous cancer diagnosis, 2 women who were diagnosed with BC during death or autopsy, 1,299 women with unknown or missing BC stage, 3,292 women who were not continuously enrolled in Medicare parts A and B in the 12 months before and 12 months after diagnosis, and 14,296 women who were members of a HMO at any time during the study period. From the remaining 39,701 women, 176 women (0.44%) had zero total costs in the initial phase of care and hence were removed from the analyses. Thus, a sample of 39,525 women was included in the final analyses.

Measures

Cost Estimates: Costs of care in the initial phase of care were separately calculated for both the study cohorts. All Medicare files including Inpatient (Medicare Analysis and Procedure), Hospital Outpatient, Carrier/NCH, Hospice, Skilled Nursing Facility, Home Health Agency, and Durable Medical Equipment, were used to estimate average direct medical costs in the initial phase of care. In addition to total direct medical costs of care, average direct medical costs within the categories of care such as inpatient services, outpatient services, physician services, and other services (costs related to durable medical equipment, hospice care and home health agency) were determined for both the study cohorts. The prescription drug costs were not included in the analysis as data pertaining to prescription drugs was not available for the years of the study.

The initial phase of care was defined as the year following BC diagnosis, based on the following reasons cited by previous studies: initial course of treatment including adjuvant therapy to be completed within one year of diagnosis, initial phase of care is also based on the consensus from a group of clinical oncologists, and it could be used for comparison purposes with previous literature ^{6,8,9,11,28}.

Defining direct medical costs: Direct medical costs were defined as the amount reimbursed by Medicare. Reimbursement rather than charges has been used as a proxy for medical care costs in previous cost studies ⁸⁻¹⁰. Moreover, charges reflect price setting rather than resource consumption and hence are not necessarily related to the cost of providing services ²⁹. Reimbursements are actual payments derived from reimbursement formulas which reflect the average resource utilization for each healthcare service ²⁹. Apart from calculating average total direct medical costs, costs by type of specific services such as inpatient services, outpatient

services, physician services, and other services were also calculated separately for both the study cohorts to identify which Medicare component contributes substantially to the average total costs of care. To account for variation in the costs of medical care services over time, consumer price indices (CPI) for medical care services were utilized to convert costs to 2007 US dollars³⁰ and hence all the costs are reported in 2007 US dollars. The Medicare reimbursement formulae for all the services already include geographic factors which may affect geographic variations in the costs, and hence the costs were not adjusted for any geographic variations.

Independent Variables: To identify the factors associated with healthcare costs in elderly Medicare FFS with first primary incident BC, the Andersen behavioral healthcare services utilization model was utilized^{31,32}. Based on this model, the independent variables were grouped into predisposing factors, enabling factors, need-related factors, healthcare use factors and external healthcare environmental factors (Figure 4.1).

Predisposing factors comprised of age at BC diagnosis (66-69, 70-74, 75-79, 80 and older), and race (white, other), while enabling factors consisted of census tract median household income ($\leq \$35,000$; $> \$35,000$), and census tract percentage of people age ≥ 25 years with at least 4 years of college education ($< 15\%$, $\geq 15\%$). Since person-level information on household income and education level are not available with both the SEER-Medicare and WV-Medicare cohorts, census tract information for these two variables were used in this study. Need-related factors included clinical factors such as stage at diagnosis (insitu, local, regional, distant), grade of tumor (well-differentiated, moderately differentiated, poorly differentiated, undifferentiated/unknown), estrogen-receptor status (positive, negative, borderline/unknown), comorbidity scores and mental conditions (depression and/or anxiety) derived from co-occurring chronic conditions during the twelve months before BC diagnosis identified from the Medicare

files using the ICD-9-CM diagnosis codes. BC stage at diagnosis was determined according to the SEER Summary staging system which uses all information available in the medical record. It is a combination of the most precise clinical and pathological documentation of the extent of disease³³. Comorbidity scores were calculated using Charlson comorbidity index with macros provided by the National Cancer Institute³⁴⁻³⁶ and were categorized as 0 (no comorbidity), 1, 2+. Mental conditions included depression and/or anxiety and was dichotomized as presence or absence of a mental condition. Factors associated with healthcare use were the number of PCP visits in the 12 months prior to the BC diagnosis, type of initial treatment in the year subsequent to BC diagnosis, and inpatient use. Similar to previous research, PCP visits were derived from the National Claims History (NCH) files using the Medicare provider specialty field found in NCH claims and the PCP included those in general practice (01), family practice (08), internal medicine (11), geriatric medicine (38), and multi-specialty group practice (70)³⁷. The PCP visits were categorized into two groups (high or low) based on the median value. Type of initial treatment was categorized as definitive surgery only, non-surgical treatment (chemotherapy or radiation therapy or both), definitive surgery plus non-surgical therapy, and no treatment. Claims related to surgical procedures, chemotherapy, radiation therapy were identified from the appropriate Medicare files using a combination of ICD-9-CM diagnosis and procedure codes, CPT codes, HCPCS codes and revenue center codes. Inpatient use during the 12 months after BC diagnosis was derived from the inpatient claims file and was dichotomized as presence or absence of inpatient use. External healthcare environmental factors included location of residence based on US Department of Agriculture rural-urban continuum codes (metro, non-metro) and ARF-derived number of hospitals offering oncology-related services in the area of

residence. The hospitals offering oncology-related services were categorized into two groups (high or low) based on the median value.

Statistical Analyses

Descriptive statistics and chi-square statistics were used to describe the characteristics and the significant differences in characteristics between the two study cohorts. CPI adjusted average total direct medical costs during the initial period after BC diagnosis and average total costs by types of specific services were estimated for both the study populations and were statistically compared using t-tests and ratio-of-means. Ratio-of-means is obtained by dividing average total costs of WV-Medicare cohort by average total costs of SEER-Medicare cohort. In addition, average total costs by type of specific services among users of the respective services were determined and reported. Adjusted average total direct medical costs were estimated for clinically relevant variables such as stage at BC diagnosis, type of initial treatment and comorbidity scores for both the study populations and their ratio-of-means were reported. Data on adjusted average total costs and average costs by types of specific services for both WV-Medicare and SEER-Medicare cohorts were positively skewed and with high kurtosis (>3). Hence transformation of these costs data was required. Breusch-Pagan/Cook-Weisberg test and simplified White test were performed to check for heteroscedasticity and kurtosis of log-scale residuals in the costs data ³⁸. Due to presence of distributional problems such as skewness, kurtosis of log-scale residuals and heteroscedasticity, Park tests ³⁹ were conducted for total costs, and for costs by types of specific service for both the study populations to determine the most appropriate model which may produce the most precise estimates for the costs data. The results of the Park tests suggested that Generalized Linear Model (GLM) with log link function and gamma distribution was the most appropriate regression to model costs in this study.

GLM regressions with log transformation for adjusted total costs and gamma distribution as the link function were conducted separately for both the study populations to determine the predictors of total healthcare costs incurred during the initial period after BC diagnosis in elderly women, after controlling for all the independent variables. GLM regressions were also conducted on total, inpatient, outpatient, and physician services costs after controlling for setting (WV-Medicare vs. SEER-Medicare) and other independent variables, to determine the significant differences between total costs and costs by services between WV-Medicare and SEER-Medicare cohorts. The independent variables, predisposing factors, enabling factors, need-related factors, factors affecting healthcare use and external environmental healthcare access factors were entered in sequential blocks in the regression models. Model 1 included only ‘type of setting (WV-Medicare vs SEER-Medicare)’ as an independent variable. Model 2 added predisposing and enabling factors in addition to setting variable. Model 3 added need-related factors and factors affecting healthcare use in addition to the variables specified in Model 2. Model 4 included external healthcare environmental factors in addition to the variables specified in Model 3. From the GLM regressions, the parameter estimates (beta coefficients), betas transformed into corresponding average costs, and standard errors were examined. The findings that were significant with p-values less than or equal to 0.05 levels were discussed. All analyses were conducted within statistical analysis system software SAS 9.3 (SAS® version 9.3, SAS Institute Inc., Cary, NC, USA) and Stata 13 (StataCorp.2013.Stata Statistical Software:Release 13.College Station,TX:StataCorp LP).

Blinder-Oaxaca Decomposition Technique

To determine the extent to which independent variables explained the differences in total average costs in the initial year between WV-Medicare and SEER-Medicare, a post-regression

linear decomposition technique was utilized^{23,24}. This technique helps in examining the proportion of total setting difference (WV-Medicare vs SEER-Medicare) being explained by different independent variables included in the model, and also in identifying how much of the setting differences in total average costs were explained by these independent variables. The decomposition method utilizes the parameter estimates (beta coefficients) from the regressions and the means of independent variables to generate two components: ‘explained’ component (also known as characteristics effect) which provides differences in the total costs due to differences in observed characteristics between WV and SEER-Medicare, and ‘unexplained’ component (also known as coefficients effect) which provides differences in the total costs between WV-Medicare and SEER-Medicare cohorts that could not be explained, either because of differences in the regression parameter estimates between the two groups or differences in unobservable or unmeasured independent variables (e.g. provider level, organizational level variables) which were not captured and included in the model.

The explained portion was calculated by multiplying the differences in the average characteristics between the WV-Medicare and SEER-Medicare cohorts with the pooled regression weights. The pooled regression weights are the coefficients of the characteristics from the regression model which used data from the WV-Medicare and SEER-Medicare cohorts. The pooled regression model included type of setting as one of the independent variables in the regression model.

RESULTS

Description of the Study Cohorts

Table 4.1 describes the WV-Medicare and SEER-Medicare cohorts age 66 and above, diagnosed with the first primary incident BC in 2003-2006. Twenty-five percent of the women

in the WV-Medicare cohort were age 80 and above as compared to 29% in SEER-Medicare cohort. Majority of WV-Medicare cohort (97.6%) was white as compared to 89% from the SEER-Medicare cohort. A higher proportion of WV-Medicare cohort had a household income below \$35,000 (91%), resided in areas with less than 15% population with some college education (51%), had lower PCP visits (51%) and resided in areas with lower number of hospitals with oncology services (60%). However, a majority of the SEER-Medicare cohort resided in metro areas (84%), had household income above \$35,000 (75%), resided in areas with greater than 15% of population with some college education (70%), had lower PCP visits (54%), and resided in areas with a lower number of hospitals with oncology services (55%).

Average Total Costs and Average Costs by Types of Services

Table 4.3 describes the CPI adjusted total average costs and average costs by types of specific services during the initial phase of care for both the WV-Medicare and SEER-Medicare cohorts, and also presents the ratio-of-means between the WV-Medicare and SEER-Medicare cohorts. The average total costs for WV-Medicare cohort during initial phase of care was \$19,875 (SE=483), while the average total costs for those belonging to the SEER-Medicare cohort was \$22,881 (SE=100). The ratio-of-means was 0.87 and the total average costs for the WV-Medicare cohort was significantly lower than that of the SEER-Medicare cohort. Total average inpatient costs for WV-Medicare cohort \$4,707 (SE=255) was also significantly lower than the costs for SEER-Medicare cohort \$5,254 (SE=59) with ratio-of-means of 0.90. The total average outpatient costs for the WV-Medicare cohort and the SEER-Medicare cohort were \$5,767 (SE=237) and \$5,806 (SE=34) respectively, with ratio-of-means 0.99. The total average costs for physician services were significantly lower for the WV-Medicare cohort (\$8,684, SE=261) as compared to the SEER-Medicare cohort (\$10,800, SE=57), with ratio-of-means of

0.80. Also the total average costs for other services were significantly lower for the WV-Medicare cohort (\$716, SE=60) as compared to the SEER-Medicare cohort (\$1,020, SE=16).

Among users of the specific services, total average inpatient costs were significantly lower for the WV-Medicare cohort (\$9,745) as compared to the SEER-Medicare cohort (\$11,239), and ratio-of-means was 0.87. The total average costs among users of physician services were also significantly lower for the WV-Medicare cohort (\$8,684) as compared to the SEER-Medicare cohort (\$10,814) with a ratio-of-means of 0.80.

Average Total Costs for Clinically Important Variables

Table 4.4 describes the average total costs for clinically important variables such as stage at diagnosis, type of initial treatment, and comorbidity score. Average total costs in the WV-Medicare women with distant stage at BC diagnosis was \$27,073 (SE=3,635) as compared to \$43,431 (SE=973) in the SEER-Medicare women with distant stage, and the ratio-of-means was 0.62. WV-Medicare cohort who had adjuvant therapy only as the initial treatment had average total expenditures of \$26,498 as compared to \$33,786 for the SEER-Medicare cohort, with ratio-of-means of 0.78. Average total costs were lower for the WV-Medicare cohort with 2 or more comorbidities as compared to the SEER-Medicare cohort with two or comorbidities (\$22,018 vs. \$27,593), with a ratio-of-means of 0.80.

Factors Associated with Average Total Costs

Table 4.5 summarizes the results from the separate GLM regression models on total average costs during the initial phase of care in the WV-Medicare and the SEER-Medicare cohorts. In the WV-Medicare cohort, women who had regional or distant stage of BC, who had surgery with adjuvant therapy or who had adjuvant therapy only, who had inpatient visits, who had two or more comorbidities, and who had either depression or anxiety had significantly

higher total average costs. Also, WV-Medicare cohort who was age 75 or older had significantly lower total average costs. In the SEER-Medicare cohort, women who resided in areas with higher education, who were diagnosed at advanced stages of BC, who did not have a well-differentiated tumor grade, who had negative ER tumor status, who had any kind of treatment in form of surgery or adjuvant therapy, who had inpatient visits and PCP visits, and who had any comorbidity had significantly higher total average costs. In addition, the SEER-Medicare cohort who was age 70 or older, and who resided in non-metro areas had significantly lower total average costs. The beta estimates and exponentiated average costs for all the independent variables within each GLM regression are reported in Table 4.4.

Differences in Average Total Costs and Average Costs by Types of Services

Table 4.6 summarizes the results from the separate multivariate GLM regression models on total average costs, average costs for types of specific services during the initial phase of care, to identify any significant differences in these costs between WV-Medicare cohort and SEER-Medicare cohort. As compared to the SEER-Medicare cohort, total average costs were significantly lower for the WV-Medicare cohort. In Model 1 without adjusting for other independent variables, the WV-Medicare cohort had lower total average healthcare costs as compared to the SEER-Medicare cohort by \$3,006. However, this difference shrunk to \$549 in Model 4 after adjusting for all the independent variables. The total average costs for inpatient and physician services were also significantly lower for the WV-Medicare cohort as compared to the average costs for these services for the SEER-Medicare cohort.

Factors Explaining Lower Average Total Costs in the WV-Medicare Cohort Using Blinder-Oaxaca Linear Decomposition Analysis

Table 4.7 summarizes the results from the Blinder-Oaxaca linear decomposition analysis. The total average costs for WV-Medicare cohort for the initial phase of care was \$19,875 and that for the SEER-Medicare cohort was \$22,881, a difference of \$3,006 in total average costs between these two cohorts. Using the pooled weights, 15.82% of the difference in the total average costs between the two cohorts was explained by the beneficiary characteristics. Enabling resources (census tract income and education) contributed 6.85%, healthcare use (PCP visits, type of initial treatment, inpatient use) contributed 7.53%, and external healthcare environmental factors (location of residence, hospital visits) contributed 3.33% to the total explained portion of 15.82%. Detailed examination of the decomposition results revealed that the differences in the type of initial treatment explained 11.52% of the differences in the total average costs between the two groups. This can be interpreted as follows: keeping all the other characteristics same, if WV-Medicare cohort had the same course of initial treatment as the SEER-Medicare cohort, then the WV-Medicare cohort would have had a lower total average costs. A total of 84.14% of the differences in the total average costs in the initial phase of care between WV-Medicare and SEER-Medicare cohorts remained unexplained.

Since only 16% of the differences between WV-Medicare and SEER-Medicare cohorts were explained by the beneficiary characteristics discussed above, it was hypothesized that other factors related to healthcare utilization such as number of radiation visits, number of chemotherapy visits, and type of surgeon seen (general surgeon vs. oncology surgeon) may explain a portion of lower total average costs in the WV-Medicare cohort. The post-hoc analyses was conducted to evaluate significant differences between the study cohorts for the additional

healthcare use factors such as number of radiation visits, number of chemotherapy visits and type of surgeon seen by the Medicare beneficiaries and its results are reported in Table 4.2. A higher proportion of the WV-Medicare cohort had no radiation visits as compared to the SEER-Medicare cohort (51% vs. 47%). However, among those who had radiation visits, WV-Medicare cohort had higher proportion of women with at least 10 radiation visits in the year following BC diagnosis as compared to the SEER-Medicare cohort. There were no significant differences between the two study cohorts for number of chemotherapy visits and type of surgeon seen in the year following BC diagnosis. Another post-hoc Blinder-Oaxaca decomposition analyses was also conducted to identify the extent to which the previously included independent variables and the additional healthcare use factors explained the magnitude of differences in these study cohorts. Using the pooled weights, only 11% of the difference in the total average costs between the two cohorts was explained by the beneficiary characteristics (data not shown). Healthcare use contributed 61%, enabling resources contributed 28% and external healthcare environmental factors contributed 29% to the total explained portion (data not shown).

DISCUSSION

As the costs of BC constitute a substantial portion of the overall national costs of cancer care and as these costs are likely to increase tremendously in the coming years ³, estimating the BC costs and the costs by types of specific services is vital for the Medicare program to focus on controlling these costs and setting priorities for the effective allocation of the resources. Previous studies which estimated total average costs in the initial phase of care in BC patients have been outdated and utilized data from SEER-Medicare registries only ^{3,6,7,10}. This study is first of its kind to identify costs by types of specific services and the factors associated with higher costs in BC patients, from a non-SEER-Medicare and rural geographic region and

compared it with the national estimates derived from SEER-Medicare data, and to examine the which factors explained the differences in the average costs between the WV-Medicare and SEER-Medicare cohorts. The study findings indicate that the two populations were statistically different in terms of most of their characteristics. The total average costs, and the average costs for inpatient services, physician services and other services in the initial phase of care in elderly BC patients from WV-Medicare cohort was significantly lower than that for the SEER-Medicare cohort. The total average costs, average costs for inpatient services and physician services were 13%, 13% and 20% higher, respectively, for SEER-Medicare cohort than for WV-Medicare cohort as seen in Table 2. These findings did not change even after controlling for the comprehensive list of covariates in the multivariate framework. A part of the lower costs in a rural state such as WV as compared to the SEER-Medicare regions may be due to the differences in the Medicare spending across various geographic regions in the US ⁴⁰. In addition, average costs by stage at diagnosis, type of initial treatment, and comorbidity scores were also lower for the BC patients in WV than that for the SEER-Medicare elderly women.

In contrast to study by Warren et al., it was found that physician services was the major contributor to the total average costs in the initial phase of care among the elderly WV-Medicare and SEER-Medicare beneficiaries with BC ¹⁰, followed by outpatient costs and inpatient costs. Average costs for physician services, inpatient services, and outpatient services were lower for WV-Medicare cohort as compared to their national counterparts. Among users of specific services, average costs due to inpatient services was the highest for both the groups, followed by average costs due to physician services. However, these costs were lower for WV-Medicare cohort as compared to their national counterparts. These findings are surprising given the fact

that elderly WV women with BC have higher comorbidity burden and possibly greater proportion of negative health-outcomes which may increase their total average costs.

In elderly WV women with BC, the factors associated with higher costs during the initial phase of care were advanced stages of the cancer, surgery with adjuvant therapy or adjuvant therapy only, any hospitalization, presence of two or more physical chronic conditions, and presence of depression and/or anxiety. But older age was associated with lower average costs in these women. These findings were consistent with those reported in the previous study on Virginia population ¹¹. These findings highlight the importance of encouraging women to utilize preventive screenings to get them diagnosed at earlier stages of BC. In addition, the findings also emphasize the importance of better co-management of physical and mental chronic conditions in elderly women with BC, to lower overall costs to Medicare in a rural state such as WV. Emerging healthcare delivery models such as ‘medical homes’ which emphasize care-coordination for management of the elderly Medicare beneficiaries with multiple chronic conditions are a step in the right direction.

The differences in the total average costs for elderly women with BC were also examined between the two cohorts in a multivariable setting. There was statistically significant difference in the total average costs between the two groups after controlling for the predisposing, enabling, need-related, healthcare use, and external healthcare environmental factors. The difference in total average costs in the initial phase of care reduced from \$3,006 to \$549 after adjusting for all the covariates.

The study also utilized the unique Blinder-Oaxaca linear decomposition technique to examine the extent to which the differences in the various factors explained the difference in the total average costs between the two cohorts. Enabling resources (household income and

education), and healthcare use (PCP visits, type of initial treatment, inpatient use) primarily explained the differences in the total average costs between the two populations. These findings are consistent to the findings from previous studies which reported that the differences in healthcare spending is largely explained by the differential treatment pattern owing to the supply of physicians and hospital resources in the area, and also household income and education ⁴¹⁻⁴⁴. Hence, if both the study populations have similar household income and education, PCP visits, initial treatment and inpatient use then the difference in the total average costs would shrink. A noteworthy finding of this study is that around 84% of the difference in total average expenditures between the two populations remained unexplained. It is plausible that some portion of this difference may be due to unmeasured factors such as health status, severity of comorbid conditions, body mass index, patient preferences and propensity to seek care. The results of the post-hoc decomposition analyses after adding additional healthcare use factors such as number of radiation visits, number of chemotherapy visits and type of surgeon seen by the beneficiaries did not increase the ‘explained’ portion of the differences in the total average costs between the two study cohorts. Hence, healthcare utilization may not be a contributing factor for lower total average costs in the initial phase for the WV-Medicare cohort as compared to the national averages.

Since the analyses of the costs for BC utilized the data from administrative claims, the results of this study should be interpreted with caution. Any healthcare services obtained outside of Medicare settings may not be captured, hence the costs may be underestimated. The costs of adjuvant therapy with prescription drugs were not captured in the analyses as these costs were not covered by Medicare prior to 2007. Also, indirect medical costs (e.g. cost due to lost productivity), indirect non-medical costs, and out-of-pocket costs borne by patients were not

included and hence the findings do not represent the total costs during the initial phase of care. Certain patient characteristics such as annual household income, education level, access to total of BC screening centers at patient level are not available in the cancer registries-Medicare linked databases and hence census tract information for these variables have been utilized ⁴⁵. Data on some important variables such as health status, severity of comorbidities, and patient preferences which may be important predictors of their cancer prognosis, or selection of type of treatment were not available. Moreover, the findings of this study are generalizable to elderly BC patients only covered by Medicare. Also the findings are not generalizable to other rural populations. Costs may vary in a younger population due to differences in their age and insurance coverage.

CONCLUSION

The difference in the total average expenditures between the elderly beneficiaries with BC from a rural state such as WV and their national counterparts narrowed but remained significantly lower after multivariate adjustment, and is mainly driven by enabling factors and healthcare use factors. Further research focusing on the incremental costs among elderly beneficiaries with BC with combination of different comorbid conditions from rural areas is suggested.

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Figure 4.1: The Andersen Behavioral Model for Health Care Utilization (Aim 3)

Table 4.1
Description of the Study Cohorts
2003-2006

Variables	WV-Medicare (N=1,387)		SEER-Medicare (N=39,525)		Sig
	N	%	N	%	
Age at Diagnosis					***
66-69	275	19.8	8,799	22.3	
70-74	384	27.7	9,868	25.0	
75-79	379	27.3	9,331	23.6	
80,+	349	25.2	11,527	29.2	
Race					***
White	1,354	97.6	34,992	88.5	
Other	33	2.4	4,533	11.5	
Location of Residence					***
Metro	761	54.9	32,989	83.5	
Non-metro	626	45.1	6,536	16.5	
Census Tract Household Income					***
LE \$35,000	1,267	91.4	9,764	24.7	
GT \$35,000	120	8.6	29,761	75.3	
Census Tract Education					***
LT 15% pop. with CE	703	50.7	12,056	30.5	
GE 15% pop. with CE	684	49.3	27,469	69.5	
Stage at Diagnosis					**
Insitu	209	15.1	6,610	16.7	
Local	866	62.5	22,738	57.5	
Regional	273	19.7	8,985	22.7	
Distant	39	2.7	1,192	3.0	
Grade of Tumor					***
Well Differentiated	325	23.4	8,459	21.4	
Moderately Differentiated	472	34.0	15,524	39.3	
Poorly Differentiated	306	22.1	9,969	25.2	
Undifferentiated/Unknown	284	20.5	5,573	14.1	
ER Status					***
Positive	627	45.2	27,260	69.0	
Negative	126	9.1	5,412	13.7	
Borderline/Unknown	634	45.7	6,853	17.3	
Initial Treatment					**
Surgery Only	560	40.4	14,478	36.6	
Surgery+Adjuvant Therapy	765	55.2	23,494	59.4	
Adjuvant Therapy Only	16	1.2	581	1.5	
No Treatment	46	3.3	972	2.5	
Inpatient Use					
Yes	681	49.1	18,621	47.1	
No	706	50.9	20,904	52.9	
Comorbidity					***
1-10 conditions	715	51.6	23,039	58.3	
11 to 20 conditions	416	30.0	10,629	26.9	
>20 conditions	256	18.4	5,857	14.8	
Mental Condition					***
Yes	134	9.7	2,411	6.1	
No	1,253	90.3	37,114	93.9	
<i>(Continued)...</i>					

Table 4.1
Description of the Study Cohorts
2003-2006

Variables	WV-Medicare (N=1,387)		SEER-Medicare (N=39,525)		Sig
	N	%	N	%	
PCP visits					*
High	681	49.1	18,051	45.7	
Low	706	50.9	21,474	54.3	
Total Hospitals with Oncology Services					***
High	551	39.7	17,613	44.6	
Low	836	60.3	21,912	55.4	

Note: Based on 1,387 elderly WV-Medicare women and 39,525 elderly SEER-Medicare women, age 66 and above diagnosed with primary incident breast cancer from 2003 to 2006. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; ER, Estrogen-receptor; PCP, Primary Care Physicians; CE, College Education; pop., population; LE, Less than or equal to; GT, Greater than; LT, Less than; GE, Greater than or equal to; Sig, Significance. Asterisks represent statistically significant group differences based on χ^2 tests: ***P<0.001; **001<=P<.01 ; *.01<=P<.05.

Table 4.2
Description of the Study Cohorts for Differences in the Healthcare Utilization
2003-2006

Variables	WV-Medicare (N=1,387)		SEER-Medicare (N=39,525)		Sig
	N	%	N	%	
Radiation Visits					***
No visit	700	50.5	18,475	46.7	
Low visits (1-10)	201	14.5	11,563	29.3	
High visits (10,+)	486	35.0	9,487	24.0	
Chemotherapy Visits					
No	1,084	78.2	30,545	77.3	
Yes	303	21.8	8,980	22.7	
Type of Surgeon Seen					
No surgeon seen	31	2.2	752	1.9	
General Surgeon	355	25.6	9,287	23.5	
Oncology Surgeon	73	5.3	2,320	5.9	
Both	928	66.9	27,166	68.7	

Note: Based on 1,387 elderly WV-Medicare women and 39,525 elderly SEER-Medicare women, age 66 and above diagnosed with primary incident breast cancer from 2003 to 2006. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; Sig, Significance. Asterisks represent statistically significant group differences based on χ^2 tests: ***P<0.001; **001<=P<.01 ; *.01<=P<.05.

Table 4.3
Average Total Healthcare Costs and Average Healthcare Costs by Type of Service
For the Study Cohorts
2003-2006

Among All Users							
	WV-Medicare (N=1,387)			SEER-Medicare (N=39,525)			Ratio-of-Means
	Average (\$)	SE	%	Average (\$)	SE	%	
Total***	19,875	483	100%	22,881	100	100%	0.87
Inpatient*	4,707	255	24%	5,254	59	23%	0.90
Outpatient	5,767	237	29%	5,806	34	25%	0.99
Physician Services***	8,684	261	44%	10,800	57	47%	0.80
Other (HHA, HSP, DME)***	716	60	4%	1,020	16	4%	0.70

Among Users of Specific Services						
	WV-Medicare			SEER-Medicare		
	N	Average (\$)	SE	N	Average (\$)	SE
Inpatient*	670	9,745	454	18,479	11,239	111
Outpatient	1,372	5,830	239	38,531	5,956	34
Physician Services***	1,387	8,684	261	39,474	10,814	57
Other (HHA, HSP, DME)***	727	1,366	110	19,579	2,060	31

Note: Based on 1,387 elderly WV-Medicare women and 39,525 elderly SEER-Medicare women, age 66 and above diagnosed with primary incident breast cancer from 2003 to 2006. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; CPI, Consumer Price Index; HHA, Home Health Agency; HSP, Hospice; DME, Durable Medical Equipment; SE, Standard Error. Asterisks represent statistically significant group differences based on t-tests: ***P<0.001; **0.01<=P<.01 ; *.01<=P<.05.

Table 4.4
Average Total Healthcare Costs for Clinically Important Variables For the Study Cohorts
2003-2006

Among All Users							
	WV-Medicare			SEER-Medicare			Ratio-of-Means
	N	Average costs (\$)	SE	N	Average costs (\$)	SE	
Stage at Diagnosis							
Insitu	209	13,148	871	6,610	14,872	169	0.88
Local	866	17,484	514	22,738	20,124	107	0.87
Regional	273	31,592	1,401	8,985	33,024	255	0.96
Distant	39	27,073	3,635	1,192	43,431	973	0.62
Initial Treatment							
Surgery Only	560	12,306	593	14,478	15,119	137	0.81
Surgery+Adjuvant Therapy	765	25,664	660	23,494	27,774	129	0.92
Adjuvant Therapy Only	16	26,498	3,832	581	33,786	1,254	0.78
No Treatment	46	13,422	3,160	972	13,699	751	0.98
Comorbidity							
0	715	18,432	625	23,039	21,438	119	0.86
1	416	21,034	954	10,629	23,412	199	0.90
2,+	256	22,018	1,171	5,857	27,593	324	0.80

Note: Based on 1,387 elderly WV-Medicare women and 39,525 elderly SEER-Medicare women, age 66 and above diagnosed with primary incident breast cancer from 2003 to 2006. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; CPI, Consumer Price Index; SE, Standard Error.

Table 4.5
Factors Associated with Average Total Healthcare Costs Separately for the Study Cohorts
Using Generalized Linear Model Regressions
2003-2006

Variables	WV-Medicare (N=1,387)				SEER-Medicare (N=39,525)			
	Beta	Average costs (\$)	SE	Sig	Beta	Average costs (\$)	SE	Sig
Intercept (Baseline Costs)	8.6015	5,440	0.1342	***	8.6028	5,447	0.0252	***
Age at Diagnosis								
66-69								
70-74	-0.0666	5,089	0.0503		-0.0349	5,260	0.0086	***
75-79	-0.1678	4,599	0.0507	***	-0.0836	5,010	0.0088	***
80,+	-0.1121	4,863	0.0538	*	-0.1376	4,747	0.0088	***
Race								
White								
Other	-0.0233	5,315	0.1120		-0.0096	5,395	0.0096	
Location of Residence								
Metro								
Non-metro	-0.0762	5,041	0.0440		-0.0814	5,021	0.0092	***
Census Tract Household Income								
LE \$35,000								
GT \$35,000	0.0208	5,554	0.0755		0.0150	5,529	0.0084	
Census Tract Education								
LT 15% pop. with CE								
GE 15% pop. with CE	-0.0075	5,399	0.0477		0.0285	5,604	0.0076	***
Stage at Diagnosis								
Insitu								
Local	0.0940	5,976	0.0508		0.1625	6,408	0.0091	***
Regional	0.4257	8,327	0.0617	***	0.4081	8,192	0.0106	***
Distant	0.5909	9,822	0.1220	***	0.7389	11,404	0.0203	***
Grade of Tumor								
Well Differentiated								
Moderately Differentiated	-0.0061	5,407	0.0462		0.0282	5,603	0.0080	***
Poorly Differentiated	0.0118	5,504	0.0538		0.0977	6,006	0.0093	***
Undifferentiated/Unknown	-0.0504	5,172	0.0539		0.0365	5,649	0.0108	***
ER Status								
Positive								
Negative	0.1061	6,049	0.0649		0.0976	6,005	0.0094	***
Borderline/Unknown	-0.0402	5,225	0.0369		0.0111	5,508	0.0087	

(Continued)...

Table 4.5
Factors Associated with Average Total Healthcare Costs Separately for the Study Cohorts
Using Generalized Linear Model Regressions
2003-2006

Variables	WV-Medicare (N=1,387)				SEER-Medicare (N=39,525)			
	Beta	Average costs (\$)	SE	Sig	Beta	Average costs (\$)	SE	Sig
Initial Treatment								
Surgery Only	0.1165	6,112	0.1040		0.1843	6,549	0.0201	***
Surgery+Adjuvant Therapy	1.0199	15,084	0.1051	***	0.9223	13,699	0.0202	***
Adjuvant Therapy Only	0.7929	12,021	0.1867	***	0.7776	11,854	0.0317	***
No Treatment								
Inpatient Use								
Yes	0.7829	11,901	0.0370	***	0.7065	11,040	0.0065	***
No								
Comorbidity								
0								
1	0.0726	5,849	0.0395		0.0668	5,823	0.0070	***
2,+	0.1904	6,581	0.0478	***	0.2105	6,723	0.0090	***
Mental Condition								
Yes	0.2480	6,971	0.0581	***	0.0841	5,925	0.0125	***
No								
PCP visits								
High	0.0138	5,515	0.0353		0.0786	5,892	0.0062	***
Low								
Total Hospitals with Oncology Services								
High	0.0654	5,807	0.0498		0.0738	5,864	0.0066	***
Low								

Note: Based on average costs in initial phase of care, in 1,387 elderly WV-Medicare women and 39,525 elderly SEER-Medicare women, age 66 and above from 2003 to 2006 diagnosed with first primary incident breast cancer from 2003 to 2006. FFS, Fee-for-service; WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; CPI, Consumer Price Index; SE, Standard Error; ER, Estrogen-receptor; PCP, Primary Care Physicians; CE, College Education; pop., population; LE, Less than or equal to; GT, Greater than; LT, Less than; GE, Greater than or equal to; Sig, Significance. Asterisks represent statistically significant group differences based on Generalized Linear Model with gamma distribution and log link function: ***P<0.001; **001<=P<.01 ; *.01<=P<.05.

Table 4.6
Differences in Average Total Costs between the Study Cohorts
Using Generalized Linear Model Regressions
2003-2006

	Model 1				Model 2				Model 3				Model 4			
	Beta	Average costs (\$)	SE	Sig	Beta	Average costs (\$)	SE	Sig	Beta	Average costs (\$)	SE	Sig	Beta	Average costs (\$)	SE	Sig
Total Costs																
Intercept	10.0381	22,882	0.0039	***	10.1151	24,713	0.0111	***	8.5944	5,401	0.0244	***	8.6060	5,464	0.0248	***
WV-Medicare	-0.1410	19,873	0.0210	***	-0.1107	22,124	0.0218	***	-0.1029	4,873	0.0170	***	-0.1059	4,915	0.0170	***
SEER-Medicare																
Inpatient Costs																
Intercept	9.3271	11,238	0.0065	***	9.1568	9,479	0.0187	***	9.6841	16,060	0.4973	***	9.7625	17,370	0.4948	***
WV-Medicare	-0.1436	9,735	0.0349	***	-0.0819	8,733	0.0361	*	-0.0915	14,656	0.0353	**	-0.0917	15,848	0.0351	**
SEER-Medicare																
Outpatient Costs																
Intercept	8.6922	5,956	0.0051	***	8.7953	6,603	0.0145	***	7.3029	1,485	0.0374	***	7.2181	1,364	0.0380	***
WV-Medicare	-0.0209	5,833	0.0275		0.0092	6,664	0.0284		0.0508	1,562	0.0245	*	0.0328	1,409	0.0244	
SEER-Medicare																
Physician Services Costs																
Intercept	9.2886	10,814	0.0042	***	9.4193	12,324	0.0116	***	7.5664	1,932	0.0262	***	7.6349	2,069	0.0266	***
WV-Medicare	-0.2191	8,686	0.0228	***	-0.1406	10,708	0.0230	***	-0.1531	1,658	0.0183	***	-0.1377	1,803	0.0183	***
SEER-Medicare																

Note: Based on average costs in initial phase of care, in 1,387 elderly WV-Medicare women and 39,525 elderly SEER-Medicare women, age 66 and above from 2003 to 2006 diagnosed with first primary incident breast cancer from 2003 to 2006. WV, West Virginia; SEER, Surveillance, Epidemiology, and End Results; CPI, Consumer Price Index; SE, Standard Error; Sig, Significance. Asterisks represent statistically significant group differences based on Generalized Linear Model with gamma distribution and log link function: ***P<0.001; **0.01<=P<.01 ; *.01<=P<.05.

Model 1 includes only WV-Medicare/SEER-Medicare groups and no other independent variables

Model 2 includes WV-Medicare/SEER-Medicare groups, and adjusts for predisposing (age, race) and enabling (census tract income and education) as independent variables

Model 3 includes WV-Medicare/SEER-Medicare groups, and adjusts for predisposing (age, race), enabling (census tract income and education), need-related (stage at diagnosis, grade of tumor, estrogen receptor status, comorbidities, mental conditions) and healthcare use (Primary care physician visits, type of initial treatment, inpatient use) as independent variables

Model 4 includes WV-Medicare/SEER-Medicare groups, and adjusts for the independent variables listed above in addition to external healthcare environmental factors (location of residence, number of hospitals with oncology services)

Table 4.7
Factors Explaining Lower Total Average Costs in WV-Medicare Cohort
Using Blinder-Oaxaca Linear Decomposition Analysis
2003-2006

Variables	Pooled Weights	% Contribution to the 'Explained' Portion
Predisposing characteristics (Age, Race)	-0.40%	-2.53%
Enabling resources (Census tract Annual Household Income and Education)	6.85%	43.30%
Need-Related Variables (Stage at Diagnosis, Grade of Tumor, ER status, Comorbidity, Mental Conditions)	-1.50%	-9.48%
Healthcare Use (PCP visits, Type of Initial Treatment, Inpatient use)	7.53%	47.60%
External Healthcare Environmental Factors (Location of Residence, Number of Hospitals with Oncology Services)	3.33%	21.05%
Total Difference Explained	15.82%	100.00%

CHAPTER 5

CHAPTER 5

SUMMARY AND CONCLUSIONS

RATIONALE AND OBJECTIVES

Breast cancer (BC) is the most common cancer among women and is the second leading cause of cancer death in women in the United States (US). Based on 2005-2009 Surveillance, Epidemiology and End Results (SEER) statistics, 41% of the new BC cases and 57.4% of the BC deaths occur in women age 65 and above ¹. The overall incidence of BC in women below 65 years of age is 82.97 per 100,000 women and is 421.30 per 100,000 women in those above age 65 ¹. The overall mortality from BC is 11.15 per 100,000 women for those less than 65 years of age and is 98.64 per 100,000 women in those above age 65 ¹. Besides, elderly women age 65 and above have a greater burden of BC as they are diagnosed at more advanced stages and with larger tumors impacting their survival ².

In a rural state such as WV which is medically underserved with rates of chronic disease and poor health behaviors ³⁻⁶, rates of advanced and unstaged BC are high ⁷⁻¹¹ owing to lower mammography screening rates in women in this state ⁸⁻¹². Also, WV have lower incidence of BC (372.8 per 100,000 vs. 411.7 per 100,000) but higher BC-related mortality (110.4 per 100,000 vs. 98.6 per 100,000) as compared to the national estimates ^{13,14}. These may be because of low mammography screening rates ^{9-11,15}, limited physical access to services, shortage of healthcare professionals and services ¹⁶, and untimely BC care. These disparities also indicate that elderly women diagnosed with BC in WV may have higher healthcare costs after cancer diagnosis.

There is no clear evidence about the beneficial effects of mammography screening in elderly women age 65 and above due to lack of inclusion of these women in clinical trials ¹⁷ and discrepancy about evidence-based guidelines for mammography screening in these women.

Previous published studies which reported benefits of mammography screening on representation of stage of BC in elderly women have been limited in terms of including women of certain age groups only, utilizing data from fewer cancer registries, not capturing persistent mammography utilization before BC diagnosis, and not distinguishing screening from diagnostic mammography claims which is an inherent issue with Medicare claims data ¹⁸⁻²¹. Moreover, very limited information is available about the association between mammography screening and stage of disease in elderly Medicare beneficiaries with BC from a rural setting and from non-SEER-Medicare states.

Although timely care in BC patients is highly crucial, the US-based guidelines have not yet defined an appropriate time frame for diagnosis and treatment. Previous published studies on timeliness of BC care ²²⁻³⁰ have no consensus in regards to an appropriate time for diagnosis and treatment. Also none of these studies have followed any published opinion-based guidelines to appropriately define timely diagnosis and treatment. With lower incidence of BC but higher BC-related mortality in elderly women in WV as compared to national estimates, it is highly likely that timeliness of BC care may be one of the important contributors to these disparities.

Female BC comprises the highest proportion of national cancer care costs which is expected to increase by 32% in 2020 ³¹. In addition, BC has the highest costs in the initial phase of care (one year after diagnosis) among all the cancers ³¹. A systematic review on BC costs in the US suggested that majority of the studies included in the review were outdated and/or focused on women with selected stages only ³². Few recent studies on costs have utilized data only till 2003 and from fewer cancer registries ^{31,33-35}. Moreover, very limited information is available about BC costs from a rural setting and from non-SEER states.

To address these gaps in the literature and to identify the factors associated with higher BC-mortality in the elderly WV women, a series of retrospective observational cohort studies were conducted using data from the elderly fee-for-service (FFS) Medicare beneficiaries with first incident primary BC from the West Virginia Cancer Registry (WVCR)-Medicare linked dataset and the results were compared with national estimates derived from the SEER-Medicare linked dataset. In study one, the proportion of Medicare FFS beneficiaries in WV with incident BC persistent with mammography screening and the association between persistence with mammography screening and stage at BC diagnosis in a multivariate framework was determined and compared with the national estimates derived from the SEER-Medicare dataset. In study two, timeliness of BC care in terms of timely diagnosis and timely treatment based on published opinion-based guidelines, factors associated with timeliness and the effect of timely care on the probability of being alive were examined in elderly WV women with BC and compared with the national estimates derived from the SEER-Medicare dataset. In study three, total average healthcare utilization and costs in the initial period of one year after BC diagnosis and average utilization and costs by types of services and the factors associated with higher healthcare costs in initial period were evaluated in elderly WV women and these estimates were compared with the national estimates derived from the SEER-Medicare dataset.

SUMMARY OF FINDINGS

Overall, the study findings indicated that the elderly FFS Medicare beneficiaries with first primary incident BC from WV were statistically different from the nationally representative population from SEER-Medicare. The WV-Medicare study cohort was relatively younger, predominantly white, lived in non-metro areas, with lower median household income and mainly belonged to the areas with lower percentage of people with college education as compared to the

SEER-Medicare cohort. In addition, the WV-Medicare cohort was mostly diagnosed at local stage of BC, had higher primary care physicians (PCP) visits, and had two or more comorbid chronic conditions.

Persistence with Mammography Screening and Stage at Diagnosis among Elderly Women Diagnosed with Breast Cancer

In the retrospective observational cohort study, 51% of women in WV-Medicare cohort were persistent with mammography screening as compared to 45.4% in the SEER-Medicare cohort. In the WV-Medicare cohort, of those not persistent with mammography screening, 31% were diagnosed with late stage BC while among those who were persistent with mammography screening, only 12% were diagnosed with late stage BC. However, in the SEER-Medicare cohort, of those not persistent with mammography screening, 39% were diagnosed with late stage BC while 17% were diagnosed with late stage BC among those who were persistent with mammography screening. In the multivariate framework for the WV study cohort, persistence with mammography screening was significantly associated with early stage BC. While for the SEER-Medicare cohort, persistence with mammography screening, higher household income and higher PCP visits were significantly associated with earlier stage at BC diagnosis. This study also showed that elderly FFS Medicare beneficiaries with BC in WV were equally likely to be diagnosed at an early stage of BC as compared to their national counterparts from SEER-Medicare after controlling for persistence with mammography screening. The study findings contradict reports of lower mammography utilization in WV ^{8,9,12,36} as the contributor of late stage BC leading to higher BC-related mortality. This also indicates that there may be other factors such as poor health status, family history of BC, BRCA gene mutation, untimely or

inappropriate care that may be responsible for higher rates of late stage BC in elderly women in WV, which affect their survival.

Timeliness of Care among Elderly Women Diagnosed with Breast Cancer

In this retrospective observational cohort study, the median days from initial consultation for abnormality to BC diagnosis was 26 (Interquartile Range (IQR)=12-50 days) for the WV-Medicare cohort as compared to 20 (IQR=8 to 41 days) for the SEER-Medicare cohort. The overall median days from BC diagnosis to any BC treatment was 8 (IQR=0-28 days) for the WV-Medicare cohort as compared to 15 (IQR=0-29 days) for the SEER-Medicare cohort.

Approximately, only 63% of women in the WV-Medicare cohort received timely diagnosis of BC (i.e. consistent with the published opinion-based EUSOMA recommendations) as compared to 71% of the SEER-Medicare cohort. Also, 76% of the WV-Medicare cohort received timely BC treatment (i.e. consistent with the published opinion-based NICE recommendations) as compared to 73% from the SEER-Medicare cohort. For the WV-Medicare cohort, census tract household income above \$35,000 and tumor size > 3 cm was significantly associated with timely diagnosis of BC; however, no factors were significantly associated with timely treatment of BC. In addition, the WV-Medicare cohort was significantly less likely to receive timely diagnosis of BC but it was equally likely as the SEER-Medicare cohort to receive timely treatment for BC. Furthermore, the WV-Medicare cohort was significantly more likely to be alive at the follow-up period of three years as compared to the SEER-Medicare cohort. It is possible that other factors such as WV women's social and cultural barriers including fear, sense of fatalism, knowledge and beliefs, perceived risk, physicians' characteristics, and health system factors^{24,37-43} which are not measured in this study may be contributing to the higher BC-mortality rate among WV women. The higher probability of being alive at the end of follow-up period for WV-Medicare

cohort compared to the SEER-Medicare cohort indicates that a three years follow-up period may not produce sufficient robust statistical estimates as compared to longer follow up period to make any conclusions in this regards due to higher five-year survival in women with BC.

Total Healthcare Costs of Breast Cancer in the Initial Phase (12-months) After Diagnosis

In this retrospective observational cohort study, the average total healthcare costs, the average total inpatient costs, and the average total costs for physician services in the initial phase of one year following BC diagnosis for the WV-Medicare cohort was significantly lower than that for the SEER-Medicare cohort. In the multivariate framework, these differences shrunk but continued to remain significant. In the WV-Medicare cohort, women who had regional or distant stage of BC, who had surgery with adjuvant therapy or who had adjuvant therapy only, who had inpatient visits, who had two or more comorbidities, and who had either depression or anxiety had significantly higher total average costs. Also, in the WV-Medicare cohort women who were of age 75 or older had significantly lower total average costs. In the Blinder-Oaxaca decomposition analyses, only 15.82% of the difference in the total average costs between the WV-Medicare and SEER-Medicare cohorts was explained by the beneficiary characteristics. Enabling resources (census tract income and education) contributed 6.85%, healthcare use (PCP visits, type of initial treatment, inpatient use) contributed 7.53%, and external healthcare environmental factors (location of residence, hospital visits) contributed 3.33% to the total explained portion of 15.82%. A total of 84.14% of the differences in the total average costs in the initial phase of care between WV-Medicare and SEER-Medicare cohorts remained unexplained. The study findings indicate that a portion of the lower costs in a rural state such as WV as compared to the SEER-Medicare regions may be due to the differences in the Medicare spending across various geographic regions in the US ⁴⁴. Also, these findings are surprising

given the higher comorbidity burden which should increase the total average costs in the initial phase following BC diagnosis. Furthermore, the study findings highlight the importance of encouraging elderly WV women to utilize preventive screenings to get BC diagnosis at earlier stages. These also emphasize the importance of better co-management of physical and mental chronic conditions in this rural and elderly population, to lower overall costs to Medicare in a rural WV state. The findings from the Blinder-Oaxaca decomposition analyses indicate that a larger portion of ‘unexplained’ differences may be due to unmeasured factors such as health status, severity of comorbid conditions, BMI, patient preferences and propensity to seek care.

CONCLUSION

This project laid the foundation for larger studies aimed at reducing and eliminating BC disparities in a rural and geographically challenged state such as WV whose population is aging and has lower socio-economic status. Given that the elderly WV women had lower incidence of BC but higher BC-related mortality as compared to the national estimates ^{13,14}, various factors such as mammography screening, timeliness of care, appropriateness of care, physical access to healthcare services and healthcare professionals need to be studied to determine if these factors are the contributors to these disparities. In this project, the association between persistence with mammography screening and stage at BC diagnosis, timeliness of BC care based on published opinion-based recommendations, and total average costs in the initial phase were evaluated and estimated to identify if these factors contributed to the higher BC-related mortality in the rural state and if these rural women bore higher costs in the initial phase. The study findings directed that only timely diagnosis of BC as per published recommendations is an issue in rural WV, however the chances of survival were better in this population as compared to the estimates from their national counterparts. Various unmeasured factors such as health status, BMI, severity of

comorbid conditions, patient preferences, social and cultural barriers to care and several physician related and health system factors may be contributing to higher BC-related mortality in elderly WV women.

FUTURE RESEARCH

Studies investigating the effect of long term persistence with mammography screening (e.g. 10-years) on stage at BC diagnosis after controlling for important covariates such as health status, BMI, patient preferences, and beliefs knowledge about mammography screening that may generate a clear picture about the beneficial effects of mammography screening in this rural and elderly population are suggested. In addition, studies which controls for various factors such as fear, sense of fatalism, knowledge and beliefs about BC, perceived risk, physicians' characteristics, and health system factors which may affect timely BC care are advocated. Furthermore, studies evaluating the effect of timely BC care on survival in elderly women should include longer follow-up period of at least five to ten years to produce accurate conclusions about this association. Future research focusing on the incremental costs due to presence of various co-occurring chronic conditions among elderly population with BC from rural areas is also recommended. Moreover, studies estimating indirect medical costs, indirect non-medical costs, out-of-pocket costs and caregiver burden in elderly women with BC in a rural setting are suggested.

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