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Predictors of Adherence to Standard Treatment Guidelines for Stage III Colon Cancer among Patients in Georgia from 2002-2005

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Bachelor of Science

Fudan University, 2013

Thesis Committee Chair: Kevin C. Ward, PhD, MPH

An abstract of

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Abstract

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By
Yunfeng Huang

Quality of colon cancer care remains problematic in the United States. National Quality Forum (NQF) endorsed quality metrics have been commonly utilized with population-based cancer registry data to assess the quality of care. However, one of the major limitations is the extent of information for quality measure assessment captured by registry data. Our augmenting study used four bilateral linkages of Georgia cancer registry data to Medicare, Medicaid, State Health Benefit Plan of Georgia (SHBPG) and Kaiser Permanente of Georgia (KPG) claims, to more completely assess factors predicting receipt of adjuvant chemotherapy within 4 months of diagnosis for patients under the age of 80 with AJCC Stage III colon cancer in Georgia from 2002-2005 and measure overall adherence to this guideline. We found 70 percent (761/1086) concordance and 30 percent (325/1086) discordance in receipt of chemotherapy between the registry data and combination of claims data from four sources. Older age was found to be a significant predictor of less receipt of chemotherapy among stage III colon cancer patients in Georgia (66-72 years vs. <=65 years: adjusted OR = 0.619, 95% CI: 0.393, 0.974; 73-79 years vs. <=65 years: adjusted OR = 0.306, 95% CI: 0.200, 0.467). In contrast, being married (adjusted OR = 1.663, 95% CI: 1.151, 2.402) and having four or more positive regional nodes (adjusted OR = 1.642, 95% CI: 1.069, 2.520) were found to significantly predict receipt of chemotherapy. Linkage of cancer registry data with insurance claims data is an effective method for augmenting missing treatment data in population-based cancer registries and better quality assessment. In addition, quality improvement of colon cancer care in Georgia should target more vulnerable populations for higher efficiency.

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Introduction

Despite considerable progress through prevention, early detection and treatment, cancer remains a leading health concern as well as cause of morbidity and mortality in the United States.[1] In the 1999 report, *Ensuring the Quality of Cancer Care*, the Institute of Medicine's National Cancer Policy Board (NCPB) concluded that quality of cancer care is a substantial and widespread problem.[2] Colorectal cancer, the third leading cause of cancer-related mortality in the United States, has a low five year survival of around sixty percent. The mortality rate is 19.1 per 100,000 persons for males and 13.5 per 100,000 persons for females. [3] Previous studies have shown that variations exist in the quality of colon cancer care, which provide us significant opportunities for targeting research to better understand and reduce those variations.[4] In 2005, the National Quality Forum (NQF) selected "adjuvant chemotherapy is considered or administered within 4 months of diagnosis for patients under the age of 80 with AJCC Stage III colon cancer" as a standard quality measure of colon cancer care, which facilitated studies to focus on this metric. Age, race, social support, and geographic distribution were reported to be associated with disparity in the receipt of adjuvant chemotherapy.[5] However, a common limitation exists in many previous population based studies, which is the completeness of the treatment data captured by registries. Because a growing proportion of adjuvant cancer care is provided outside the hospital setting, population-based cancer registries face the challenge of collecting these data in an efficient manner.[6 7] To overcome this limitation, our study developed

a series of bilateral linkages between the Georgia Cancer Registry and administrative claims datasets known to capture information on payment for adjuvant therapy. Using an augmented registry-claims dataset capable of more accurately measuring adherence to the standard treatment guideline for stage III colon cancer, we were able to quantify the proportion of treatment data missing from the registry, assess statewide adherence to the NQF guideline, and develop a prediction model to assess the factors associated with the receipt of standard care among stage III colon cancer patients in Georgia.

Literature Review

Colorectal Cancer

Colorectal cancer is cancer arising in the large intestine (colon) or the rectum (end of the colon). It is the third most common cancer in both men and women. Colorectal cancer is the fourth most common cause of cancer death globally, accounting for roughly 700,000 deaths per year.[8] Geographic variation in the incidence of colorectal cancer has been observed globally. The highest incidence is observed in North America, Oceania, and Europe, including Eastern European countries, whereas incidence is lowest in some countries of Asia, Africa and South America.[9] High colorectal cancer incidence is considered most likely the result of increases in risk factors associated with "Westernization" or "Western lifestyle", such as obesity and physical inactivity.[10] However, due to the optimization of surgical techniques, the introduction of more effective neoadjuvant therapies and recent developments in

diagnostic imaging modalities, the mortality rate of colorectal cancer has decreased in many longstanding as well as newly economically developed countries. In contrast, the mortality rate continues to increase in some of the limited-resource countries of South America and Eastern Europe.[11]

In the United States, the lifetime risk of colorectal cancer is 4.7%. There are approximately one million Americans who have either been cured of or are currently under treatment for colorectal cancer.[12] Based on data of the Surveillance, Epidemiology and End Results Program (SEER) from 2007-2011, the age-adjusted rate of colorectal cancer was 43.7 per 100,000 men and women per year, and the rate of death was 15.9 per 100,000 men and women per year. The age-adjusted incidence rates have been falling on average 3.1% each year over the last 10 years. Death rates have been falling on average 2.9% each year over 2002-2011.[13]

According to State Cancer Profiles, the average annual incidence rate of colorectal cancer in Georgia was 43.3 per 100,000 from 2007-2011, which ranked the 4th among all cancer sites. There were 3891 average annual cases over this same period. Colorectal cancer is more common among men compared to women with an annual incidence rate in Georgia of 50.8 per 100,000 males and 37.6 per 100,000 females. In addition, older individuals tend to have higher incidence of colorectal cancer. The annual incidence rate of colorectal cancer is 137.1 per 100,000 among those who are 50 or older, while the annual incidence rate is 7.5 per 100,000 among those younger than 50.[14]

Treatments for Colon Cancer

The treatment of colon cancer is largely decided by the stage of disease at the time of diagnosis.[15] Surgery to take out the cancerous cells is the main treatment for stage 0 and stage I colon cancer patients. For those diagnosed with stage II colon cancer, surgery to remove the section of the colon containing the cancer along with nearby lymph nodes (partial colectomy) is necessary, but chemotherapy after surgery may be recommended depending on the risk of cancer recurrence. In stage III, the colon cancer has spread to nearby lymph nodes but has not spread to other parts of the body. Surgery to remove the section of the colon containing the cancer along with nearby lymph nodes followed by adjuvant chemo is the standard treatment. In patients diagnosed with stage IV colon cancer, the cancer has spread from the colon to distant organs and tissues, making it very difficult to cure the cancer in this stage. Surgery, chemotherapy before and after surgery, and radiation therapy are chosen depending on the goal of treatments.

Quality Issues of Colorectal Cancer Care

Although the incidence and mortality of colorectal cancer have decreased over the past several years, resulting in part from improvements in screening and treatment, colorectal cancer is still a major health concern in the United States. Based on SEER data from 2004-2010, the five-year survival of colorectal cancer is 64.7. This low survival rate is related to the high percentage of regional and distant cases, accounting for more than half of all new diagnoses.[13] In addition to poor survival outcomes,

colorectal cancer has serious implications for a patient's quality of life. Colorectal cancer patients have shown significantly lower emotional and social functioning, and many patients have expressed concerns with satisfaction of care, receiving information regarding medical condition and making sense of the cancer experience.[16,17]

Despite the high incidence, low survival rate and detrimental consequences of colorectal cancer, deficiencies exist in many aspects of colorectal cancer care. Accurate staging is required for proper colorectal cancer management, but a large number of cases lack efficient elements for stage determination in their pathology reports.[18] Another issue is the number of lymph nodes included in the surgical specimen, since inadequate resections or pathology assessments is associated with decreasing survival rates.

From the treatment perspective, colostomy rate and mortality rate reflect the quality of care. Some comparison studies have shown that small hospital size may be associated with high colostomy rate, high mortality rate and worse quality of care.[19] Another area of colorectal cancer treatment, part of the standard treatment of stage III colon cancer, is adjuvant therapy. Many patients did not receive appropriate treatment based on their conditions. In one study from 2002, one third of stage III colon cancer patients did not receive adjuvant chemotherapy.[20] In fact, previous studies have shown that in the absence of adjuvant therapy, a three year disease-free survival (DFS) in stage III colorectal cancer is merely 44% to 52%, [21] and the DFS and overall

survival can be both increased by the combination of oxaliplatin and 5-fluorouracil chemotherapy from the MOSAIC trial in 2004.[22] However, disparity in the receipt of adjuvant chemotherapy is still common among colon cancer patients, in other words, the standard treatment guideline of stage III colon cancer treatments is not consistently met.

Disparities in Receipt of Standard Treatment – Adjuvant Chemotherapy

There are several published studies that addressed the factors associated with receipt of chemotherapy, which is an essential part of standard treatment, among colon cancer patients. First, increasing age was strongly associated with decreasing likelihood of receiving chemotherapy for lymph node-positive colon cancer patients. Individuals older than 70 years were significantly less likely to receive chemotherapy then those younger than 65 years old.[23] Second, there is conflicting information about the racial disparities in adjuvant chemotherapy among colon cancer patients. Some researchers have shown that eligible black patients are less likely to receive chemotherapy compared to eligible white patients, and the benefits from chemotherapy are lower among black patients. [24 25] With the worst 5-year cancer survival of all racial/ethnic groups in the U.S., American Indians and Alaskan Natives have significantly lower rates of adjuvant chemotherapy.[26] Nevertheless, other studies showed that the racial disparity in colon cancer treatment can be well explained by access to medical care[27], illness severity, social support, and the referral rate to medical oncologist. [25 28] In addition, there are other reported factors associated with the receipt of standard of

care colon cancer treatment. Comorbidity, marital status, being uninsured, having rectal cancer and increasing tumor stage were associated with increased risk of non-adherence with standard colon cancer treatment.[29] [30] [31] Insurance status and type also played an important role in the receipt of chemotherapy among colon cancer patients. [32] [33] Previous research results showed that hospitals serving a higher percentage of Medicaid patients are associated with poorer colon cancer care.[34] Some researchers also reported geographic variation, which has not been widely studied, and social demographic characteristics are associated with the use of chemotherapy in stage III colon cancer patients.[35] [36] Patients with colon cancer in rural counties were less likely to undergo chemotherapy than those in micropolitan counties.[37] The uneven geographic distribution of medical oncologists may contribute to decreasing access to cancer care, therefore, the availability of medical oncologist can affect the initialization of adjuvant chemotherapy for colon cancer patients.[38]

Quality Measurement Based on Adjuvant Chemotherapy

Facing a large demand for improvement in quality of cancer care, especially breast cancer and colorectal cancer care, construction of the Rapid Quality Reporting System (RQRS), which was developed by Commission on Cancer (CoC), was aimed at promoting evidence-based cancer care at the local level. In early 2005, the CoC submitted three quality of care measures reported through RQRS for colorectal cancer to the National Quality Forum (NQF). Our study selected "adjuvant chemotherapy is considered or administered within 4 months of diagnosis for patients under age of

80 with AJCC Stage III colon cancer" as a standard measure for quality of colorectal cancer care among patients in Georgia.

The NQF endorsement of a quality measure based on adjuvant chemotherapy provided us a great opportunity to assess the quality of colon cancer care at the local level. During previous work in Georgia, researchers found that patients with stages III colon and II/III rectal cancers who reside in rural areas were significantly less likely than their urban and suburban counterparts to receive chemotherapy and older patients were less likely than younger ones to receive chemotherapy. In addition, the Black–White disparities in receipt of chemotherapy were identified to exist but were confined to urban patients. [39] A common limitation of the previous studies, however, for the adherence of standard treatment guideline among colon cancer patients is the completeness of data for adjuvant chemotherapy. Studies have shown that population-based cancer registries under ascertain information on therapies provided outside the hospital setting. [6] Although cancer registry data can be used in their existing form as a tool to measure the quality of cancer care, augmenting registry data with information from other electronic sources known to capture treatment is desired. The data from external sources, such as administrative claims, can be used to validate the registry data and to augment missing information in the registry thus allowing for a more accurate assessment of quality of care measures[7]

Our study presented here augmented cancer registry data with 4 separate medical claims data sources (Medicare, Medicaid, Kaiser and the State Health Benefit Plan for

Georgia), to create an "augmented registry" database capable of more accurately assessing adherence to one of the NQF endorsed quality measurement for colon cancer care. In order to clarify the disparity in quality of colon cancer care in the State of Georgia, this study will explore individual characteristics and the receipt of standard colon cancer treatment. Using the augmented dataset with several insurance claims, we will analyze individual sociodemographics to more accurately predict the receipt of standard care among stage III colon cancer patients. In addressing this question with a retrospective cohort and a more complete model, we hope to fill in the gaps of information regarding predictors for the receipt of standard care of stage III colon cancer in the state of Georgia.

Methods

Data Source

We identified 1927 stage III colon cancer cases diagnosed in Georgia residents from 2002 through 2005 between the ages of 18 and 79. Cases were selected from the Georgia Cancer Registry (GCR). 1086 (56.36%) cases were bilaterally linked to medical claims data from one or more of the following data sources for the period 2002-2006: Medicaid, Medicare, State Health Benefit Plan of Georgia (SHBPG) and Kaiser Permanente of Georgia (KPG).

Quality Measure

We focused on one of the quality measures endorsed by NQF: "adjuvant chemotherapy is considered or administered within 4 months of diagnosis for patients

under the age of 80 with AJCC Stage III colon cancer". To assess the receipt of standard care based on the quality measure above, we first identified if the patients had chemotherapy administration within 4 months documented through the registry data. We then linked registry data to claims data from Medicaid, Medicare, SHBPG and KPG, and looped through the claims datasets to identify claims for the administration of chemotherapy after the diagnosis date of the colon cancer patient. For each dataset, we captured the fact of a claim for chemotherapy and the date of the first claim for chemotherapy. We then created five binary indicators for guideline concordant therapy based on registry data and each of the four resources to which we bilaterally linked (Medicaid, Medicare, SHBPG or KPG). We also created an overall binary indicator for the receipt of standard care with the combination of registry data and all four claims data sources. We defined adherence to the quality measure if registry data or any of the four resources of claims data indicated the patient received adjuvant chemotherapy within 4 months of diagnosis of AJCC Stage III colon cancer.

Predictors

Data on predictors were obtained from the GCR including age at diagnosis, gender, race, marital status, poverty level and diagnosis year. Two geographic predictors: Rural Urban Commuting Area Codes (RUCAs) and diagnosis county of the patient were also included. We also included a binary predictor to assess the effect of utilization of the Commission on Cancer (CoC) facilities. This indicator reflected whether the patient was treated in a hospital accredited by the CoC. Two additional

predictors assessed the number of regional nodes examined and the number of positive regional nodes for each patient. The number of regional nodes examined recorded the total number of regional lymph nodes that were removed and examined by the pathologist. The number of positive regional nodes recorded the exact number of regional nodes examined by the pathologist and found to contain metastases.

Age at diagnosis was categorized into three different groups: less than or equal to 65 years, 66 to 72 years, and 73 to 79 years. Gender was dichotomized into male and female. Race was categorized into White and other races. We combined Black and other races due to the small sample size of patients with other races (n=8). Marital status at the time of diagnosis was categorized into three groups: married, other, and unknown. Other included never married, separated, divorced, widowed and not common law marriages. Poverty level was measured with an area-based measure of socioeconomic status based on the census tract of the patient's address at diagnosis. It was obtained from the 2000 U.S. Census, the decennial census closest to the diagnosis years covered in this study. We dichotomized this variable as less than 20%, and 20% or above. An area with greater than 20% of the population living below the federally defined poverty level meets the definition of a federal poverty area. For geographic predictors, RUCA primary codes were applied to indicate urbanicity. RUCA codes are a new Census tract-based classification scheme that utilizes the standard Bureau of Census Urbanized Area and Urban Cluster definitions in combination with work commuting information to characterize all of the nation's Census tracts regarding their

rural and urban status and relationships. We categorized RUCA primary codes into three groups: metropolitan area, micropolitan area and other area. In addition, a variable was created called SEER region which dichotomized counties in Georgia into 2 groups, Atlanta and other, based on the 5 county definition of the historic Metropolitan Atlanta SEER Registry (DeKalb, Cobb, Clayton, Fulton and Gwinnett). A binary predictor for treatment at a CoC facility was created to indicate whether a patient received care through one of these accredited facilities. The number of regional nodes examined was dichotomized into less than 12 and 12 or above, and the number of positive regional nodes was categorized into three different groups: 1, 2-3, 4 and more. Patients without information on the exact number of regional nodes examined or positive regional nodes were excluded from our study.

Analysis

Based on the NQF quality measure, we first generated four cross tables (Table 1-4) to assess the agreement on the receipt of standard care by looking at each of the bilateral linked datasets: Medicaid, Medicare, SHBPG and KPG. From these tables, we studied the completeness and validity of the cancer registry data. We also assessed the agreement on the receipt of standard care between cancer registry data and medical claims data from all four resources combined (Table 5). By combining all four bilaterally linked datasets, we estimated the overall contribution of the linkage of cancer registry data with medical claims data on quality measurement.

We next summarized the proportion of patients meeting the standard care guideline by patient and clinical characteristics in Table 6. A Chi-square test was used to assess the bivariate association between each predictor and the receipt of standard care. We then built a multivariate logistic model to study if any of the predictors can significantly predict the receipt of standard care of AJCC stage III colon cancer after controlling for other predictors. The dependent variable, receipt of standard care (i.e. adherence to the NQF quality metric), was defined based on the overall binary indicator. Patients were considered adherent to the quality measure if registry data or any of the four resources of claims data indicated the patients received adjuvant chemotherapy within 4 months of diagnosis of AJCC Stage III colon cancer. All the predictors were treated as categorical variables. Interaction between poverty and marital status, as well as the interaction between race and marital status, was assessed by adding two product terms into the initial model. All data analyses were performed in SAS 9.4.

Results

Among the 1086 stage III colon cancer patients included in our study, 800 linked with Medicare claims, 301 linked with Medicaid claims, 49 linked with KPG claims and 173 linked with SHBPG claims. In the linkage from registry to Medicare (Table 1), 403 (50.38%) patients had agreement on meeting the guideline between registry data and Medicare claims, and 167 (20.88%) patients had agreement on not meeting the guideline. In addition, we found 186 (23.25%) patients met the guideline based on Medicare claims but not registry data and 44 (5.50%) patients met the guideline based

on registry data but not Medicare claims. Among patients linked with Medicaid claims (Table 2), 136 (45.18%) of them received administered chemotherapy based on either registry data or Medicaid claims data, while 72 (23.92%) of them had concordance of not receiving administered chemotherapy between registry and Medicaid claims. In contrast, 52 (17.28%) patients had administered chemotherapy only based on Medicaid claims while 41 (13.62%) patients had administered chemotherapy only based on registry data. Our results from the linkage with KPG showed that 20 (40.82%) patients agreed on adherence of the guideline in either registry data or KPG claims, and 5 (10.20%) patients agreed on no adherence of the guideline (Table 3). However, 24 (48.98%) patients followed the guideline in KPG claims but not in registry data, and no patients followed the guideline based on registry data only. Among those linked with SHBPG claims (Table 4), we found 97 (56.07%) patients had agreement on receiving administered chemotherapy from both registry data and SHBPG claims data, and 14 (8.09%) patients had agreement on not receiving administered chemotherapy. We also found 46 (26.59%) patients had administered chemotherapy through SHBPG claims data only and 16 (9.25%) patients had administered chemotherapy through registry data only. In the combination of all four sources and registry data (Table 5), we found 564 (51.93%) patients had agreement on receiving administered chemotherapy based on both registry data and claims data from Medicaid, Medicare, KPG or SHBPG, while 197 (18.14%) patients had agreement of not receiving administered chemotherapy. However, 269 (24.77%)

patients had administered chemotherapy based on claims data only, and 56 (5.16%) patients had administered chemotherapy based on registry data only.

After assessing the predictors, we excluded 30 patients due to missing values in the number of regional nodes examined or the number of positive regional nodes. Thus, the final sample size for our prediction model was 1056. The proportions of patients meeting the standard treatment guideline by each of predictors were summarized in Table 6. Among these patients, 876 patients met the standard treatment guideline, which accounts for 83.0 percent of our total sample. Age distribution among patients who met the guideline was significantly different from patients who did not ($p<0.001$). 40.4 percent of patients who met the guideline were less or equal to 65 years old, while 22.8 percent of patients who did not meet the guideline were in this age group. In contrast, only 27.4 percent of patients who meet the guideline were older than 72 years, while 49.4 percent of patients who did not meet the guideline were in this category. In our sample, 47.2 percent of the patients were males while 52.8 percent were females. There was no significant gender disparity in the receipt of standard care among these patients ($p=0.757$). In utilization of CoC facilities, 80.3 percent of patients who met the guideline were diagnosed in the CoC accredited hospitals while 75.0 percent of patients who did not meet the guideline were diagnosed in the CoC accredited hospitals, but the proportions were not significantly different ($p=0.113$). Compared to those who met the guideline, slightly but not significantly higher percent of patients who did not meet the guideline had 20 percent or more poverty (32.2% vs.

25.6%, p=0.066). We also did not find significant racial disparities in the receipt of standard treatment (p=0.437) as 69.1 percent of patients who met the guideline were White, compared to 66.1 percent of those who did not. A very significant disparity was identified, however, based on marital status (p<0.001). 61.0 percent of patients who met the guideline were married compared to 46.7 percent of patients who did not. There was no significant bivariate association was found from year of diagnosis (p=0.631), SEER region (p=0.883) or urbancity defined by RUCA primary codes (p=0.652). When looking at the number of positive regional nodes, we found significant disparity especially comparing patients who had one positive node with patients who had 4 or more positive nodes (p=0.021). 34.93 percent of patients who met the guideline had one node while 44.4 percent of patients who did not had one positive node. In contrast, 31.7 percent of patients who met the guideline had 4 or more positive nodes while 22.8 of patients who did not had 4 or more positive nodes. However, no significant disparity was found in the number of regional nodes examined (p=0.759).

In our prediction model, we started from a logistic regression model including all predictors and two interaction terms: marital status with race, marital status with poverty. Neither of the interaction terms was found to be significant, so we dropped the interaction terms in our final model. Estimates of the model including interaction terms can be found in the appendices. In our final prediction model, we found three significant predictors: age, marital status and the number of positive regional nodes

(Table 7). Compared to patients who were less than or equal to 65 years old, patients who were between 66 to 72 years were 38.1percent less likely to meet the standard treatment guideline (adjusted OR = 0.619, 95% CI: 0.393, 0.974), and patients who were older than 72 years were 69.4 percent less likely to meet the standard treatment guideline (adjusted OR = 0.306, 95% CI: 0.200, 0.467). For marital status, compared to people with other marital status: never married, separated, divorced, widowed or not common law marriages, patients who were married were 66.3 percent more likely to receive the standard care (adjusted OR = 1.663, 95% CI: 1.151, 2.402). In addition, patients with four or more positive regional nodes were 64.2 percent more likely to receive administered chemotherapy for stage III colon cancer than those with only one positive regional node (adjusted OR = 1.642, 95% CI: 1.069, 2.520).

Discussion

Agreement and Disagreement between Registry Data and Claims Data

From our augmented bilaterally linked datasets with each of the four health insurance claims data, we found 71.3 percent agreement between registry data and Medicare Claims data, which is the highest among the four sources (69.1 percent in Medicaid, 51.0 percent in KPG and 64.2 percent in SBHPG), reflecting the best completeness and validity of registry data on Medicare patients. However, there were still 23.3 percent of patients captured as not receiving the administered chemotherapy for their stage III colon cancer by registry data but found receiving administered chemotherapy by looking through Medicare claims data. In another word, we captured more than 20

percent of the information lost by registry data, which has been reported as a major limitation of population based registry data in previous SEER-Medicare studies. In addition, in looking at other three resources, we found 17.3 percent information lost by registry data was captured through bilateral linkage with Medicaid claims data, as well as 26.6 percent and 49.0 for linkages with SHBPG and KPG respectively. After the combination of all four bilaterally linked datasets, we found about 25 percent of information on adherence to the treatment guideline among stage III colon cancer patients were lost by the registry data, but we were able to capture this part of information through claims data.

Predictors for Receipt of Standard Care

From the results of our prediction model, we found age and marital status as two most important predictors for receipt of standard care among stage III colon cancer patients in Georgia. Older patients are less likely to receive administered chemotherapy compared to those who are younger. This trend has also been reported in previous studies focused on quality of colon cancer care. In addition, marital status, which reflects social support, is another very significant predictor for the receipt of standard care. Patients who are married are much more likely to have adherence to the standard treatment guideline after they were diagnosed of stage III colon cancer compared to others, which thus addressed the role of social support in the quality of colon cancer care. In addition, the insignificant gender disparity in receipt of administered chemotherapy among stage III colon cancer patients in Georgia reflected the equal

quality of colon cancer care between men and women. It is essential to colon cancer care since this disease has equal burden among both males and females. We also did not find significant disparity in receipt of standard treatment for stage III colon cancer by looking at race, poverty level, diagnosed year, and utilization of CoC facilities. Therefore, quality of colon cancer care does not appear to be directly associated with these factors in Georgia. As for geographic variation, there was no significant association between the adherence to standard treatment guideline of stage III colon cancer and SEER region. Urbanicity defined by RUCA primary codes was also found not associated with receipt of standard stage III colon cancer treatment in our study.

When assessing the effect of the number of regional nodes examined and the number of positive regional nodes, we found that patients with 4 or more positive regional nodes are much more likely to receive administered chemotherapy after diagnosis of stage III colon cancer compared to patients with only one positive regional node. This was not entirely surprising as patients with more severe conditions could potentially receive stronger recommendations for receiving adjuvant chemotherapy. In contrast, the number of regional nodes examined is not significantly associated with adherence to the standard treatment guideline for colon cancer care. Therefore, our findings suggested more attention on the effect of the exact number of regional nodes examined by the pathologist and found to contain metastases, which encouraged registry database to collect more accurate and complete records on this information.

Finally, we also assessed if the strong effect of marital status on receipt of standard care was modified by poverty level and race. The results of interaction assessment showed this was not the case in our data.

Strengths and Limitations

One of the major strengths in our study is the augmenting bilaterally linked datasets we developed, which has been shown to be effective for more accurate assessments for the quality measure examined by this study. Although our augmenting study was conducted in Georgia, this augmenting methodology can also be applied in other states to eliminate the information gap in data collection of standard treatments by population-based cancer registry data. Another major strength is the completeness of our prediction model. We examined most of the factors reported by the previous literatures associated with the receipt of chemotherapy among colon cancer patients to assess the quality of colon cancer in Georgia. Our study did not only present the most important factors associated with adherence to the NQF quality metric among stage III colon cancer patients in Georgia, but also added more explanation of the disparity in receipt of standard colon cancer care among patients in Georgia through the augmented outcome variable.

However, our study also has several limitations. The first limitation is the relatively small sample size of our study. This could lead to the loss of power in our statistical tests, which could explain why we observed noticeable but not significantly different distributions of some predictors between patients who met the guideline and those

who did not. Another major limitation is the time period of our data, which is from 2002 to 2005. The data we used in our study may be insufficient to apply our results to the current situation of quality of colon care in Georgia. Other limitations include the sparse data of patients with race other than White and the missing values in marital status, the number of regional nodes examined and the number of positive regional nodes. These limitations might cause barrier on looking at other races separately and loss of power when testing predictors with missing values. Another limitation is the generalization of study. Because of the scale of our study is confined in Georgia, our results might not be able to explain the disparity in receipt of standard colon cancer care in other states. At last, our inability to assess the role of patient comorbidities in this study along with the inability to identify situations where chemotherapy was recommended but not received could both potentially explain the findings observed in this study, specifically for age and number of regional nodes.

Future Recommendations and Research

Based on our results, this study recommends placing a priority on patients who are older, non-married or with a limited number of positive nodes. It might also be beneficial to continue the development on ongoing programs that assess real-time compliance to standard of care measures so that patients not meeting guidelines can be followed-up with to encourage compliance where appropriate. In addition, it might be interesting in the future to develop methods to explore the role of the specific physician in quality of care assessment. Comparing physician performance, as

measured by patients' outcomes, with those around them may lead to increased adherence to standard treatment for all patients.

To remedy many of the limitations of our study, future studies should utilize larger more recent datasets, perhaps from combining more years, to more closely examine risk factors of standard of care adherence. Data incorporating a more in-depth measure of marital status or family/friend support may provide a more nuanced explanation for the results of our study. Finally, data should also incorporate sufficient individual and contextual level factors on the patient to allow researchers account for the effect of patient choice on receipt of care plan.

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Tables

Table 1: Concordance/Discordance for Receipt of Standard Care Treatment based on Registry Data and Medicare Claims

Source = Medicare		Met Guideline in Claims Data		
		Yes	No	Total
Met Guideline in Registry Data	Yes	403 (50.38%)	44 (5.50%)	447 (55.88%)
	No	186 (23.25%)	167 (20.88%)	353 (44.13%)
	Total	589 (73.63%)	211 (26.38%)	800 (100%)

Table 2: Concordance/Discordance for Receipt of Standard Care Treatment based on Registry Data and Medicaid Claims

Source = Medicaid		Met Guideline in Claims Data		
		Yes	No	Total
Met Guideline in Registry Data	Yes	136 (45.18%)	41 (13.62%)	177 (58.80%)
	No	52 (17.28%)	72 (23.92%)	124 (41.20%)
	Total	188 (62.46%)	113 (37.54%)	301 (100%)

Table 3: Concordance/Discordance for Receipt of Standard Care Treatment based on Registry Data and KPG Claims Data

Source = KPG		Met Guideline in Claims Data		
		Yes	No	Total
Met Guideline in Registry Data	Yes	20 (40.82%)	0 (0.00%)	20 (40.82%)
	No	24 (48.98%)	5 (10.20%)	29 (59.18%)
	Total	44 (89.80%)	5 (10.20%)	49 (100%)

Table 4: Concordance/Discordance for Receipt of Standard Care Treatment base on Registry Data and SHBPG Claims Data

Source = SHBPG		Met Guideline in Claims Data		
		Yes	No	Total
Met Guideline in Registry Data	Yes	97 (56.07%)	16 (9.25%)	113 (65.32%)
	No	46 (26.59%)	14 (8.09%)	60 (34.68%)
	Total	143 (82.66%)	30 (17.34%)	173 (100%)

Table 5: Concordance/Discordance for Receipt of Standard Care Treatment based on Registry Data and Combination of Medicare, Medicaid, KPG and SHBPG Claims Data

Source = ALL		Met Guideline in Claims Data		
		Yes	No	Total
Met Guideline in Registry Data	Yes	564 (51.93%)	56 (5.16%)	620 (57.09%)
	No	269 (24.77%)	197 (18.14%)	466 (42.91%)
	Total	833 (76.70%)	253 (23.30%)	1086(100%)

Table 6: Distribution of Characteristics by Receipt of Standard Care among AJCC stage III colon cancer patients between 18 - 79 years old in Georgia from 2002 – 2005

Characteristics	Overall (N = 1056)		Met Guideline Yes(N=876)		No(N=180)		P-Value
	N	%	N	%	N	%	
Age							<0.001
<=65Years	395	37.41	354	40.41	41	22.78	
66 to 72 Years	332	31.44	282	32.19	50	27.78	
73 to 79 Years	329	31.16	240	27.40	89	49.44	
Sex							0.757
Male	498	47.16	415	47.37	83	46.11	

Female	558	52.84	461	52.63	97	53.89	
Commision on Cancer							0.113
Yes	838	79.36	703	80.25	135	75.00	
No	218	20.64	179	19.75	45	25.00	
Poverty							0.066
Less than 20%	774	73.30	652	74.43	122	67.78	
20% and above	282	26.70	224	25.57	58	32.22	
Race							0.437
White	724	68.56	605	69.06	119	66.11	
Other	332	31.44	271	30.94	61	33.89	
RUCA							0.652
Metropolitan	691	65.44	568	64.84	123	68.33	
Micropolitan	155	14.68	130	14.84	25	13.89	
Other	210	19.89	178	20.32	32	17.78	
Marital Status							<0.001
Married	618	58.52	534	60.96	84	46.67	
Other	422	39.96	333	38.01	89	49.44	
Unknown	16	1.52	9	1.03	7	3.89	
Diagnosed Year							0.631
2002	270	25.57	219	25.28	51	28.33	
2003	262	24.81	218	24.26	44	24.44	
2004	295	27.94	251	28.8	44	24.44	
2005	229	21.69	188	21.66	41	22.78	
Number of positive regional nodes							0.021
1	386	36.55	306	34.93	80	44.44	
2 and 3	351	33.24	292	33.33	59	32.78	
4 and above	319	30.21	278	31.74	41	22.78	
Number of regional nodes examined							0.759
0-11	476	45.08	393	44.86	83	46.11	
12 and 12+	580	54.92	483	55.14	97	53.89	
Seer Region							0.883
Atlanta	245	23.20	204	23.29	41	22.78	
Other	811	76.80	672	76.71	139	77.22	

Table 7: Adjusted Odds Ratios with 95% Confidence Intervals from final prediction model for receipt of standard care among AJCC stage III colon cancer patients between 18 - 79 years old in Georgia from 2002 – 2005

Predictors	OR	95% Confidence Interval	
Age			
<=65 Years	Ref.	Ref.	Ref.
66-72 Years	0.619	0.393	0.974
73-79 Years	0.306	0.200	0.467
Race			
White	Ref.	Ref.	Ref.
Other	0.894	0.602	1.327
Urbanicity			
Metropolitan	Ref.	Ref.	Ref.
Micropolitan	1.215	0.728	2.027
Other	1.323	0.821	2.132
Marital Status			
Other	Ref.	Ref.	Ref.
Married	1.663	1.151	2.402
Unknown	0.463	0.156	1.373
Diagnosed Year			
2002	Ref.	Ref.	Ref.
2003	1.117	0.701	1.779
2004	1.253	0.791	1.984
2005	1.042	0.647	1.676
No. of Nodes Positive			
1	Ref.	Ref.	Ref.
2-3	1.206	0.819	1.778
4+	1.642	1.069	2.520
No. of Nodes Examined			
0-11	Ref.	Ref.	Ref.
12+	0.969	0.689	1.365
County			
Atlanta	Ref.	Ref.	Ref.
Other	0.989	0.633	1.547
Commission on Cancer			
No	Ref.	Ref.	Ref.

Yes	1.427	0.949	2.144
Poverty			
Less than 20%	Ref.	Ref.	Ref.
20% and above	0.739	0.499	1.094
Gender			
Male	Ref.	Ref.	Ref.
Female	1.250	0.873	1.791

Appendices

Table 8: Estimates from the Starting Model with Two Interaction Terms (Marital Status with Poverty, Marital Status with Race)

Predictors	Estimates	Standard Error	P-value
Intercept	1.4493	0.4241	0.0006
Age			
<=65 Years	Ref.	Ref.	Ref.
66-72 Years	-0.4836	0.2329	0.0379
73-79 Years	-1.2093	0.2181	<.0001
Race			
White	Ref.	Ref.	Ref.
Other	-0.1604	0.2682	0.5499
Urbanicity			
Metropolitan	Ref.	Ref.	Ref.
Micropolitan	0.2066	0.2620	0.4303
Other	0.2806	0.2451	0.2521
Marital Status			
Other	Ref.	Ref.	Ref.
Married	0.3126	0.2407	0.1941
Unknown	-1.0219	0.7837	0.1923
Diagnosed Year			
2002	Ref.	Ref.	Ref.
2003	0.1060	0.2383	0.6563
2004	0.2098	0.2356	0.3732
2005	0.0316	0.2437	0.8969
No. of Nodes Positive			
1	Ref.	Ref.	Ref.
2-3	0.1739	0.1998	0.3842
4+	0.5014	0.2194	0.0223
No. of Nodes Examined			

0-11	Ref.	Ref.	Ref.
12+	-0.0262	0.1753	0.8814
County			
Atlanta	Ref.	Ref.	Ref.
Other	-0.0288	0.2289	0.8997
Commission on Cancer			
No	Ref.	Ref.	Ref.
Yes	0.3625	0.2082	0.0817
Poverty			
Less than 20%	Ref.	Ref.	Ref.
20% and above	-0.5374	0.2690	0.0458
Gender			
Male	Ref.	Ref.	Ref.
Female	0.2143	0.1839	0.2440
Interactions			
Marrital Status * Poverty			
Married, 20% and above poverty	0.4507	0.4056	0.2664
Unknown, 20% and above poverty	1.7660	1.3564	0.1929
Marital Status * Race			
Married, Other races	0.1869	0.4015	0.6415
Unknown, Other races	-0.4918	1.1253	0.6621