How Do Integrated Health Care Systems Address Racial and Ethnic Disparities in Colon Cancer?

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Published online ahead of print at www.jco.org on January 26, 2015.

Supported by Grant No. 1R21CA161786-01A1 from the National Cancer Institute and a Harold Amos Medical Faculty Development award from the Robert Wood Johnson Foundation, Princeton, NJ (K.F.R.).

Presented as a poster at the American Society of Clinical Oncology Quality Care Symposium, San Diego, CA, November 30-December 1, 2012.

K.F.R. and Y.M. had full access to all in the study and take responsibility for the integrity of the data and accuracy of the analysis.

Authors' disclosures of potential conflicts of interest are found in the article online at www.jco.org. Author contributions are found at the end of this article.

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0732-183X/15/3308w-854w/\$20.00

DOI: 10.1200/JCO.2014.56.8642

ABSTRACT

Purpose

Colorectal cancer (CRC) disparities have persisted over the last two decades. CRC is a complex disease requiring multidisciplinary care from specialists who may be geographically separated. Few studies have assessed the association between integrated health care system (IHS) CRC care quality, survival, and disparities. The purpose of this study was to determine if exposure to an IHS positively affects quality of care, risk of mortality, and disparities.

Patients and Methods

This retrospective secondary-data analysis study, using the California Cancer Registry linked to state discharge abstracts of patients treated for colon cancer (2001 to 2006), compared the rates of National Comprehensive Cancer Network (NCCN) guideline–based care, the hazard of mortality, and racial/ethnic disparities in an IHS versus other settings.

Results

More than 30,000 patient records were evaluated. The IHS had overall higher rates of adherence to NCCN guidelines. Propensity score–matched Cox models showed an independent and protective association between care in the IHS and survival (hazard ratio [HR], 0.87; 95% CI, 0.85 to 0.90). This advantage persisted across stage groups. Black race was associated with increased hazard of mortality in all other settings (HR, 1.15; 95% CI, 1.04 to 1.27); however, there was no disparity within the IHS for any minority group ($P > .11$ for all groups) when compared with white race.

Conclusion

The IHS delivered higher rates of evidence-based care and was associated with lower 5-year mortality. Racial/ethnic disparities in survival were absent in the IHS. Integrated systems may serve as the cornerstone for developing accountable care organizations poised to improve cancer outcomes and eliminate disparities under health care reform.

J Clin Oncol 33:854-860. © 2015 by American Society of Clinical Oncology

INTRODUCTION

Disparities in colorectal cancer (CRC) have persisted over the past two decades.¹ Minority patients have suffered disproportionately worse outcomes in both statewide²⁻⁴ and national studies⁵⁻⁹ of cancer treatment and survival. Additional studies have shown racial/ethnic disparities by social characteristics^{10,11} and other socioeconomic status (SES) factors.^{12,13} More recent studies have suggested that differences in the receipt of appropriate care^{7,9} and the location of care may also predict survival after treatment for cancer.¹⁴⁻¹⁶ These studies suggest that minorities cluster for care in low-performing hospitals^{17,18} or hospitals that fail to adhere to evidence based care delivery.¹⁹ Each of these studies highlights

the link between location of care, cancer survival, and disparities.

CRC is a complex disease to treat, requiring care from a multidisciplinary group of specialists often geographically disparate. Gaps in the delivery of multistep care may have severe consequences. Patients with stage III CRC who fail to receive chemotherapy lose a potential increase in survival of 15% to 30%.²⁰⁻²² Despite the well-documented disparity in receipt of adjuvant therapy,^{9,23} only a handful of studies have assessed the survival impact of treatment within an integrated health care system (IHS).^{24,25} Studies from the Veterans' Administration health care system suggest that standardized care may lead to equitable care delivery^{25,26} and may decrease survival disparities.²⁴ However, no studies

have compared quality of care, outcomes, and disparities in patients treated within an integrated setting against other settings during a period of time preceding health care reform.

We have previously shown that adherence with National Comprehensive Cancer Network (NCCN) guidelines improves survival in patients with pancreatic cancer.²⁷ We have also shown a correlation between hospitals with a poor payer mix and low-level adherence to NCCN guidelines for colon¹⁹ and liver cancers.²⁸ These findings support the assertion that location and type of system used may explain some survival disparities. In the study we report here, we used a diverse, all-age, all-payer statewide cancer database to assess outcomes after treatment for colon cancer in integrated versus other settings. We compared adherence with NCCN guidelines (ie, appropriate surgery, pathologic examination of > 12 lymph nodes (LNs), and stage-specific chemotherapy), 5-year mortality, and racial/ethnic disparities in an IHS against all other settings. We hypothesized that the IHS would have higher rates of NCCN guideline compliance, a lower hazard of mortality, and lower racial/ethnic differences in receipt of evidence-based care and mortality.

PATIENTS AND METHODS

Sources of Data

Institutional review board approval was obtained from Stanford University and the State of California to analyze California Cancer Registry (CCR) and California Office of Statewide Health Planning and Development Patient Discharge Data (OSHDP-PDD). Staff at the CCR used International Classification of Diseases (ICD) for Oncology (third edition) codes (C 18.0 and 18.2 to 18.9) to identify all first primary, nonrecurrent colon cancers diagnosed and/or treated in the state from 2001 to 2006. The staff then linked the records to corresponding discharge abstracts using a probabilistic linking algorithm based on sex, day and date of birth, and social security number before disclosure to our team.

The CCR contains detailed information on all California patients diagnosed and/or treated for any primary malignancy except nonmelanoma skin cancers. Because reporting of cancer care is mandated, regardless of modality of treatment, the lost-to-follow-up rate is low. The CCR is well recognized as one of the most complete registries nationwide.²⁹ There are fewer than 3% missing race data, and fewer than 2% of patients are identified through death records. Variables from the CCR included: patient age, sex, race/ethnicity, insurance status, census block group SES data, validated SES composite score,³⁰ American Joint Committee on Cancer consolidated stage at diagnosis, receipt and sequence of chemotherapy and surgery, number of LNs retrieved and examined after surgery, and survival time. The CCR records whether chemotherapy was recommended but not administered because of patient refusal.

The OSHDP-PDD is statewide all-payer discharge data set containing patient-level information for each general, acute, nonfederal hospital discharge in California. The data set also contains secondary diagnoses, with an indicator of whether the condition was present at admission, allowing identification of comorbidities. Variables from the OSHDP-PDD included: patient comorbidities, ICD (ninth edition) Clinical Modification principle procedure codes, and unique identification number to indicate the name and address of the facility where care was delivered.

IHSs were defined by the executive summary from the Berkeley Forum to Improve California's Healthcare Delivery System.³¹ By the definition of the forum, a fully integrated system is one where "care is provided by a single entity; whereby one organization is responsible for all services including delivery of care, payment and risk management."^{31(p3)} According to the forum, California has only one fully IHS. Member hospitals in this system were identified with the unique hospital identifier and labeled as IHS.

Selection of Patients

We included records for adult patients with stage I to III colon cancer, diagnosed and treated in California between 2001 and 2006 (inclusive). No patients with isolated metastases or recurrent cancer were included. Cancers of the appendix and rectum were excluded, because NCCN guidelines are different than for colon cancer. Records with a small cell size (< 100; American Indian/Alaskan Native) were excluded.

Primary Outcomes

We compared the proportions of patients who received NCCN guideline-based care^{32,33} for colon cancer: surgical resection (ICD [ninth edition] procedure codes: 45.8x, 45.7x, 45.8x), pathologic examination of > 12 LNs after resection, and stage-appropriate chemotherapy, defined as chemotherapy for patients with node-positive disease. We compared the risk-adjusted hazard of mortality associated with care within an IHS and racial/ethnic differences in mortality within and outside the IHS setting.

Data Analysis

To compare rates of evidence-based care,^{32,33} we used Pearson χ^2 analysis. The Mantel-Haenszel *P* value was used to determine significance of associations for ordinal variables. Records where chemotherapy was recommended but not administered because of patient refusal (1.8% of records) were coded as treatment provided.

To compare survival within versus outside the IHS, we used propensity score matching (PSM) with a five-to-one Greedy matching approach.³⁴ Patients were matched on characteristics known to affect colon cancer survival, including: age, sex, race,³⁵ composite SES score,^{30,36} Deyo-modified Charlson comorbidity score,³⁷ and stage of disease. We did not match on insurance, because patients treated in the IHS have an exclusive type of insurance that does not exist outside the system. The balance of variables after matching was compliant with recommended ranges for standardized mean differences and variance ratios^{38,39} (Data Supplement). PSM Kaplan-Meier (KM) survival curves and PSM-adjusted Cox proportional hazards models compared mortality between the two systems.

To assess disparity gaps within and outside the IHS, we generated stratified KM curves and Cox models by race for each setting. Cox models were adjusted first for sociodemographic and clinical characteristics (model one) and then for receipt of compliant care (model two). A combined model with interaction terms for race and location of care was also constructed to further test the results of the stratified models.

All tests of significance were two tailed, with significant differences denoted at *P* values < .05. The Dunnett correction for multiple comparisons was applied on KM curves.⁴⁰ Differences in predicted mortality were considered significant if hazard ratios (HRs) were not equal to 1 and associated 95% CIs excluded 1.

RESULTS

Distribution of Patients Across Settings

There were 348 hospitals and 33,593 patient records included in the analysis. Approximately 13% of facilities (*n* = 44) were part of the IHS system. Table 1 shows the distribution of patients across settings. The IHS treated 19% of all patients (*n* = 6,357). The proportion of patients who were age 55 to 74 years was higher in the IHS, whereas the proportion of patients age > 85 years was higher in other settings. The proportion of white patients treated outside the IHS (71.4%) was higher than within (66%). The proportion of Hispanic patients was distributed relatively evenly across settings, but more black patients were treated within the IHS (11.9% v 5.6%). A slightly lower proportion of Asian/Pacific Islander (API) populations were treated within the IHS (8.9%) than outside (10.6%). The IHS treated more patients with high comorbidity scores (9.3% v 7.9%) and an equal distribution

Table 1. Distribution of Patient Demographic and Clinical Characteristics in IHS Versus Other Settings

Characteristic	Total No. of Patients	IHS		Other Settings	
		No.	%	No.	%
Total No.	33,593	6,357	18.9	27,236	81.1
Age, years					
0-44	1,148	244	3.8	904	3.3
45-54	2,976	647	10.2	2,329	8.6
55-64	5,025	1,204	18.9	3,821	14.0
65-74	8,812	1,812	28.5	7,000	25.7
75-84	10,846	1,840	28.9	9,006	33.1
≥ 85	4,786	610	9.6	4,176	15.3
Sex					
Male	15,973	3,131	49.3	12,842	47.1
Female	17,620	3,226	50.7	14,394	52.9
Race					
White	23,653	4,213	66.2	19,440	71.4
Black	2,280	757	11.9	1,523	5.6
Hispanic	4,194	823	13.0	3,371	12.4
API	3,466	564	8.9	2,902	10.6
Insurance					
Private	15,479	5,186	81.6	10,293	37.8
Medicare	16,054	1,148	18.1	14,906	54.7
Medicaid	1,506	8	0.1	1,498	5.5
No Insurance	427	7	0.1	420	1.5
Missing	127	8	0.1	119	0.5
Comorbidities					
0	19,951	3,663	57.6	16,288	59.8
1	8,197	1,619	25.5	6,578	24.2
2	2,703	486	7.7	2,217	8.1
≥ 3	2,742	589	9.3	2,153	7.9
Stage					
I	8,480	1,489	23.4	6,991	25.7
II	13,579	2,624	41.3	10,955	40.2
III	11,534	2,244	35.3	9,290	34.1
SES					
I (low)	4,090	576	9.1	3,514	12.9
II	6,136	1,106	17.4	5,030	18.5
III	7,321	1,411	22.2	5,910	21.8
IV	7,906	1,634	25.7	6,272	23.0
V (high)	8,134	1,630	25.6	6,504	23.8

Abbreviations: API, Asian/Pacific Islander; IHS, integrated health system; SES, socioeconomic status.

of patients by stage. The IHS treated a smaller proportion of patients with low SES (9.1% v 12.9%).

Comparing Delivery of Evidence-Based Care Between Settings

Figure 1 shows a comparison of the rate of delivery of evidence-based care overall and by racial/ethnic group for each setting. Overall, the IHS provided higher rates of surgery (95.1% v 92.3%; $P < .001$) and chemotherapy (75.8% v 54.0%; $P < .001$) than other settings. There was no significant difference in quality of LN examination between the two settings.

Comparing Delivery of Evidence-Based Care Within Settings

Figure 1 also shows differences in receipt of evidence-based care by race/ethnicity within each care setting. Within the IHS, the propor-

Fig 1. Percent delivery of evidence-based care comparing integrated health system (IHS) setting against other settings, stratified by race/ethnicity, for stage I to III colon cancer from 2001 to 2006. Surgery indicates resection for stage I to III disease; 12 lymph nodes indicates examination of ≥ 12 lymph nodes after resection; chemotherapy indicates American Joint Committee on Cancer stage-appropriate chemotherapy. API, Asian/Pacific Islander. (*) $P < .05$ for comparisons between racial groups within each setting.

tion of black patients who underwent surgery was lower than that of whites. Although this was also true in other settings, the difference in the IHS was smaller (-2.2% v -5.8% ; $P < .05$ for both settings). There were no differences in receipt of an adequate LN examination or receipt of appropriate chemotherapy between black and white patients in either setting.

For Hispanic patients, the rate of surgery within the IHS was lower than that of white patients (-1.5% ; $P =$ not significant), but the difference was less pronounced than that in the non-IHS settings (-2.7% ; $P < .001$). The rate of LN examination was relatively equal between Hispanic and white patients in the IHS, in contrast to all other settings, where the rate was 4.2% lower ($P < .001$). There was a higher rate of stage-appropriate chemotherapy delivered to Hispanic over white patients in both settings, but the advantage was higher within the IHS (7.8% v 5.3%; $P < .01$ for both comparisons).

For API patients, there were relatively equal rates of surgery compared with white patients in both settings. There was a lower rate of receipt of an adequate LN examination within the IHS (-5.2% ; $P = .02$), which was a larger gap than that found in non-IHS settings (-2.8% ; $P = .005$). Like Hispanic patients, API patients received a higher rate of chemotherapy compared with white patients in both settings, with a greater advantage in the IHS (10.9% v 5.4%; $P \leq .002$ for both comparisons).

Comparing Survival Across Health Care Settings

Figure 2 shows the results of PSM comparisons of mortality within and outside the IHS. Of the 6,357 patients treated in the IHS, approximately 95% were matched at the five- or four-digit level (Data Supplement). PSM KM survival curves show better survival in the IHS setting (log-rank $P < .001$). PSM Cox models show a protective association between the IHS and mortality for all three stages (HR, 0.87; 95% CI, 0.85 to 0.90). There was a similarly protective effect noted in each stage group.

Comparing Racial/Ethnic Group Survival and Disparities Across Settings

Figures 3A and B show the side-by-side comparison of KM survival curves for each minority group, stratified by health care setting. There was an unadjusted survival advantage for black versus white patients ($P < .001$) in the IHS. For patients treated in non-IHS settings, there was a survival disparity for black compared with white patients ($P = .02$). Improved survival compared with white patients was noted for Hispanics and API groups in both settings ($P < .001$ for all comparisons).

Table 2 summarizes stratified Cox models estimating the hazard of mortality for each racial group in each setting. In the IHS setting, there were no significant differences in survival comparing all racial groups against white patients ($P > .11$ for each pairwise comparison) after adjusting for patient factors. In the non-IHS setting, there was a 15% increased hazard of mortality for black versus white patients ($P = .007$). There was a survival advantage in non-IHS settings for Hispanic (HR, 0.87; 95% CI, 0.80 to 0.95) and API patients (HR, 0.74; 95% CI, 0.68 to 0.81).

Adjusting the model for receipt of evidence-based care positively affected survival in both settings. In model two, there was a survival advantage for black (HR, 0.79; 95% CI, 0.65 to 0.96) and API patients (HR, 0.79; 95% CI, 0.64 to 1.00) treated in the IHS setting. Furthermore, in the non-IHS settings, accounting for high-quality care neutralized the disparity for black patients (HR, 1.09; 95% CI, 0.98 to 1.21)

Fig 2. Propensity score-matched Kaplan-Meier curves (upper panel) and Cox models (lower panel) comparing survival in integrated health system (IHS) setting versus other settings. HR, hazard ratio; ref, referent.

and was associated with a slight increase in the survival advantage for Hispanic and API patients (Table 2).

A combined model estimating mortality in both settings was adjusted for the potential interaction between race and location of care. The results (Appendix Table A1, online only) show a survival advantage for black patients treated in the IHS (HR, 0.76; 95% CI, 0.61 to 0.93). There were no significant mortality differences for either Hispanic ($P = .79$) or API patients ($P = .26$) treated in the IHS setting.

DISCUSSION

The purpose of our investigation was to determine the association between colon cancer care in an IHS and receipt of evidence-based care, overall survival, and disparities. We found that the IHS delivered higher rates of surgery and chemotherapy, but there was no difference in the rate of LN examination. Minorities in these systems largely received higher rates of evidence-based care than those treated outside, and the racial gaps in receipt of quality care were generally smaller within the IHS than outside. PSM mortality models showed an overall survival advantage associated with care in the IHS for all stages of disease. There were no racial/ethnic disparities in survival noted within the IHS. Receiving evidence-based care was associated with improved survival for all racial/ethnic groups. More importantly, receipt of evidence-based care was associated with a survival advantage for black patients in the IHS and neutralized the black-white disparities in other settings.

Our results contrast with those of a previous study that showed no differences in cancer care or outcomes when comparing Medicare patients enrolled in a health maintenance organization with those outside.⁴¹ The difference between that study and ours relates to the homogeneity of the Medicare sample (by age and insurance status). This may have limited the ability to detect differences. By capturing all-age, all-payer data from a racially and ethnically diverse population-based data set and combining it with robust PSM and detailed patient risk adjustment, we were able to make comparisons across multiple racial/ethnic groups and between settings. We even included a validated SES composite score to address the issues of selection based on inclusion in the IHS network. Thus, our results will advance the understanding of the impact of health care setting and quality of care on survival and disparities.

Our results are consistent with those of others who have found variation in adherence to evidence-based guidelines in association with hospital characteristics.^{19,27,28,42,43} In these studies, select hospital characteristics were correlated with poor performance on guideline-driven care for both benign^{42,43} and malignant diseases.^{19,27,28} Our findings also support published literature correlating hospital characteristics with disparities and overall cancer survival.^{7,15,18} Donabedian's triad of health care quality gives face validity to our results.⁴⁴ In the triad, structural quality (IHS or not) can influence both process quality (NCCN guideline adherence) and outcome quality (survival and disparities). Our study largely shows that treatment in the IHS was associated with higher rates of guideline adherence and improved survival. We also found that gaps in evidence-based care were smaller or favored minority populations in the IHS. Mortality for minorities was also lower within the IHS than outside. Our results suggest that the IHS may provide a model for improving

Fig 3. Kaplan-Meier curves showing survival by race, comparing outcomes stratified by health care setting. Survival after care in (A) integrated health system setting and (B) all other settings. API, Asian/Pacific Islander. (*) $P < .05$ and (†) $P < .001$ for minority groups compared with white patients after Dunnett adjustment.

the delivery of cancer care, addressing racial/ethnic disparities, and improving colon cancer outcomes.

Despite similarities to other work, our investigation is quite novel. Although prior studies have assessed the health effects of IHSs,^{24,26,45,46} the majority have focused on cancer survival and/or disparities within a select system. There is only one published study comparing process quality in the index system with another system outside of itself.²⁵ To our knowledge, we are the first to compare process quality, outcome quality, and disparities between systems in a single investigation; we are also the first to use validated SES measures in the analysis. Because membership in an IHS may be a marker for SES class (must be employed or able to afford membership), which may correlate with survival, inclusion of these factors is critical to the validity of our findings. Another important aspect of the work is that disparities between black and white patients outside the system were neutralized after accounting for delivery of evidence-based care. The results are therefore quite robust and important, because they bolster the assertion that the provision of equitable, high-quality care may serve as a powerful driver in eliminating cancer disparities.

One potential explanation for our findings relates to the complexity of treating cancer^{47,48} and the potential advantage of a highly networked system of delivery. Theoretically, patients in an IHS receive each step in cancer care (surgery and adjuvant therapy) within the

system. When cancer treatment occurs in outside an IHS, patients undergoing surgery in one hospital may receive adjuvant therapy elsewhere, with no obligatory coordination of care. The unintended consequences of fragmentation include failed hand-offs and lapses in treatment.⁴⁹⁻⁵¹ Our findings suggest that IHSs may provide high-quality care and outcomes through coordination among multidisciplinary providers. Thus, our results provide support for the idea that accountable care organizations, as envisioned in the Affordable Care Act, could improve cancer survival and eliminate disparities by coordinating and integrating care.

Our study has some limitations. First, it is based on cross-sectional, administrative data; thus, we cannot show causation. Nonetheless, we can and do convincingly argue that the care delivered in an IHS is more highly compliant with guidelines than care in other settings. Moreover, our results show a strong association between the use of an IHS and improved survival. This is consistent with previous work showing that better outcomes in cancer are supported by NCCN guideline compliance.^{27,46,52} Thus, our study has uncovered important insights into the potential for an IHS to positively influence cancer survival and disparities. We were also limited in that we could not determine if the temporal delivery of chemotherapy (ie, within 4 months) was compliant with guidelines. Nonetheless, the benefit of any chemotherapy is shown in the

Table 2. Cox Proportional Hazards Models Predicting Hazard of Mortality by Race, Stratified by Location of Care

Table 2. Sex- and Racially Stratified Hazard Ratios (HRs) for Mortality, by Race, Stratified by Location of Care										
Location of Care	White	Black			Hispanic			API		
		HR	95% CI	P	HR	95% CI	P	HR	95% CI	P
IHS setting										
Model one*	1.0†	0.86	0.72 to 1.04	.12	0.92	0.77 to 1.10	.37	0.83	0.67 to 1.04	.11
Model two‡	1.0†	0.79	0.65 to 0.96	.02	0.86	0.72 to 1.02	.09	0.79	0.64 to 1.00	.05
All other settings										
Model one*	1.0†	1.15	1.04 to 1.27	.007	0.90	0.83 to 0.90	.009	0.74	0.68 to 0.81	< .001
Model two‡	1.0†	1.09	0.98 to 1.21	.12	0.87	0.80 to 0.95	.001	0.73	0.67 to 0.81	< .001

Abbreviations: API, Asian/Pacific Islander; HR, hazard ratio; IHS, integrated health system.

*Adjusted for age, sex, Charlson comorbidity score, stage of disease, insurance, and socioeconomic status.

†Referent.

‡Adjusted for all variables in model one plus receipt of evidence-based care.

study. Future studies will need to assess the relative importance of timing vis-à-vis location of care.

In conclusion, the IHS approach to care is associated with higher levels of evidence-based medicine, improved survival, and reduced colon cancer disparity gaps. Thus, IHS may represent an important model for improving cancer outcomes and addressing disparities. Other settings may benefit from targeted efforts to increase NCCN guideline adherence to achieve similar results. Future studies should replicate our study in other tumor types. If these results are consistent, they could guide the rational development of accountable care organizations emerging under health care reform with the incentives and capacity to improve cancer outcomes and address cancer disparities.

REFERENCES

1. American Cancer Society: Cancer facts and figures 2013. <http://www.cancer.org/acs/groups/content/epidemiologysurveillance/documents/document/acscp-036845.pdf>
2. Rhoads KF, Cullen J, Ngo JV, et al: Racial and ethnic differences in lymph node examination after colon cancer resection do not completely explain disparities in mortality. *Cancer* 118:469-477, 2012
3. Cunningham JE, Butler WM: Racial disparities in female breast cancer in South Carolina: Clinical evidence for a biological basis. *Breast Cancer Res Treat* 88:161-176, 2004
4. Harari A, Li N, Yeh M: Racial and socioeconomic disparities in presentation and outcomes of well-differentiated thyroid cancer. *J Clin Endocrinol Metab* 99:133-141, 2014
5. Patel MI, Ma Y, Mitchell BS, et al: Understanding disparities in leukemia: A national study. *Cancer Causes Control* 23:1831-1837, 2012
6. Patel MI, Ma Y, Mitchell BS, et al: Age and genetics: How do prognostic factors at diagnosis explain disparities in acute myeloid leukemia? *Am J Clin Oncol* [epub ahead of print on April 19, 2013]
7. Breslin TM, Morris AM, Gu N, et al: Hospital factors and racial disparities in mortality after surgery for breast and colon cancer. *J Clin Oncol* 27:3945-3950, 2009
8. Morris AM, Billingsley KG, Baxter NN, et al: Racial disparities in rectal cancer treatment: A population-based analysis. *Arch Surg* 139:151-155, 2004; discussion 156
9. Morris AM, Billingsley KG, Hayanga AJ, et al: Racial treatment disparities after oncology referral for rectal cancer. *J Natl Cancer Inst* 100:738-744, 2008
10. Freedman RA, Virgo KS, He Y, et al: The association of race/ethnicity, insurance status, and socioeconomic factors with breast cancer care. *Cancer* 117:180-189, 2011
11. Nathan H, Frederick W, Choti MA, et al: Racial disparity in surgical mortality after major hepatectomy. *J Am Coll Surg* 207:312-319, 2008
12. Gong G, Belasco E, Hargrave KA, et al: Determinants of delayed detection of cancers in Texas Counties in the United States of America. *Int J Equity Health* 11:29, 2012
13. Siegel R, Ward E, Brawley O, et al: Cancer statistics, 2011: The impact of eliminating socioeconomic and racial disparities on premature cancer deaths. *CA Cancer J Clin* 61:212-236, 2011
14. Hayanga AJ, Waljee AK, Kaiser HE, et al: Racial clustering and access to colorectal surgeons, gastroenterologists, and radiation oncologists by African Americans and Asian Americans in the United States: A county-level data analysis. *Arch Surg* 144:532-535, 2009
15. Rhoads KF, Ackerson LK, Jha AK, et al: Quality of colon cancer outcomes in hospitals with a high percentage of Medicaid patients. *J Am Coll Surg* 207:197-204, 2008
16. Keating NL, Kouri E, He Y, et al: Racial differences in definitive breast cancer therapy in older women: Are they explained by the hospitals where patients undergo surgery? *Med Care* 47:765-773, 2009
17. Dimick J, Ruhter J, Sarrazin MV, et al: Black patients more likely than whites to undergo surgery at low-quality hospitals in segregated regions. *Health Aff (Millwood)* 32:1046-1053, 2013
18. Lucas FL, Stukel TA, Morris AM, et al: Race and surgical mortality in the United States. *Ann Surg* 243:281-286, 2006
19. Rhoads KF, Ngo JV, Ma Y, et al: Do hospitals that serve a high percentage of Medicaid patients perform well on evidence-based guidelines for colon cancer care? *J Health Care Poor Underserved* 24:1180-1193, 2013
20. Sanoff HK, Carpenter WR, Stürmer T, et al: Effect of adjuvant chemotherapy on survival of patients with stage III colon cancer diagnosed after age 75 years. *J Clin Oncol* 30:2624-2634, 2012
21. Glimelius B, Dahl O, Cedermark B, et al: Adjuvant chemotherapy in colorectal cancer: A joint analysis of randomised trials by the Nordic Gastrointestinal Tumour Adjuvant Therapy Group. *Acta Oncol* 44:904-912, 2005
22. Taal BG, Van Tinteren H, Zoetmulder FA: Adjuvant 5FU plus levamisole in colonic or rectal cancer: Improved survival in stage II and III. *Br J Cancer* 85:1437-1443, 2001
23. Morris AM, Wei Y, Birkmeyer NJ, et al: Racial disparities in late survival after rectal cancer surgery. *J Am Coll Surg* 203:787-794, 2006
24. Zullig LL, Carpenter WR, Provenzale D, et al: Examining potential colorectal cancer care disparities in the Veterans Affairs health care system. *J Clin Oncol* 31:3579-3584, 2013
25. Hynes DM, Tarlov E, Durazo-Arvizu R, et al: Surgery and adjuvant chemotherapy use among veterans with colon cancer: Insights from a California study. *J Clin Oncol* 28:2571-2576, 2010
26. Jackson GL, Melton LD, Abbott DH, et al: Quality of nonmetastatic colorectal cancer care in the Department of Veterans Affairs. *J Clin Oncol* 28:3176-3181, 2010
27. Visser BC, Ma Y, Zak Y, et al: Failure to comply with NCCN guidelines for the management

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Disclosures provided by the authors are available with this article at www.jco.org.

AUTHOR CONTRIBUTIONS

Conception and design: All authors

Provision of study materials or patients: Kim F. Rhoads

Collection and assembly of data: Kim F. Rhoads

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Manuscript writing: All authors

Final approval of manuscript: All authors

of pancreatic cancer compromises outcomes. *HPB (Oxford)* 14:539-547, 2012

28. Zak Y, Rhoads KF, Visser BC: Predictors of surgical intervention for hepatocellular carcinoma: Race, socioeconomic status, and hospital type. *Arch Surg* 146:778-784, 2011

29. North American Association of Central Cancer Registries: US registries certified in 2013 for 2010 incidence data. <http://www.naaccr.org/Certification/USCert2010.aspx>

30. Yost KJ, Hahn EA, Zaslavsky AM, et al: Predictors of health-related quality of life in patients with colorectal cancer. *Health Qual Life Outcomes* 6:66, 2008

31. Sheffler RM, Bowes LG: A new vision for California's healthcare system: Integrated care with aligned financial incentives—Berkeley Forum for Improving California's Healthcare Delivery System. <http://berkeleyhealthcareforum.berkeley.edu/wp-content/uploads/A-New-Vision-for-California's-Healthcare-System.pdf>

32. National Comprehensive Cancer Network: NCCN guidelines for treatment of cancer by site. http://www.nccn.org/professionals/physician_gls/f_guidelines.asp#site

33. Desch CE, McNiff KK, Schneider EC, et al: American Society of Clinical Oncology/National Comprehensive Cancer Network quality measures. *J Clin Oncol* 26:3631-3637, 2008

34. Gu X, Rosenbaum PR: Comparison of multivariate matching methods: Structures, distances, and algorithms. *J Comput Graph Stat* 2:405-420, 1993

35. Siegel R, Desantis C, Jemal A: Colorectal cancer statistics, 2014. *CA Cancer J Clin* 64:104-117, 2014

36. Yost K, Perkins C, Cohen R, et al: Socioeconomic status and breast cancer incidence in California for different race/ethnic groups. *Cancer Causes Control* 12:703-711, 2001

37. Deyo RA, Cherkin DC, Ciol MA: Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *J Clin Epidemiol* 45:613-619, 1992

38. Rubin DB: Using propensity scores to help design observational studies: Application to the tobacco litigation. *Health Serv Outcomes Res Methodol* 2:169-188, 2001. <http://sekhon.berkeley.edu/papers/other/Rubin2001.pdf>

39. Rubin DB, Thomas N: Matching using estimated propensity scores: Relating theory to practice. *Biometrics* 52:249-264, 1996

40. Dunnett CW, Tamhane AC: Step-down multiple tests for comparing treatments with a control in

unbalanced one-way layouts. *Stat Med* 10:939-947, 1991

41. Riley GF, Warren JL, Potosky AL, et al: Comparison of cancer diagnosis and treatment in Medicare fee-for-service and managed care plans. *Med Care* 46:1108-1115, 2008
42. Ly DP, Lopez L, Isaac T, et al: How do black-serving hospitals perform on patient safety indicators? Implications for national public reporting and pay-for-performance. *Med Care* 48:1133-1137, 2010
43. Goldman LE, Vittinghoff E, Dudley RA: Quality of care in hospitals with a high percent of Medicaid patients. *Med Care* 45:579-583, 2007
44. Donabedian A: Evaluating the quality of medical care. *Milbank Mem Fund Q* 44:166-206, 1966 (suppl)
45. Strandberg-Larsen M: Measuring integrated care. *Dan Med Bull* 58:B4245, 2011
46. Sandulache VC, Kubik MW, Skinner HD, et al: Impact of race/ethnicity on laryngeal cancer in patients treated at a Veterans Affairs medical center. *Laryngoscope* 123:2170-2175, 2013
47. Aiello Bowles EJ, Tuzzio L, Wiese CJ, et al: Understanding high-quality cancer care: A summary of expert perspectives. *Cancer* 112:934-942, 2008
48. Hewitt M, Simone JV (eds): *Ensuring Quality Cancer Care* (ed 1). Washington, DC, National Academies Press, 1999
49. Taplin SH, Clauser S, Rodgers AB, et al: Interfaces across the cancer continuum offer opportunities to improve the process of care. *J Natl Cancer Inst Monogr* 2010:104-110, 2010
50. Zapka J, Taplin SH, Price RA, et al: Factors in quality care: The case of follow-up to abnormal cancer screening tests—Problems in the steps and interfaces of care. *J Natl Cancer Inst Monogr* 2010: 58-71, 2010
51. Fennell ML, Das IP, Clauser S, et al: The organization of multidisciplinary care teams: Modeling internal and external influences on cancer care quality. *J Natl Cancer Inst Monogr* 2010:72-80, 2010
52. Boland GM, Chang GJ, Haynes AB, et al: Association between adherence to National Comprehensive Cancer Network treatment guidelines and improved survival in patients with colon cancer. *Cancer* 119:1593-1601, 2013

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

How Do Integrated Health Care Systems Address Racial and Ethnic Disparities in Colon Cancer?

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No relationship to disclose

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No relationship to disclose

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No relationship to disclose

Appendix**Table A1.** Combined Cox Model Comparing Survival by Race Between IHS and Other Settings With Interaction Terms for Racial/Ethnic Subgroups by Location of Care and Adjustment for Evidence-Based Care

Racial/Ethnic Group	Model One*			Model Two†		
	HR	95% CI	P	HR	95% CI	P
White	1.0	Referent		1.0	Referent	
Black	1.14	1.04 to 1.26	.01	1.07	0.97 to 1.20	.19
Hispanic	0.90	0.83 to 0.97	.01	0.87	0.80 to 0.94	.001
API	0.74	0.68 to 0.81	< .001	0.73	0.67 to 0.80	< .001
IHS	0.94	0.86 to 0.99	.04	1.02	0.94 to 1.09	.69
White/IHS‡	1.0	Referent		1.0	Referent	
Black/IHS‡	0.76	0.62 to 0.93	.01	0.78	0.64 to 0.96	.02
Hispanic/IHS‡	1.03	0.85 to 1.24	.79	1.02	0.84 to 1.23	.86
API/IHS‡	1.15	0.91 to 1.45	.26	1.12	0.88 to 1.42	.37

Abbreviations: API, Asian/Pacific Islander; HR, hazard ratio; IHS, integrated health system.

*Adjusted for age, sex, Charlson comorbidity score, stage of disease, insurance, and socioeconomic status.

†Adjusted for all variables in model one plus receipt of evidence-based care.

‡Interaction term.