ORIGINAL ARTICLE

Cancer Surgery Among American Indians

Abraham Markin, BA; Elizabeth B. Habermann, MPH, PhD; Yanrong Zhu, MS; Anasooya Abraham, MD; Jasjit S. Ahluwalia, MD, MPH, MS; Selwyn M. Vickers, MD; Waddah B. Al-Refaie, MD

Importance: American Indians (AIs) have the poorest cancer survival rates of any US ethnic group. Late diagnosis, poor access to specialty care, and delays in therapy likely contribute to excess mortality. Surgery plays a central role in therapy for solid organ cancer.

Objective: To determine whether operative outcomes also contribute to poor long-term survival among AI patients with cancer.

Design: Population-based retrospective cohort study comparing patient- and hospital-level factors and short-term operative outcomes for AI and non-Hispanic white patients. Survey-weighted multivariate analyses assessed the effect of AI ethnicity on hospital location, in-hospital mortality, and prolonged length of stay.

Setting: A 20% stratified sample of all US community hospitals.

Patients: Patients undergoing oncologic resection for 1 of 20 malignant neoplasms in the Nationwide Inpatient Sample from January 1, 1998, through December 31, 2009.

Main Outcome Measure: In-hospital mortality, length of stay, and hospital location (rural vs urban).

Results: Of 740 878 patients who met our inclusion criteria, 3048 were AIs. The AI patients were younger, more likely to undergo cancer surgery at rural hospitals, and more likely to be admitted for nonelective procedures and had more comorbidities than non-Hispanic white patients of similar ages (all, $P < .05$). The AI patients had comparable inpatient mortality and length of stay.

Conclusions and Relevance: This investigation is the largest study of surgical outcomes among AIs to date and the first to focus on cancer surgery. This relatively young cohort does not experience poor outcomes after oncologic resection. Future research should uncover other factors in the continuum of cancer care that may contribute to the poor long-term survival of AI patients with cancer, including delivery of perioperative therapies.

JAMA Surg. 2013;148(3):277-285

Author Affiliations: Division of Surgical Oncology, Department of Surgery, Surgical Outcomes Research Center (Mr Markin, Drs Habermann, Abraham, Vickers, and Al-Refaie, and Ms Zhu) and Center for Health Equity (Mr Markin and Dr Ahluwalia), University of Minnesota, and Department of Surgery, Minneapolis Veterans Affair Medical Center (Dr Al-Refaie), Minneapolis. Dr Habermann is now with the Center for the Science of Health Care Delivery, Division of Health Care Research and Policy, Mayo Clinic, Rochester, Minnesota. Dr Al-Refaie is now with the Department of Surgery, Lombardi Comprehensive Cancer Center, Georgetown University Hospital, Washington, DC.

American Indians (AIs) have the worst cancer survival rates of any US ethnic group,[1] and available evidence suggests that mortality due to cancer among AIs is increasing.[2] Relative to non-Hispanic white (NHW) patients, AI patients present with more advanced stages of cancer,[3] are less likely to receive appropriate therapy,[4] and experience significant delays between diagnosis and surgical intervention.[5] Indeed, the most recent data from the American Cancer Society indicate that AI and Alaskan Native women are the only demographic groups not to benefit from a remarkable decline in cancer death rates during the past decade.[6]

Oncologic resection represents a critical component of therapy for most solid malignant neoplasms. However, a paucity of information is available regarding the AI cancer surgery experience, although significant research has been dedicated to disparities in surgical oncology for other ethnic and racial minorities.[7] Several obstacles limit research of this type among AIs, including small numbers of available subjects, regional and tribal heterogeneity,[2] and racial miscategorization.[8] As such, we do not know how or whether unique patterns of oncologic resections contribute to poor long-term cancer survival among AI patients.

See Invited Critique at end of article

To better understand the origins of excess long-term cancer mortality among AIs, this study used a large national database to examine short-term operative outcomes. We compared patient characteristics, hospital characteristics, and hospital course for AI and NHW patients

©2013 American Medical Association. All rights reserved.

Downloaded From: http://archsurg.jamanetwork.com/ on 05/05/2015

undergoing cancer surgery. We hypothesized that AI ethnicity affects patterns of surgical oncologic procedures and operative outcomes.

METHODS

DATA SOURCE

As the largest all-payer source of hospital stay data in the United States, the Nationwide Inpatient Sample (NIS) is uniquely suited to answer these questions. The NIS contains nationally representative data from a 20% stratified sample of nonfederal community hospitals and includes 5 million to 8 million inpatient discharges per year. We used the NIS to identify admissions for cancer surgery from January 1, 1998, through December 31, 2009. Alaska does not submit data to the NIS, so the present study does not include information on Alaskan natives, who frequently are grouped with AIs for research purposes. In addition, although the NIS is well suited to studying perioperative outcomes, it does not include cancer-specific variables or long-term outcomes. All NIS data are de-identified; this study was deemed exempt by the institutional review board of the University of Minnesota.

CASE SELECTION AND DATA EXTRACTION

Data were extracted for all admissions that contained matching procedure and diagnosis codes from the *International Classification of Diseases, Ninth Revision*, for 1 of 22 solid organ tumor resections. Patient-level information included age, sex, insurance status, Elixhauser comorbidity index,[9] zip code–level annual income, inpatient mortality, disposition at discharge, length of stay (LOS), and cost of stay. Hospital-level data were extracted for size, teaching status, urban vs rural location, and region in the United States. We excluded from analysis patients identified as African American, Hispanic, Asian/Pacific Islander, or other and those missing race/ethnicity information. Fewer than 10 AI patients were diagnosed with bone or adrenal cancers, so these 2 sites were not included in the subsequent analyses.

STATISTICAL ANALYSIS

Bivariate analyses were performed to compare patient- and hospital-level variables and inpatient operative outcomes by ethnicity (AI vs NHW). Association was assessed with the χ^2 and 2-tailed *t* tests for categorical and continuous variables, respectively, with $P \leq .05$ considered statistically significant. The 2 groups differed in the distribution of age, so stratified analyses compared comorbidities among AI and NHW patients for each age group. We stratified mortality by rural location to explore the effect of hospital location on operative outcomes for both ethnic groups.

Survey-weighted logistic regression models were constructed to assess the effect of AI ethnicity on hospital location and postoperative mortality using factors that emerged as significant in the bivariate analyses and clinically relevant factors. We created a prolonged LOS variable and developed regression models to assess whether AI ethnicity predicted prolonged LOS. Prolonged LOS was defined as a hospital stay greater than or equal to the 75th percentile of the cohort.

The information included in the NIS database changed during the study period. Of particular relevance to the present investigation was the addition of the Elixhauser comorbidity index[9] in 2002 and adjustment of the quartiles used for the income factor in 2003. To account for these variations, multiple regression models were developed for each outcome. The models reported herein correspond to the years 2003 through 2009 and most accurately fit the data as assessed using the *C* statistic.

Finally, we performed additional tests for interactions among ethnicity, income, and insurance status. Owing to the colinearity of income and insurance status, the regression was repeated after separately removing each factor. Additional sensitivity analyses included repeating all models after removing patients older than 80 years. Data were analyzed using commercially available software (SAS, version 9.1; SAS Institute, Inc).

RESULTS

PATIENT CHARACTERISTICS

Less than 1% of our cohort were AIs (n=3052). Bivariate analyses (**Table 1**) indicated that, compared with NHW patients, AI patients were younger ($P < .001$) and more likely to reside in lower-income zip codes ($P < .001$), to be covered by Medicaid ($P < .001$), and to be admitted to the hospital for nonelective procedures ($P < .001$). Cross-tabulation of the comorbidity index by age revealed that, despite comparable comorbidities for AI and NHW patients for all ages combined, AIs had more comorbidities in each age group (**Figure 1**). Relative to NHW patients, the oncologic resections performed among AI patients included a greater proportion of tumors of the stomach, testicle, brain, uterus, kidney, thyroid, and gallbladder. Conversely, AI patients were less likely to undergo lung, bladder, or colon resections (**Table 2**).

HOSPITAL CHARACTERISTICS

On bivariate analysis (Table 1), AI patients were more likely to receive their cancer surgery at rural hospitals. In addition, hospital region within the United States varied significantly by ethnicity, with a significantly greater proportion of AI patients found in the western United States compared with NHW patients. Our multivariate analysis (**Table 3**) confirmed that AI ethnicity was associated with receipt of cancer surgery at rural hospitals (odds ratio [OR], 1.31 [95% CI, 1.16-1.50). Of note, mean annual income in the zip code of residence was the strongest predictor of receipt of surgery at rural hospitals; those in the lowest-income zip codes were more than 20 times as likely to be treated at rural hospitals than those residing in the highest-income zip codes (OR, 22.72 [95% CI, 21.28-23.81]; data not shown).

An interaction was observed between ethnicity and income ($P = .02$). Stratification by income revealed that, among residents of low-income zip codes, AI ethnicity predicted care at rural hospitals; this association lost significance for high-income patients (data not shown).

POSTOPERATIVE OUTCOMES

Overall, our unadjusted analysis showed no significant differences in inpatient mortality between AI and NHW groups, but AI patients exhibited a nonsignificant trend toward longer hospital stays (mean LOS, 6.2 vs 6.1 days; median, 4 days for both groups [$P = .41$]). After adjustment for covariates using multivariate regression, AI

©2013 American Medical Association. All rights reserved.

Downloaded From: http://archsurg.jamanetwork.com/ on 05/05/2015

Table 1. Bivariate Analyses of Patient and Hospital Factors for 740 878 Patients Undergoing Cancer Surgery by Ethnicity

Factor	Patient Group, %[a] NHW (n = 737 826)	AI (n = 3052)	*P* Value
Age, y			
<50	15.10	24.08	<.001
50-65	35.07	38.70	
66-80	37.64	30.96	
>80	12.19	6.26	
Sex			
Female	55.32	55.70	.67
Male	44.68	44.30	
Income, $			
1998-2002			
<25 000	2.64	10.51	<.001
25 000-35 000	23.63	27.66	
35 000-45 000	28.28	19.55	
>45 000	43.13	36.97	
Unknown	2.32	5.32	
2003-2009			
<39 000	18.21	35.26	<.001
39 000-48 000	24.16	22.96	
48 000-63 000	25.46	19.13	
>63 000	30.06	18.26	
Unknown	2.10	4.39	
Insurance status			
Medicare	49.43	37.42	<.001
Medicaid	3.21	11.57	
Private	43.63	42.01	
Self-pay	1.53	2.82	
No charge	0.21	1.02	
Other	1.99	5.18	
Admission			
Elective	69.62	62.71	<.001
Nonelective	17.36	28.41	
Unknown	13.03	8.88	
Elixhauser comorbidity index[9]			
0	24.76	25.04	<.001
1	28.15	28.25	
2	21.19	20.57	
≥3	23.91	26.02	
Unknown	1.98	0.12	
Study year			
1998	8.75	2.65	<.001
1999	9.21	3.18	
2000	8.73	4.19	
2001	8.27	9.37	
2002	8.22	5.24	
2003	7.78	2.82	
2004	7.87	5.21	
2005	7.99	6.95	
2006	7.40	8.62	
2007	7.96	20.18	
2008	9.36	10.98	
2009	8.46	20.61	
Region			
Northeast	26.29	20.51	<.001
Midwest	17.73	11.14	
South	36.93	38.73	
West	19.05	29.62	
Hospital bed size			
Small	11.44	8.72	<.001
Medium	22.80	30.55	
Large	65.76	60.73	

(continued)

©2013 American Medical Association. All rights reserved.

Downloaded From: http://archsurg.jamanetwork.com/ on 05/05/2015

Table 1. Bivariate Analyses of Patient and Hospital Factors for 740 878 Patients Undergoing Cancer Surgery by Ethnicity (continued)

Factor	Patient Group, %[a] NHW (n = 737 826)	AI (n = 3052)	*P* Value
Hospital location			
Rural	9.62	13.31	<.001
Urban	90.38	86.69	
Teaching status			
Teaching	48.24	38.54	<.001
Nonteaching	51.76	61.64	
Disposition			
Home/routine	75.18	80.01	<.001
Rehabilitation facility	23.21	18.64	
In-hospital mortality	1.52	1.31	.34

Abbreviations: AI, American Indian; NHW, non-Hispanic white.
[a] Percentages have been rounded and may not total 100.

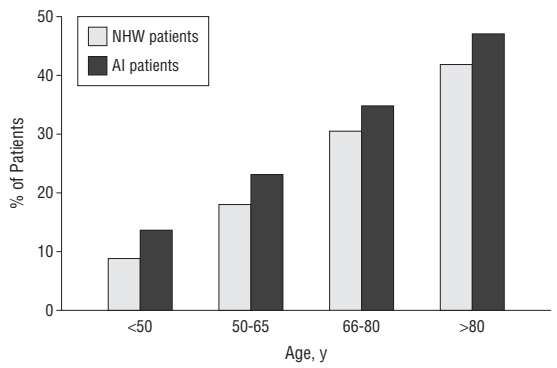

Figure 1. Comorbidities by age and ethnicity. Percentages of American Indian (AI) and non-Hispanic white (NHW) patients with an Elixhauser comorbidity index[9] of 3 or more by age ($P < .01$ for patients aged <50, 50-65, and 66-80 years; $P = .10$ for those aged >80 years).

ethnicity did not predict overall poorer in-patient mortality or prolonged LOS (Table 3). When we examined each type of malignant neoplasm individually, we found that unadjusted mortality was comparable for all but 2 tumor sites. The AI patients had poorer in-hospital mortality than NHW patients after surgery for cancer of the rectum (4.55% vs 1.75%; $P = .005$ [data not shown]) or esophagus (25.00% vs 7.22%; $P = .02$ [data not shown]); however, fewer than 10 AI patients died after either procedure.

ADDITIONAL SENSITIVITY AND INTERACTION ANALYSES

To ensure that these results were not influenced by our choice of modeling, we conducted repeated sensitivity and interaction analyses. We found no significant interactions between ethnicity and income or insurance status for inpatient mortality. Similarly, ethnicity did not interact significantly with insurance in the prediction of prolonged LOS. However, an interaction was observed between race and income in the prediction of prolonged LOS. Stratified analyses revealed that residence in low-income zip codes was a significant predictor of prolonged LOS for NHW but not for AI patients. Given the colinearity of insurance status and income, we repeated our models after separately removing each. The impact of AI ethnicity did not change (data not shown). Our choice to use income was largely owing to a better model fit compared with insurance status (*C* statistics for income vs insurance, 0.79 vs 0.68). Finally, because of the potential confounding by differences in age distribution, we repeated our analyses after removing patients older than 80 years from the models and found that our results remained unchanged (data not shown).

Table 2. Frequency of Type of Malignant Neoplasm in AI and NHW Patients

Malignant Neoplasm	Patient Group, No. (%) NHW (n = 737 826)	AI (n = 3052)	*P* Value
Colon	132 787 (18.00)	469 (15.37)	<.001
Rectum	38 181 (5.17)	176 (5.77)	.14
Stomach	10 022 (1.36)	62 (2.03)	.002
Liver	1755 (0.24)	12 (0.39)	.08
Pancreas	6350 (0.86)	29 (0.95)	.59
Lung	56 696 (7.68)	113 (3.70)	<.001
Esophagus	2357 (0.32)	12 (0.39)	.47
Prostate	125 738 (17.04)	496 (16.25)	.25
Breast	129 468 (17.55)	505 (16.55)	.15
Thyroid	25 334 (3.43)	149 (4.88)	<.001
Bladder	15 046 (2.04)	46 (1.51)	.04
Kidney	49 667 (6.73)	283 (9.27)	<.001
Ovary	22 706 (3.08)	91 (2.98)	.76
Uterus	78 266 (10.61)	373 (12.22)	.004
Testicle	1231 (0.17)	11 (0.36)	.009
Larynx	5661 (0.77)	20 (0.66)	.48
Soft tissue	4723 (0.64)	25 (0.82)	.22
Skin	5099 (0.69)	17 (0.56)	.37
Gallbladder	3978 (0.54)	40 (1.31)	<.001
Brain	22 761 (3.08)	123 (4.03)	.003

Abbreviations: AI, American Indian; NHW, non-Hispanic white.

COMMENT

The present investigation is, to our knowledge, the largest study of AI surgical outcomes to date and the first to

©2013 American Medical Association. All rights reserved.
Downloaded From: http://archsurg.jamanetwork.com/ on 05/05/2015

Table 3. Survey-Weighted Multivariate Analyses of AI Ethnicity and Surgical Oncology Procedure Outcomes Within Nationwide Inpatient Sample Hospitals

	OR (95% CI)		
Factor	In-Hospital Mortality (n = 419 781)	Prolonged LOS[a] (n = 413 857)	Rural Hospital Location (n = 420 113)
Ethnicity			
NHW	1 [Reference]	1 [Reference]	1 [Reference]
AI	0.95 (0.65-1.40)	0.96 (0.85-1.07)	1.31 (1.16-1.50)
Age, y			
<50	1 [Reference]	1 [Reference]	1 [Reference]
50-65	1.41 (1.20-1.64)	0.99 (0.97-1.02)	0.99 (0.95-1.03)
66-80	2.80 (2.40-3.24)	1.38 (1.34-1.42)	1.21 (1.16-1.26)
>80	5.00 (4.29-5.84)	1.94 (1.87-2.00)	1.38 (1.32-1.45)
Sex			
Male	1 [Reference]	1 [Reference]	1 [Reference]
Female	0.76 (0.72-.81)	0.98 (0.97-1.00)	1.07 (1.04-1.10)
Income, $			
<39 000	1 [Reference]	1 [Reference]	1 [Reference]
39 000-48 000	0.97 (0.89-1.04)	0.93 (0.91-0.96)	0.65 (0.63-0.67)
48 000-63 000	0.90 (0.83-0.97)	0.84 (0.82-0.86)	0.21 (0.20-0.22)
>63 000	0.79 (0.73-0.86)	0.76 (0.74-0.78)	0.04 (0.04-0.05)
Unknown	0.90 (0.74-1.09)	0.99 (0.94-1.05)	0.64 (0.60-0.69)
Elixhauser comorbidity index[a]			
0	1 [Reference]	1 [Reference]	1 [Reference]
1	1.81 (1.56-2.10)	1.65 (1.61-1.70)	0.92 (0.89-0.95)
2	2.74 (2.37-3.16)	2.49 (2.43-2.56)	0.86 (0.83-0.90)
≥3	4.79 (4.16-5.51)	4.87 (4.74-5.01)	0.79 (0.76-0.82)
Admission			
Elective	1 [Reference]	1 [Reference]	1 [Reference]
Nonelective	2.71 (2.55-2.88)	3.92 (3.83-4.00)	1.48 (1.43-1.52)
Hospital location			
Urban	1 [Reference]	1 [Reference]	. . .
Rural	0.90 (0.82-0.99)	0.74 (0.72-0.76)	. . .
Region			
South	1 [Reference]	1 [Reference]	1 [Reference]
Midwest	0.88 (0.81-0.95)	1.07 (1.05-1.10)	2.29 (2.26-2.31)
Northeast	1.10 (1.03-1.18)	1.07 (1.05-1.10)	1.71 (1.69-1.74)
West	0.89 (0.79-1.00)	1.03 (0.99-1.06)	1.11 (1.07-1.15)
Year			
2003	1 [Reference]	1 [Reference]	1 [Reference]
2004	0.89 (0.81-0.99)	0.93 (0.90-0.96)	0.99 (0.94-1.03)
2005	0.81 (0.74-0.89)	0.81 (0.78-0.83)	0.85 (0.81-0.89)
2006	0.82 (0.75-0.91)	0.78 (0.76-0.81)	0.93 (0.89-0.98)
2007	0.76 (0.69-0.84)	0.77 (0.74-0.79)	0.80 (0.76-0.83)
2008	0.74 (0.67-0.82)	0.71 (0.69-0.74)	0.70 (0.67-0.73)
2009	0.70 (0.63-0.78)	0.62 (0.60-0.64)	0.65 (0.63-0.67)
No. of events	5923	120 121	34 488
Event rate	0.01	0.29	0.08
C statistic of model	0.84	0.85	0.79

Abbreviations: AI, American Indian; ellipsis, not applicable; LOS, length of stay; NHW, non-Hispanic white; OR, odds ratio.
[a] Prolonged LOS is defined as those who experienced a hospital stay at or beyond the 75th percentile of the cohort.

focus on cancer surgery. In this large national cohort, AI ethnicity significantly influenced patterns of oncologic procedures. The AI patients undergoing cancer surgery were younger, lived in lower-income zip codes, and had more comorbidities than did similarly aged NHW patients. The AI patients were more likely to undergo operations at rural hospitals and more likely to undergo nonelective procedures; however, AI patients did not demonstrate worse inpatient mortality or longer LOS.

To our knowledge only 6 other studies have examined surgical outcomes among AIs,[10-15] including only 2 unique samples of more than 160 AIs. Our results are consistent with previous reports that AI surgery patients are on average younger,[11-14] a finding potentially attributable to lower overall life expectancy, which leads to fewer elderly AI patients.[16] Our results showing that AI patients are substantially more likely to be admitted for nonelective procedures are consistent with the trend toward urgent admission status observed among AI patients undergoing coronary artery bypass grafting.[14] In contrast to our findings for cancer surgery, AI patients have been reported to have significantly higher in-hospital mortality after coronary artery bypass grafting[14] and higher 30-day mortality after major noncardiac surgical procedures.[11] These differences may reflect features specific to cancer surgery and differences in the

©2013 American Medical Association. All rights reserved.

Downloaded From: http://archsurg.jamanetwork.com/ on 05/05/2015

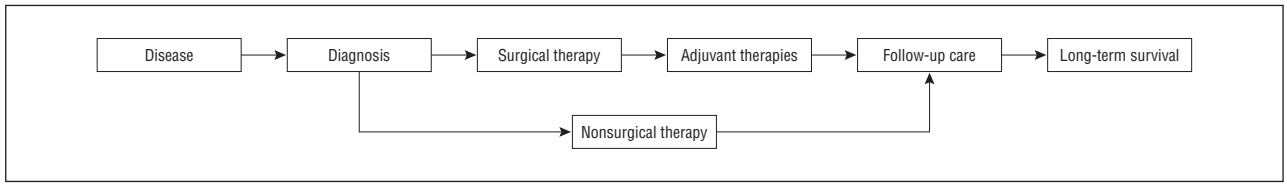

Figure 2. The continuum of cancer care. American Indians are subject to disparities at multiple points along the continuum of cancer care.

factors that underlie in-hospital mortality and 30-day mortality.

In answer to this study's central question, differences in short-term operative mortality do not appear to contribute to the overall poor cancer survival rates among AIs, with the possible exception of rectal and esophageal cancer. Ethnic disparities in the delivery of cancer care exist at multiple points along the pathway from entry into the health care system to definitive management (**Figure 2**). American Indians receive cancer diagnoses when the disease is at more advanced stages,[3] have significant delays from diagnosis to treatment,[5] and are less likely to receive appropriate therapy.[4] However, the long-term survival deficit has been reported to persist even after controlling for tumor grade and stage at diagnosis and the type of treatment delivered.[17] Our data contribute to an understanding of poor survival among AIs with cancer by demonstrating that the remaining variance in long-term survival is not accounted for by in-hospital mortality after surgical procedures. Differences at other points along the continuum of cancer care remain potential contributors to the AI cancer survival disparity, including the delivery of adjuvant therapies and long-term follow-up care. Alternately, AIs may fare worse among patients receiving nonsurgical therapies, such as those whose disease severity precludes operative management.

The present results highlight the challenge of delivering oncologic services to isolated populations in the era of centralized surgical care. Proximity to the place of treatment has been shown to affect cancer therapy modality,[18] and rural location has been shown to limit access to other forms of surgical care.[19] Trends in the national referral system for cancer surgery toward the redistribution of resources out of rural areas may adversely affect access to services for those who already face geographic barriers to care because travel distance increases when care is shifted to high-volume centers.[20] Significantly, because most low-volume cancer surgery occurs in urban areas, reports suggest that centralization efforts can exempt rural hospitals and still achieve their objectives.[21] Policy makers should also be aware that validated strategies to reduce the distance rural patients travel for cancer therapy are available[22] and that telemedicine may have an emerging role in nonoperative oncologic management in remote areas.[23]

Efforts to reverse the discouraging trend toward a broadening gap in cancer mortality between AI and NHW patients should target the unique needs of rural and urban AI patients. Although rural patients face these challenges and traditionally have been thought to present with later-stage cancer,[24] a developing body of literature suggests that for some cancers, residents of urban areas receive diagnoses at later stages.[25] Among residents of urban areas, AIs may be particularly vulnerable because the Indian Health Service (IHS) is best equipped to serve rural populations,[26] although urban IHS programs are evolving and improving.[16]

Of 5.2 million people in the United States who belong to 1 of 565 federally recognized American Indian and Alaskan native tribes, approximately 2 million receive health care through the IHS. The IHS is an agency within the Department of Health and Human Services with an annual budget of approximately $4.1 billion. The agency provides health care through federally administered programs, services administered via tribal governments, and the Urban Indian Health Programs, including a total of 45 hospitals and 582 smaller health centers and other facilities. In addition, funds are available to purchase services that would otherwise be unavailable, such as complex surgical care, through contracts with outside providers. These limited funds are allocated annually based on the acuity of patients' needs and reflect broader scarcity within the system.[16] Although AIs bear a disproportionate burden of preventable disease, the per capita personal health expenditure for IHS users ($2741) is less than half that of the US population in general.[27] Despite these challenges, IHS initiatives have contributed to a reduction in the life expectancy disparity between AIs and the NHW population from 8 to 5 years during the past several decades.[16] Although federally administered IHS hospitals are not included in the NIS, the IHS provides much of its surgical cancer care through contracts with outside hospitals that would fall within the NIS sampling frame.

Our results should be interpreted in light of several limitations related to the use of administrative data. First, our data set does not include patients who did not undergo surgery, such as those with disseminated disease, those who declined operative management, and those whose comorbid conditions precluded surgery. Second, some states do not participate in the NIS, including Alaska. Therefore, our results should not be extrapolated to Alaskan natives, whose patterns of cancer incidence[3] and mortality[2] have been shown to be distinct from those of AIs. Third, the NIS does not contain information on tumor characteristics or stage. Finally, although the 2009 edition of the NIS provides the most comprehensive reporting of ethnicity to date, it is still missing this information for 15% of discharges, limiting the generalizability of our results in those states that do not report ethnicity data. Despite these limitations, the large, inclusive nature of the NIS makes it uniquely suited to address the important but underexplored issue of surgical outcomes among this group.

The present study also has several significant strengths. As the largest study of AI surgical patients, it provides an important perspective on the AI surgical experience.

©2013 American Medical Association. All rights reserved.

Downloaded From: http://archsurg.jamanetwork.com/ on 05/05/2015

Furthermore, given that more than half of AIs and Alaskan natives do not receive care through the IHS, the all-payer nature of the NIS database is an important strength that provides data on AI patients from diverse backgrounds.[16] Finally, by considering AIs separately from Alaskan natives, our data may provide more precise information than do studies that lump together these 2 very different groups.

Our findings suggest that the observed deficit in long-term survival among AIs cannot be explained by excess perioperative mortality. Other factors in the continuum of cancer care might account for the previously reported unexplained variance in long-term outcomes. In particular, differences in the use of adjuvant chemotherapy or radiotherapy may contribute to disparities in survival and merit further investigation as potential points of intervention. This possibility is supported by research showing that AI patients treated for breast cancer have different patterns of adjuvant therapy than NHW patients,[28] and that radiotherapy and medical oncology services are even more difficult for rural patients to access than surgical care.[29] Future research should delineate clearly the significance of these potential contributors to poor outcomes and further explore outcomes specific to malignant disease. Researchers and policy makers should also expand work to redress established disparities, such as ongoing IHS innovations that have increased rates of colonoscopy.[16]

CONCLUSIONS

To our knowledge, this study is first to examine the effect of AI ethnicity on patterns and outcomes of cancer surgery in the United States. This relatively young cohort of surgical patients is not subject to excess short-term operative mortality. Future research should uncover other factors in the continuum of cancer care that may contribute to poor long-term cancer survival for AIs, including the delivery of perioperative therapies and follow-up care, while simultaneously developing interventions to target known shortcomings.

Accepted for Publication: July 10, 2012.
Correspondence: Waddah B. Al-Refaie, MD, Department of Surgery, Lombardi Comprehensive Cancer Center, Georgetown University Hospital, 3800 Reservoir Rd NW, 4 PHC, Washington, DC 20007 (waddah.b.al-rafaie@gunet.georgetown.edu).
Author Contributions: Mr Markin and Dr Al-Refaie had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Markin, Habermann, Vickers, and Al-Refaie. *Acquisition of data:* Abraham. *Analysis and interpretation of data:* Markin, Habermann, Zhu, Ahluwalia, and Al-Refaie. *Drafting of the manuscript:* Markin and Al-Refaie. *Critical revision of the manuscript for important intellectual content:* All authors. *Statistical analysis:* Markin, Habermann, Zhu, and Al-Refaie. *Obtained funding:* Vickers. *Administrative, technical, and material support:* Ahluwalia. *Study supervision:* Habermann, Abraham, Ahluwalia, and Al-Refaie.
Conflict of Interest Disclosures: None reported.
Funding/Support: This study was supported by Enhancing Minority Participation in Clinical Trials grant 5RC2MD004797-02 and by the National Institute for Minority Health Disparities grant 1P60MD003422 from the Center for Health Equity.
Previous Presentation: This work was presented in part at the 2012 Academic Surgical Congress; February 16, 2012; Las Vegas, Nevada.
Additional Contributions: Binyam Muluneh, MD, contributed to an earlier version of this project and Crystal Cunningham, MD, provided insightful perspectives on surgical oncology services provided by the IHS.

REFERENCES

1. Clegg LX, Li FP, Hankey BF, Chu K, Edwards BK. Cancer survival among US whites and minorities: a SEER (Surveillance, Epidemiology, and End Results) Program population-based study. *Arch Intern Med*. 2002;162(17):1985-1993.
2. Espey D, Paisano R, Cobb N. Regional patterns and trends in cancer mortality among American Indians and Alaska Natives, 1990-2001. *Cancer*. 2005;103(5):1045-1053.
3. Perdue DG, Perkins C, Jackson-Thompson J, et al. Regional differences in colorectal cancer incidence, stage, and subsite among American Indians and Alaska Natives, 1999-2004. *Cancer*. 2008;113(5)(suppl):1179-1190.
4. Fesinmeyer MD, Goulart B, Blough DK, Buchwald D, Ramsey SD. Lung cancer histology, stage, treatment, and survival in American Indians and Alaska Natives and whites. *Cancer*. 2010;116(20):4810-4816.
5. Wilson RT, Adams-Cameron M, Burhansstipanov L, et al. Disparities in breast cancer treatment among American Indian, Hispanic and non-Hispanic white women enrolled in Medicare. *J Health Care Poor Underserved*. 2007;18(3):648-664.
6. Siegel R, Ward E, Brawley O, Jemal A. Cancer statistics, 2011: the impact of eliminating socioeconomic and racial disparities on premature cancer deaths. *CA Cancer J Clin*. 2011;61(4):212-236.
7. Lucas FL, Stukel TA, Morris AM, Siewers AE, Birkmeyer JD. Race and surgical mortality in the United States. *Ann Surg*. 2006;243(2):281-286.
8. Frost F, Taylor V, Fries E. Racial misclassification of Native Americans in a Surveillance, Epidemiology, and End Results cancer registry. *J Natl Cancer Inst*. 1992;84(12):957-962.
9. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. *Med Care*. 1998;36(1):8-27.
10. Alvord LA, Henderson WG, Benton K, Buchwald D. Surgical outcomes in American Indian veterans: a closer look. *J Am Coll Surg*. 2009;208(6):1085.e1-1092.e1. doi:10.1016/j.jamcollsurg.2009.02.058.
11. Alvord LA, Rhoades D, Henderson WG, et al. Surgical morbidity and mortality among American Indian and Alaska Native veterans: a comparative analysis. *J Am Coll Surg*. 2005;200(6):837-844.
12. Cohen MM, Young TK, Hammarstrand KM. Ethnic variation in cholecystectomy rates and outcomes, Manitoba, Canada, 1972-84. *Am J Public Health*. 1989;79(6):751-755.
13. Fine A, Cox D, Bouw M. Higher incidence of peritonitis in native Canadians on continuous ambulatory peritoneal dialysis. *Perit Dial Int*. 1994;14(3):227-230.
14. Nallamothu BK, Saint S, Saha S, Fendrick AM, Kelley K, Ramsey SD. Coronary artery bypass grafting in Native Americans: a higher risk of death compared to other ethnic groups? *J Gen Intern Med*. 2001;16(8):554-559.
15. Smith SM, Harford AM. IgA nephropathy in renal allografts: increased frequency in Native American patients. *Ren Fail*. 1995;17(4):449-456.
16. Sequist TD, Cullen T, Acton KJ. Indian health service innovations have helped reduce health disparities affecting American Indian and Alaska native people. *Health Aff (Millwood)*. 2011;30(10):1965-1973.
17. Gilliland FD, Hunt WC, Key CR. Trends in the survival of American Indian, Hispanic, and non-Hispanic white cancer patients in New Mexico and Arizona, 1969-1994. *Cancer*. 1998;82(9):1769-1783.
18. Boscoe FP, Johnson CJ, Henry KA, et al. Geographic proximity to treatment for early stage breast cancer and likelihood of mastectomy. *Breast*. 2011;20(4):324-328.
19. Wallace AE, Young-Xu Y, Hartley D, Weeks WB. Racial, socioeconomic, and rural-urban disparities in obesity-related bariatric surgery. *Obes Surg*. 2010;20(10):1354-1360.
20. Stitzenberg KB, Sigurdson ER, Egleston BL, Starkey RB, Meropol NJ. Centralization of cancer surgery: implications for patient access to optimal care. *J Clin Oncol*. 2009;27(28):4671-4678.

©2013 American Medical Association. All rights reserved.
Downloaded From: http://archsurg.jamanetwork.com/ on 05/05/2015

21. Dimick JB, Finlayson SRG. Rural hospitals and volume standards in surgery. *Surgery*. 2006;140(3):367-371.
22. Elliott TE, Elliott BA, Regal RR, et al. Improving rural cancer patients' outcomes: a group-randomized trial. *J Rural Health*. 2004;20(1):26-35.
23. Kitamura C, Zurawel-Balaura L, Wong RK. How effective is video consultation in clinical oncology? a systematic review. *Curr Oncol*. 2010;17(3):17-27.
24. Fazio L, Cotterchio M, Manno M, McLaughlin J, Gallinger S. Association between colonic screening, subject characteristics, and stage of colorectal cancer. *Am J Gastroenterol*. 2005;100(11):2531-2539.
25. Paquette I, Finlayson SRG. Rural versus urban colorectal and lung cancer patients: differences in stage at presentation. *J Am Coll Surg*. 2007;205(5):636-641.
26. Forquera R. *Urban Indian Health*. Washington, DC: Kaiser Family Foundation; 2001.
27. Indian Health Service. IHS fact sheet: IHS year 2013 profile. http://www.ihs.gov/factsheets/index.cfm?module=dsp_fact_profile. Accessed February 5, 2013.
28. Frost F, Tollestrup K, Hunt WC, Gilliland F, Key CR, Urbina CE. Breast cancer survival among New Mexico Hispanic, American Indian, and non-Hispanic white women (1973-1992). *Cancer Epidemiol Biomarkers Prev*. 1996;5(11):861-866.
29. Baldwin LM, Cai Y, Larson EH, et al. Access to cancer services for rural colorectal cancer patients. *J Rural Health*. 2008;24(4):390-399.

INVITED CRITIQUE

Poor Cancer Survival Among American Indians

Why?

Markin and colleagues[1] examined the role of surgery in an effort to explain why American Indians (AIs) have the poorest survival rates for cancer among all ethnic groups in the United States. Despite all the issues associated with a retrospective cohort study using an administrative database, the authors identified some important disparities. Compared with non-Hispanic white patients, AI patients were younger, had more comorbid conditions, and were more likely to have surgery in smaller, rural hospitals. Despite these inequities, short-term surgical outcomes were similar.

If we look closer, however, we see that the types of surgical resections were different, with fewer lung or colon resections in the AI cohort. Also, in-hospital mortality was higher in AI patients who underwent more technically demanding surgery for rectal and esophageal cancers. Because of the small numbers involved, these findings did not affect the overall findings but suggest that, for certain surgical procedures, surgical care systems in place in large cancer centers may allow for improved surgical outcomes.

Perhaps the biggest limitation of the study is that it examined only short-term outcomes, and the adequacy of oncologic resection could not be assessed. The role of surgery still needs to be better defined. The database did not include tumor stage. For many tumors, adequate surgery and access to neoadjuvant and adjuvant therapies are critical for optimizing oncologic outcomes, and certain modalities might not be easily accessible from rural areas. The data were quite clear that only those AI patients with high incomes were more likely to receive care in urban centers.

Although access to care remains an issue for low-income, rural populations, AI patients represent a special challenge. Markin and colleagues and other investigators should continue to look deeper into this disparity if we are to develop systems of care to narrow the survival gap and improve cancer care among AI patients.

James C. Hebert, MD

Author Affiliation: Department of Surgery, University of Vermont College of Medicine, Burlington.
Correspondence: Dr Hebert, Department of Surgery, University of Vermont College of Medicine, Fletcher Allen Health Care, 111 Colchester Ave, Burlington, VT 05401 (james.hebert@vtmednet.org).
Conflict of Interest Disclosures: None reported.

1. Markin A, Habermann EB, Zhu Y, et al. Cancer surgery among American Indians. *JAMA Surg*. 2013;148(3):277-284.

©2013 American Medical Association. All rights reserved.
Downloaded From: http://archsurg.jamanetwork.com/ on 05/05/2015