POPULATIONS AT RISK

Coronary Artery Bypass Grafting in Native Americans

A Higher Risk of Death Compared to Other Ethnic Groups?

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BACKGROUND: **While the efficacy and safety of coronary artery bypass grafting (CABG) has been established in several clinical trials, little is known about its outcomes in Native Americans.**

MEASUREMENTS AND MAIN RESULTS: **We assessed clinical outcomes associated with CABG in 155 Native Americans using a national database of 18,061 patients from 25 nongovernmental, not-for-profit U.S. health care facilities. Patients were classified into five groups: 1) Native American, 2) white, 3) African American, 4) Hispanic, and 5) Asian. We evaluated for ethnic differences in in-hospital mortality and length of stay, and after adjusting for age, gender, surgical priority, case-mix severity, insurance status, and facility characteristics (volume, location, and teaching status). Overall, we found the adjusted risk for in-hospital death to be higher in Native Americans when compared to whites (odds ratio [OR], 3.8; 95% confidence interval [CI], 1.5 to 9.8), African Americans (OR, 3.4; 95% CI, 1.1 to 9.9), Hispanics (OR, 7.1; 95% CI, 2.5 to 20.3), and Asians (OR, 2.8; 95% CI, 1.1 to 7.0). No significant differences were found in length of stay after adjustment across ethnic groups.**

CONCLUSIONS: **The risk of in-hospital death following CABG may be higher in Native Americans than in other ethnic groups. Given the small number of Native Americans in the database (*n* = 155), however, further research will be needed to confirm these findings.**

KEY WORDS: **Native Americans; ethnicity; race; coronary artery bypass grafting; coronary artery disease.**
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The burden of cardiovascular disease is rising in Native Americans. Incidence rates for cardiovascular disease in Native Americans—which at one time were remarkably low[1]—are now 2-fold higher than the rates seen in other ethnic groups in the United States.[2] In addition, recent evidence suggests that cardiovascular events are more likely to be fatal in Native Americans[3] and that cardiovascular disease is now the leading cause of death in most tribes.[4]

In the United States, coronary artery bypass grafting (CABG) is a commonly used method for treating patients with severe coronary heart disease. While several studies have established the overall efficacy and safety of CABG for relieving symptoms and improving life expectancy,[5] little is known about the outcomes of CABG in Native Americans.

We therefore examined outcomes of CABG in Native Americans using a national database of clinical and administrative information from 25 healthcare facilities across the United States. Specifically, we sought to determine if there were differences, for patients undergoing CABG, between Native Americans and other U.S. ethnic groups regarding in-hospital mortality and length of stay.

METHODS

Setting and Patient Population

This study was conducted as a retrospective analysis using administrative data from HBSI EXPLORE, a comparative healthcare outcomes benchmarking database from Solucient, LLC. HBSI EXPLORE contains data from more than 160 nongovernmental, not-for-profit, healthcare facilities across the United States and has been used in previous research studies.[6] All subjects undergoing CABG at the involved centers and discharged between January 1, 1997, and June 30, 2000, were included. Patients were identified by searching all records at the institutions for 1 of 8 ICD-9-CM procedure codes for CABG (36.10 to 36.16 and 36.19). Subjects who underwent emergent CABG, surgeries other than isolated CABG (e.g., concomitant valve or aortic surgery), or coronary angioplasty and CABG during the same hospitalization (presumably for complications of

angioplasty) were eliminated. In addition, our analysis only included facilities that had performed a CABG in at least one subject of Native American descent.

Administrative records contained detailed patient information on ethnicity, age, gender, surgical priority (elective or urgent), length of hospital stay, status at discharge, principal insurance carrier (Medicare, Medicaid/other governmental, or private), principal ICD-9-CM procedure code, and case-mix. Case-mix was determined using the All Patient Refined-Diagnosis Related Group (APR-DRG) (3M/HIS, Minneapolis, Minn). The APR-DRG is a discharge abstract-based measure that classifies patients by their risk of in-hospital mortality within adjacent DRG categories. Within each DRG, four levels (minor, moderate, major, and extreme) are possible based on: 1) secondary diagnoses; 2) the complexity of secondary diagnoses and their interaction with each other; and 3) the interaction between secondary and principal diagnoses (see Figure 1). Additional details about the APR-DRG case-mix measure are available online at www.blackwellscience.com/jgi. Classification with APR-DRG has been shown to be useful and valid at predicting in-hospital mortality and length of stay in CABG when compared to other measures of disease severity.[7,8] Facility-specific information included hospital setting (urban or rural), teaching status (teaching or nonteaching) and annual CABG volume.

Data Analysis

We classified patients into five ethnic groups: 1) Native American, 2) white, 3) African American, 4) Hispanic, and 5) Asian (including Pacific Islanders). Unadjusted differences in the demographic and clinical characteristics of Native Americans and the other combined ethnic groups (i.e., non-Native Americans) were assessed using the nonparametric Wilcoxon rank sum test for continuous variables and the χ^2 test for categorical variables. Statistical significance was determined using a 2-sided P value of .05.

Logistic regression was used to model the association between ethnicity and in-hospital mortality.[9] We adjusted for several factors that could potentially confound the association between ethnicity and in-hospital mortality including age, gender, surgical priority, case-mix (using APR-DRG), health insurance coverage, institutional CABG volume (<200 or ≥ 200 annual cases), facility location, and teaching status. A variable was included in the model based on either its univariate association with in-hospital mortality (using a P value less than .10) or its clinical importance determined a priori. Because exploratory analyses and a review of the medical literature suggested a nonlinear relationship between CABG volume and in-hospital mortality,[10] we dichotomized centers into 2 groups based on an average annual CABG volume of 200 cases. We systematically evaluated the model for any evidence of significant 2-way interaction effects between ethnicity and the various covariates. The Hosmer-Lemeshow goodness-of-fit test was used to assess the overall fit of the model.[9]

Adjusting for all the factors listed above and in-hospital mortality, we used ordinary least squares regression to model the association between ethnicity and length of stay. Because length of stay was found to be a highly skewed variable, we performed a logarithmic transformation of this variable before conducting the regression analysis. We then retransformed length of stay into its natural units of days prior to final reporting.

In both regression models, we used robust variance estimates to account for any clustering effects at the facility level.[11] All analyses were performed using Stata (version 6.0, Stata Corp., College Station, Tex).

RESULTS

Health Care Facilities and Patient Demographics

From the more than 160 institutions available in the database, 25 healthcare facilities that had performed CABG in at least one individual of Native American descent were identified. The facilities were predominately located in urban settings (24 facilities), across 17 states (California, Connecticut, Florida, Georgia, Hawaii, Kansas, Louisiana, Minnesota, Montana, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Dakota, Texas, and Wisconsin) and, on average, each center annually performed 267 CABGs (range, 18 to 791; SD, 184).

A total of 18,470 subjects underwent isolated, nonemergent CABG at the 25 included centers. Of these subjects, 409 were eliminated because of uncertain ethnic background. Overall, the average age was 65.3 (SD, 10.4) and mean length of stay was 8.0 days (SD, 5.0). Of the 18,061 subjects that remained, 155 (0.9%) were Native Americans, 16,077 (89.0%) were white, 619 (3.4%) were African American, 250 (1.4%) were Hispanic, and 960 (5.3%) were Asian. Most Native Americans underwent CABG in the following 5 states: North Dakota (17.4%), Montana (16.8%), Ohio (14.2%), Oklahoma (11.6%), and South Dakota (10.3%). The in-hospital mortality rate following CABG for the entire study population was 2.0%. Table 1 outlines the characteristics of the study population stratified by ethnicity. Significant differences were seen between Native Americans and the other ethnic groups in age (60.4 vs 65.3; $P < .001$), percentage of women (19.4% vs 27.2%; $P = .03$), in-hospital mortality (4.5% vs 2.0%; $P = .024$), percentage of cases performed at low-volume CABG facilities (42.6% vs 17.8%; $P < .001$), and percentage of cases performed at rural centers (9.7% vs 0.8%; $P < .001$).

Adjusted Analyses

After adjusting for potentially confounding variables, we found that Native Americans had a significantly higher risk of in-hospital death following CABG compared to other ethnic groups. When compared to the other groups combined, the risk of in-hospital death was nearly 4-fold

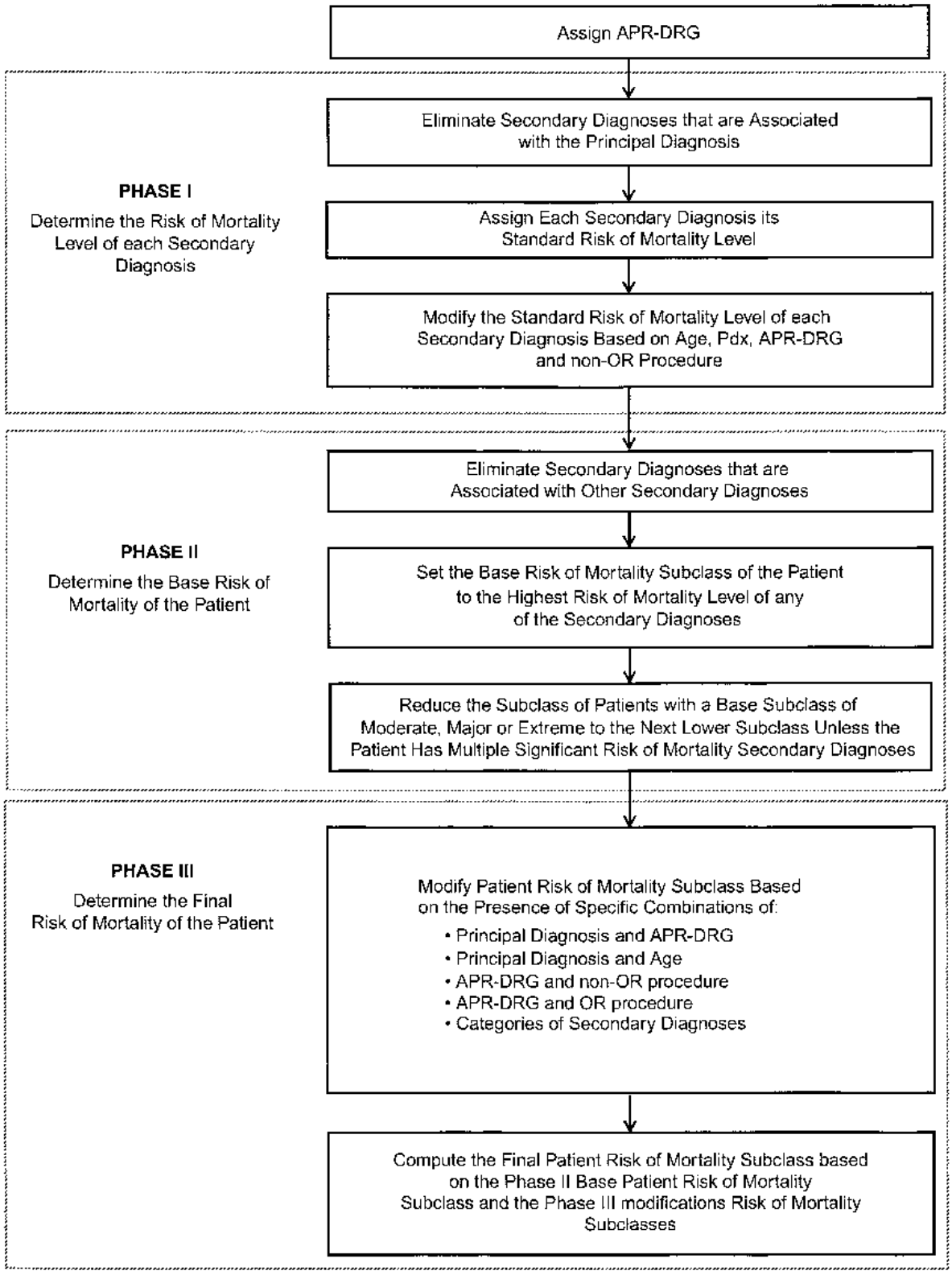

FIGURE 1. Three-phase process for determining patient risk of mortality. Reprinted with permission from: All Patient Refined-Diagnosis Related Groups (APR-DRGs) Definitions Manual, Version 15.0 Methodology Overview, 1998, 3M.

greater in Native Americans (OR, 3.7; 95% CI, 1.5 to 9.6; P = .006). Pairwise comparisons revealed significant differences in in-hospital mortality between Native Americans and whites (OR, 3.8; 95% CI, 1.5 to 9.8; P = .006), African Americans (OR, 3.4; 95% CI, 1.1 to 9.9; P = .027), Hispanics (OR, 7.1; 95% CI, 2.5 to 20.3;

Table 1. Characteristics of Patients Undergoing Nonemergent CABG in 12 U.S. Healthcare Facilities

Characteristic	Native Americans *N* = 155	Whites *N* = 16,077	African Americans *N* = 619	Hispanic *N* = 250	Asians *N* = 960
Mean age, y ± SD	60.4 ± 10.7	65.6 ± 10.3	61.3 ± 11.1	64.3 ± 10.2	64.6 ± 10.4
Female, %*	19.4	26.4	44.3	26.8	28.7
Cases at highest risk of mortality level (APR-DRG classification), %	7.1	7.9	7.6	7.4	10.0
Urgent cases, %	45.2	39.9	38.9	26.4	42.5
Surgeries at facilities with 200 or fewer annual cases, %*	42.6	18.7	22.5	11.2	1.7
Rural facilities, %*	9.7	0.9	0	0	0
Length of stay, d (mean ± SD)	7.5 ± 3.9	8.0 ± 4.9	8.6 ± 5.0	8.1 ± 5.3	7.9 ± 5.2
Suffering in-hospital death, %*	4.5	1.9	2.3	1.2	3.3

* P < *.05 for differences between Native Americans and the other ethnic groups combined.*

P < .001), and Asians (OR, 2.8; 95% CI, 1.1 to 7.0; *P* = .033). The Hosmer-Lemeshow goodness-of-fit suggested that overall model fit was adequate (*P* = .47). We found no statistically significant association between ethnicity and length of stay after adjusting for several factors.

DISCUSSION

The efficacy and safety of common treatments for cardiovascular disease in Native Americans are unknown. Accordingly, we examined the outcomes of CABG in 155 Native Americans using a national database of over 18,000 patients from 25 U.S. healthcare facilities. Our study has several noteworthy findings. First, after adjusting for age, gender, surgical priority, case-mix severity, insurance status, and facility characteristics (volume, location, and teaching status), we found that the risk of in-hospital death following CABG in Native Americans was significantly higher than in whites, African Americans, Hispanics, and Asians. Compared to other ethnic groups, we also found that Native Americans were more likely to be younger, to be men, and to have their CABG performed at low-volume facilities and in rural centers.

Earlier studies have shown that ethnicity may contribute to the variability seen in clinical outcomes following CABG. Gray et al. in 1996 found a 2-fold increase in the risk of death between African American and white patients at 5 years following CABG.[12] More recently, Verderber et al. documented significant differences in the hospital course of post-CABG patients of Japanese, Pacific Island, and white descent.[13] Importantly, while these studies and others have documented substantial variations in outcomes among different ethnic groups, it remains unclear as to whether these differences are due to cultural, socioeconomic, environmental, or genetic factors.

Poorer outcomes in Native Americans following CABG are most likely due to multiple factors. One potential cause for the rising incidence of cardiovascular disease in American Indians is the increasing prevalence of important cardiovascular risk factors due to gradual acculturation of Western diets and lifestyles.[14] Diabetes mellitus, in particular, is highly prevalent in several Native American tribes[15] and because diabetes may confer increased risk for death following CABG,[16,17] this might explain, at least in part, our findings of increased in-hospital mortality from CABG among Native Americans. In our study, however, we were not able to identify whether diabetes mellitus was more prevalent in Native Americans than in the other ethnic groups. Socioeconomic factors may also have contributed to poor outcomes in Native Americans undergoing CABG.[18] We were unable to adjust for socioeconomic differences in this database; future research will be needed to confirm and quantify its importance in relation to Native Americans and CABG-related mortality. Finally, obstacles in accessing and utilizing healthcare services may also have contributed to the differences we observed. For instance, we found Native Americans more likely to undergo their surgeries at low-volume centers and in rural areas. Although we adjusted for these factors, residual confounding might explain our observation of worse in-hospital mortality rates in Native Americans.

Several limitations need to be considered when interpreting our results. First, we evaluated CABG-related outcomes in a relatively small number of Native Americans (*n* = 155). Small sample size is a frequent limitation in national studies of Native Americans, who make up only 1% of the U.S. population.[19] Despite this limitation, however, our tests of significance and model fit demonstrated that our sample, which was drawn from a large national database of CABG hospitalizations, was of sufficient size to demonstrate a statistically significant difference in mortality between Native Americans and other groups. These results, of course, should still be considered exploratory and need to be confirmed through further study. Second, we were unable to classify Native Americans based on individual tribal backgrounds. While Native Americans share common ethnic origins and recent studies have documented comparable cardiovascular mortality rates among different tribes,[2,4] significant regional variations in cardiovascular disease may exist among different tribes due to social and cultural differences. Most Native Americans in our study were from the Northern Plains and

Midwest; thus, our findings might not be generalizable to tribes in other regions such as the Southwestern United States. Third, our data were primarily administrative in nature; therefore, we could not identify or adjust for all the clinical indices such as chronic heart failure or chronic obstructive pulmonary disease that have been linked to adverse CABG outcomes. Instead, we used the APR-DRG severity measure to adjust for disease severity and important comorbidities. Although the APR-DRG case-mix measure has been shown to be a valid method for severity adjustment in CABG,[8] it is possible that some degree of residual confounding remained. Finally, we focused on in-hospital mortality as our primary clinical outcome. We were unable to examine the effects of ethnicity on the incidence of other important complications such as stroke, renal failure, or long-term CABG-related mortality.

Our results suggest that the risk of in-hospital mortality following CABG may be higher in Native Americans than in other ethnic groups. Further research will be needed to confirm these findings in larger cohorts and to explore which specific factors might contribute to this difference. Until then, however, we recommend continuing efforts to aggressively reduce the increasing incidence of cardiovascular risk factors in Native Americans.

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APPENDIX

The All Patient Refined-Diagnosis Related Group (APR-DRG) case-mix measure expands the basic structure of the Diagnosis Related Group (DRG) by adding four subclasses to each DRG. The four subclasses address patient differences relating to severity of illness and risk of mortality and are numbered sequentially from 1 to 4 indicating minor, moderate, major, or extreme severity of illness or risk of mortality, respectively. For evaluating resource use, the severity of illness subclass is used as a case-mix measure; for assessing patient mortality, the risk of mortality subclass is used.

The underlying principle of the APR-DRG is that a patient's clinical course is highly dependent on the patient's underlying problem (principal diagnosis) and his or her co-morbidities (secondary diagnoses). Patients with multiple co-morbidities involving multiple organ systems and a severe underlying condition therefore constitute the most challenging cases with the worst expected clinical outcomes.

The assignment of a patient to a specific severity of illness or risk of mortality subclass takes into account the principal and secondary diagnoses that are present and the interaction between the principal diagnosis, secondary diagnoses, age, and the presence of certain operating room and non-operating room procedures. Figure 1 details the 3 phases for assigning a risk of mortality subclass to a patient.

Development of the APR-DRG involved an iterative process of formulating clinical hypotheses and then testing the hypotheses with historical data. Separate clinical models were first developed for each of the 355 base APR-DRGs. Once the models were developed, they were evaluated and revised using historical data; if there were substantial discrepancies between the clinical expectations of the model and the data results, however, the clinical expectations were always utilized as the basis of the APR-DRGs. Thus the APR-DRG is a clinical model that has been extensively reviewed with historical data. The historical data used in the development of Version 15 of the APR-DRGs was a random, national sample of 5.7 million discharges from 657 hospitals in 35 states across the U.S.

Source: Health Information Systems, 3M Health Care. All Patient Refined-Diagnosis Related Groups (APR-DRGs) Definitions Manual, Version 15.0 Methodology Overview. 1998.