Minorities Are Less Likely to Receive Autologous Blood Transfusion for Major Elective Orthopaedic Surgery

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Received: 5 February 2014 / Accepted: 26 June 2014 / Published online: 16 July 2014
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Abstract

Background Surgeons commonly arrange for patients to perform autologous blood donation before elective orthopaedic surgery. Understanding sociodemographic patterns of use of autologous blood transfusion can help improve quality of care and cost containment.

Questions/purposes We sought to determine whether there were (1) racial disparities, (2) insurance-based disparities, or (3) income-based disparities in autologous blood use. Additionally, we evaluated the combined effect of (4) race and insurance and (5) race and income on autologous blood use, and we compared ratios of autologous with allogeneic blood use.

Methods Of the more than 3,500,000 patients undergoing major elective orthopaedic surgery identified in the Nationwide Inpatient Sample between 2008 and 2011, 2.4% received autologous blood transfusion and 12% received allogeneic blood transfusion. Multivariable

logistic regression was performed to determine the influence of race, insurance status, and income on autologous blood use.

Results Compared with white patients, Hispanic patients had lower odds of autologous blood use for elective hip (odds ratio [OR], 0.75; 95% CI, 0.69–0.82) and knee arthroplasties (OR, 0.71; 95% CI, 0.67–0.75). Black patients had lower odds of receiving autologous blood transfusion for hip arthroplasty (OR, 0.78; 95% CI, 0.74–0.83). Compared with the privately insured, uninsured and publicly insured patients were less likely to receive autologous blood for total joint arthroplasty and spinal fusion. Patients with low and medium income were less likely to have autologous blood transfusion for total joint arthroplasty and spinal fusion compared with high-level income earners. Even at comparable income and insurance levels with whites, Hispanic and black patients tended to be less likely to receive autologous blood transfusion. Ratios of autologous to allogeneic blood use were lower among minority patients.

Conclusions Historically disadvantaged populations receive fewer autologous blood transfusions for elective orthopaedic surgery. Whether the differential use is attributable to patient preference or unequal access to this practice should be investigated further.

Level of Evidence Level II, prognostic study. See the Instructions for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution waived approval for the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.

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Introduction

Blood loss associated with major elective orthopaedic surgery can be substantial, and many patients require

allogeneic or autologous blood transfusions [2, 7, 32, 45, 46]. Although infrequent, allogeneic transfusions carry important medical risks, including bloodborne infections, allergic and hemolytic reactions, and transfusion-associated sepsis [2, 15, 16, 18, 36, 37, 41]. Transfusion of preoperatively donated autologous blood is a theoretically safer, yet more costly and logistically difficult alternative [2, 18, 32].

A 1996 Nationwide Inpatient Sample (NIS) analysis by Segal et al. [37] showed that the use of autologous blood transfusion in the United States varied by race, ethnicity, and insurance status. This study, however, is relatively old, only analyzed 1 year of data, was not specific to orthopaedic surgery, and did not evaluate the combined effect of sociodemographic factors in the use of autologous blood [37]. It is possible that patterns in the use of autologous blood transfusion for orthopaedic surgery may have changed since 1996. An understanding of sociodemographic patterns of use of autologous blood transfusion may aid in developing initiatives to improve quality of care and reduce healthcare costs.

We therefore sought to determine whether there were (1) racial disparities, (2) insurance-based disparities, or (3) income-based disparities in autologous blood use for major elective orthopaedic surgery. Additionally, we evaluated the combined effect of (4) race and insurance and (5) race and income on autologous blood use and compared ratios of autologous with allogeneic blood use.

Materials and Methods

We performed a retrospective cross-sectional analysis of the NIS for a 4-year period from January 1, 2008, to December 31, 2011. Operated by the Agency for Healthcare Research and Quality, the NIS is the largest all-payer inpatient care database in the United States [17, 25]. Each data set year contains approximately 8 million discharge records from more than 1000 short-term and non-Federal hospitals, which approximate a 20% stratified sample of US community hospitals. The NIS provides weights that allow for statistically valid national estimates [27]. More than 100 clinical and nonclinical data elements, including primary and secondary diagnoses (up to 25) and procedures (up to 15), patient demographic characteristics (eg, age, sex, race, median household income for zip code), expected payment source, length of hospital stay, and discharge status, are encompassed in the NIS. Institutional review board approval was waived for this study because the data in the NIS are publicly available and anonymous.

All patients with an International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) procedure code for primary THA (81.51), primary TKA

(81.54), or elective spinal fusion (81.00–81.08) were identified. As emergency surgical procedures generally do not afford the time necessary for preoperative donation of blood, patients whose source of admission was nonelective were excluded from the analysis. In line with the study by Segal et al. [37], patients were stratified into those who received autologous blood transfusion (preoperative donation of one's own blood; ICD-9-CM 99.02), allogeneic blood transfusion (ICD-9-CM 99.04), or no transfusion. Among an estimated 3,628,879 patients undergoing major elective orthopaedic surgery (THA, TKA, or spinal fusion) for 2008 to 2011, 2.4% received autologous blood transfusion, 12% received allogeneic blood transfusion, and 86% received no transfusion. For THA, autologous and allogeneic transfusion rates were 3.8% and 19%, respectively; for TKA, 2.7% and 13%; and for spinal fusion, 0.82% and 6.9%.

Patient demographic and provider-related characteristics were compared among patients receiving autologous transfusion, allogeneic transfusion, and no transfusion (Table 1). Explanatory variables consisted of age (categorized into the age groups: < 55, 55–74, and ≥ 75 years), sex, comorbidity burden (quantified with the Elixhauser comorbidity score [11, 34]), race/ethnicity (white, black, Hispanic, and other), insurance status (private insurance, public insurance, and no insurance), household income based on postal zip code analysis (USD 1 to USD 38,999, USD 39,000 to USD 62,999, and ≥ USD 63,000), surgical procedure (THA, TKA, and spinal fusion), length of hospitalization, discharge disposition (home, home health care, rehabilitation/skilled nursing facility, hospital transfer, and other), hospital location (urban and rural), and hospital teaching status (nonteaching and teaching). Ratios of autologous to allogeneic blood use were calculated for all explanatory variables.

Transfusion of autologous blood was the primary response variable. Multivariable binary logistic regression analyses were performed to assess the individual effect of race/ethnicity, insurance status, and household income on use of autologous blood transfusion. White race, private insurance, and high income (≥ USD 63,000) were used as the three reference groups against which other races (black, Hispanic, other), other insurance status (public insurance, no insurance), and other income levels (low, medium) were compared. Twenty-four variables were then computed to determine the combined effect of (1) race and insurance and (2) race and income on autologous blood use. The two reference categories used to evaluate such effect were (1) white race and private insurance (“privately insured white patient”) and (2) white race and high income (“white patient with high income”). All regression models were adjusted for known patient- and provider-related confounders. The level of statistical significance was set at *p* less than 0.001 in all analyses.

Table 1. Patient and healthcare system-related characteristics*

Parameter	All patients	Blood transfusion status						Ratio of autologous to allogeneic blood use
		None	p value	Autologous transfusion	p value	Allogeneic transfusion	p value	
Total (%)	100	86		2.4		12		0.20
Sex (%)								
Female	59	57	< 0.001	65	< 0.001	73	< 0.001	0.17
Male	41	43		35		27		0.25
Age group (years) (%)								
< 55	25	27	< 0.001	17	< 0.001	13	< 0.001	0.23
55–74	56	56		64		53		0.23
≥ 75	19	17		20		33		0.11
Elixhauser comorbidity score								
0	18	20	< 0.001	14	< 0.001	8.6	< 0.001	0.32
1	28	29		28		21		0.25
≥ 2	54	51		58		71		0.16
Race/ethnicity								
White	86	86	< 0.001	88	< 0.001	82	< 0.001	0.21
Black	7.4	7.0		6.4		10		0.12
Hispanic	3.7	3.7		2.4		4.1		0.11
Other	3.4	3.3		2.9		4.1		0.14
Insurance status (%)								
Private insurance	48	51	< 0.001	48	< 0.001	32	< 0.001	0.28
Public insurance	51	49		52		67		0.15
Uninsured	0.70	0.70		0.30		0.60		0.11
Median household income (%)								
USD 1 to USD 38,999	22	22	< 0.001	15	< 0.001	24	< 0.001	0.12
USD 39,000 to USD 62,999	53	53		49		51		0.19
≥ USD 63,000	25	25		36		26		0.27
Procedure								
TKA	49	48	< 0.001	55	< 0.001	50	< 0.001	0.21
THA	21	20		35		33		0.20
Spinal fusion	30	32		10		17		0.12
Hospital teaching status								
Nonteaching	54	54	< 0.001	53	< 0.001	54	0.27	0.19
Teaching	46	46		47		46		0.20
Hospital location								
Urban	91	91	< 0.001	91	< 0.001	10	< 0.001	0.17
Rural	8.9	8.7		8.6		90		0.19
Length of stay (days) (%)								
≤ 2	27	31	< 0.001	13	< 0.001	5.0	< 0.001	0.50
3 or 4	61	59		75		67		0.21
≥ 5	12	10		12		29		0.081
Discharge disposition (%)								
Home	39	42	< 0.001	20	< 0.001	19	< 0.001	0.20
Home health care	34	34		40		30		0.25
Rehabilitation or skilled nursing facility	27	23		38		50		0.15
Hospital transfer	1.0	1.0		1.0		1.3		0.15
Other	0.10	0.10		0.10		0.30		0.077

* N = 3,628,879.

Table 2. Risk-adjusted odds ratio of use of autologous blood transfusion

Parameter	Use of autologous blood transfusion		
	THA OR (95% CI)	TKA OR (95% CI)	Spinal fusion OR (95% CI)
Race (reference: white)			
Black	0.78 (0.74–0.83)	0.97 (0.93–1.0)	1.1 (1.0–1.2)
Hispanic	0.75 (0.69–0.82)	0.71 (0.67–0.75)	0.87 (0.78–1.0)
Other	0.90 (0.84–0.97)	0.81 (0.77–0.86)	0.81 (0.72–1.0)
Insurance status (reference: private insurance)			
Public insurance	0.83 (0.81–0.85)	0.91 (0.89–0.93)	0.83 (0.79–0.87)
No insurance	0.66 (0.55–0.78)	0.50 (0.41–0.61)	0.74 (0.57–0.96)
Household income (reference: $\geq$ USD 63,000)			
USD 1 to USD 38,999	0.44 (0.42–0.46)	0.55 (0.54–0.57)	0.53 (0.50–0.56)
USD 39,000 to USD 62,999	0.63 (0.61–0.64)	0.69 (0.67–0.70)	0.68 (0.65–0.72)
Insurance status + race (reference: privately insured white patient)			
Private insurance + black	0.83 (0.77–0.89)	1.0 (0.98–1.1)	1.1 (1.0–1.3)
Private insurance + Hispanic	0.81 (0.72–0.92)	0.82 (0.75–0.89)	0.90 (0.78–1.03)
Private insurance + other	0.88 (0.79–1.0)	0.95 (0.88–1.0)	1.0 (0.88–1.2)
Public insurance + white	0.83 (0.81–0.86)	0.93 (0.91–0.95)	0.85 (0.81–0.90)
Public insurance + black	0.62 (0.57–0.67)	0.85 (0.81–0.90)	0.95 (0.84–1.1)
Public insurance + Hispanic	0.57 (0.49–0.65)	0.59 (0.55–0.64)	0.72 (0.60–0.88)
Public insurance + other	0.78 (0.70–0.87)	0.66 (0.61–0.71)	0.40 (0.31–0.53)
Uninsured + white	0.72 (0.60–0.87)	0.57 (0.46–0.70)	1.0 (0.78–1.3)
Uninsured + black	*	0.16 (0.066–0.41)	*
Uninsured + Hispanic	0.81 (0.43–1.5)	0.25 (0.10–0.60)	*
Uninsured + other	0.37 (0.15–1.0)	0.56 (0.29–1.1)	*
Household income + race (reference: white patient earning $\geq$ USD 63,000)			
USD 1 to USD 38,999 + white	0.43 (0.41–0.45)	0.59 (0.57–0.61)	0.53 (0.49–0.57)
USD 1 to USD 38,999 + black	0.40 (0.36–0.43)	0.49 (0.46–0.52)	0.60 (0.53–0.68)
USD 1 to USD 38,999 + Hispanic	0.27 (0.21–0.33)	0.27 (0.24–0.31)	0.37 (0.30–0.47)
USD 1 to USD 38,999 + other	0.39 (0.32–0.46)	0.36 (0.31–0.41)	0.54 (0.40–0.72)
USD 39,000 to USD 62,999 + white	0.63 (0.61–0.65)	0.69 (0.68–0.71)	0.68 (0.65–0.72)
USD 39,000 to USD 62,999 + black	0.49 (0.46–0.54)	0.73 (0.69–0.78)	0.77 (0.69–0.86)
USD 39,000 to USD 62,999 + Hispanic	0.47 (0.41–0.54)	0.57 (0.52–0.61)	0.65 (0.56–0.76)
USD 39,000 to USD 62,999 + other	0.45 (0.40–0.51)	0.50 (0.46–0.55)	0.50 (0.41–0.61)
USD 63,000 + black	0.60 (0.53–0.68)	0.98 (0.90–1.1)	1.0 (0.89–1.2)
USD 63,000 + Hispanic	0.84 (0.72–1.0)	0.81 (0.73–0.91)	0.90 (0.73–1.1)
USD 63,000 + other	1.1 (1.0–1.3)	1.0 (0.96–1.1)	0.83 (0.68–1.0)

* OR could not be calculated owing to low number of cases; odds ratio adjusted for age, sex, Elixhauser comorbidity score, insurance status, race, household income, length of stay, hospital location, and teaching status; OR = odds ratio.

Results

After controlling for numerous variables including age, sex, comorbidity, insurance status, and income, Hispanics exhibited lower odds of autologous blood use for elective THA (odds ratio [OR], 0.75; 95% CI, 0.69–0.82; $p < 0.001$) and TKA (OR, 0.71; 95% CI, 0.67–0.75; $p < 0.001$) compared with white patients (Table 2). Black patients had lower odds of receiving autologous blood transfusion for

THA (OR, 0.78; 95% CI, 0.74–0.83; $p < 0.001$) but not for TKA. Hispanics and blacks were as likely as whites to receive autologous blood transfusion for elective spine fusion surgery. As a consequence, the ratio of autologous transfusion to allogeneic transfusion was lower in Hispanics (0.11) and blacks (0.12) than in whites (0.21) ($p < 0.001$).

Accounting for potential confounding factors such as age, race, income, and comorbidity burden, there was a

lower likelihood of autologous blood use for all three orthopaedic procedures in uninsured (THA: OR, 0.66; 95% CI, 0.55–0.78; $p < 0.001$; TKA: OR, 0.50; 95% CI, 0.41–0.61; $p < 0.001$; spinal fusion: OR, 0.74; 95% CI, 0.57–0.96; $p < 0.001$) or publicly insured patients (THA: OR, 0.83; 95% CI, 0.81–0.85; $p < 0.001$; TKA: OR, 0.91; 95% CI, 0.89–0.93; $p < 0.001$; spinal fusion: OR, 0.83; 95% CI, 0.79–0.87; $p < 0.001$) compared with privately insured patients (Table 2). Similar to the results for race, the ratio of autologous transfusion to allogeneic transfusion was higher in privately insured patients (0.28) than in publicly insured (0.15) or uninsured (0.11) patients ($p < 0.001$).

After adjusting for patient and hospital characteristics, low or medium household income was independently associated with decreased odds of autologous blood use for THA (low income: OR, 0.44; 95% CI, 0.42–0.46; $p < 0.001$; medium income: OR, 0.63; 95% CI, 0.61–0.64; $p < 0.001$), TKA (low income: OR, 0.55; 95% CI, 0.54–0.57; $p < 0.001$; medium income: OR, 0.69; 95% CI, 0.67–0.70; $p < 0.001$), and spinal fusion (low income: OR, 0.53; 95% CI, 0.50–0.56; $p < 0.001$; medium income: OR, 0.68; 95% CI, 0.65–0.72; $p < 0.001$) (Table 2). Patients with low income received approximately one autologous blood transfusion for every 10 allogeneic blood transfusions (ratio = 0.12). The ratio was higher in patients with medium and high income (0.19 and 0.27, respectively) ($p < 0.001$).

Even when insured at levels comparable to white patients, Hispanics and blacks tended to be less likely to receive autologous blood transfusion for THA and TKA. Such differences were not so apparent for spine fusion surgery (Table 2).

When examining the combined effect of race and income, we found that Hispanics and blacks, regardless of income level, tended to experience lower odds of autologous blood use for all three orthopaedic procedures (Table 2).

Discussion

Blood transfusions are often medically necessary. Allogeneic transfusions have been associated with immune modulation and postoperative infection, and autologous transfusions may be a safer alternative [14, 21, 44]. A 1996 NIS analysis suggested sociodemographic disparities in the use of autologous blood transfusion, but more recent data are lacking [37]. An understanding of current practice patterns for autologous transfusion in elective orthopaedic surgery can stimulate further investigation and can alert hospitals to the importance of considering all segments of the population when recommending preoperative

autologous blood donation. We therefore sought to evaluate the individual and combined effects of race, insurance status, and income on autologous blood use for elective THA, TKA, and spinal fusion.

The results of our study should be interpreted in light of several limitations, most of which are inherent to the analysis of large administrative databases [22, 26]. First, the NIS database is based on billing data from ICD-9-CM codes. Given the large weighted sample size, we cannot ignore the possibility of misclassification of the codes used in this study; nonetheless, coding mistakes have been reported to be acceptably low and tend to be equally distributed among groups subject to analysis in large-scale studies [28, 40]. Second, race/ethnicity classification in administrative databases is thought to be only moderately accurate with greater precision for blacks than for other races [37]. Since misclassification should be nondifferential regarding autologous transfusion (ie, the tendency to misclassify a patient is independent of the likelihood that the patient will receive a transfusion), the true ORs for race may be even greater than we observed [5]. The NIS has been used regularly for racial disparity research across different medical specialties, and the coding for race is more accurate than in other commonly used databases such as the American College of Surgeons National Surgical Quality Improvement Program [8, 31, 42, 43]. Third, the NIS does not include important data regarding how much volume of autologous blood was collected and wasted, and how many units of blood were transfused. Fourth, we lacked data on religion and were unable to assess patient preferences, which might have influenced decisions regarding preoperative donation of blood; differences might vary by race [35]. Fifth, this study only studied association and does not establish causality. Finally, it is important to consider that findings in large-scale studies can be statistically significant yet clinically insignificant. For instance, albeit both statistically significant, the decreased likelihood of patients with low income receiving autologous transfusion for THA (OR, 0.44, 95% CI, 0.42–0.46) appears to be more clinically meaningful than the decreased likelihood of publicly insured patients receiving autologous transfusion for TKA (OR, 0.91, 95% CI, 0.89–0.93).

Our results seem to reflect a substantial underrepresentation of Hispanics and blacks among patients receiving autologous blood transfusion for elective orthopaedic surgery, particularly THA and TKA. Analogously, Segal et al. [37] reported that minority patients were less likely to receive autologous blood transfusion than whites in their retrospective analysis of data from 1996. We cannot say whether the observed dissimilarities in the use of this procedure are to the benefit or harm of the patient. Reasons for the differential use of autologous transfusion services

among historically disadvantaged populations remain largely unexplored and warrant further research. Preoperative processing of blood for potential autologous transfusion is a discretionary procedure, and its use is largely influenced by patient-physician communication and patient awareness of this practice [23, 37]. We do not know if different sociodemographic groups have different preferences regarding autologous blood transfusion. Factors such as language barriers between patients and healthcare providers and low levels of health literacy could account for some of the observed variability in autologous transfusion use among racial minorities [1]. Moreover, it has been shown that minority patients are more likely to be distrustful of their healthcare providers and thus to decline recommended care [24, 39]. From the physician's perspective, preconceived notions regarding minorities and inadequate cultural competency might contribute to the unequal use of autologous transfusion services. Widespread adoption of a simple decision aid for preoperative self-donation of blood might help unaware patients and people with different educational backgrounds become knowledgeable of the procedure and its associated risks and ultimately may improve shared decision-making and treatment satisfaction scores [29].

Compared with privately insured patients, those with public insurance or without insurance coverage were less likely to receive autologous blood transfusion for elective TKA, THA, and spinal fusion. Our findings are consistent with the analysis by Segal et al. [37] of 1996 NIS data and with a more recent trend analysis by Yoshihara and Yoneoka [45] in patients undergoing spinal fusion. It remains uncertain whether the observed differential use of autologous transfusion is the result of limited access to this procedure or clinical characteristics impairing the ability to donate. However, our analysis adjusted for important clinical variables, so it is likely that there is some differential recommendation of this procedure on nonmedical grounds.

Rates of autologous blood use for elective orthopaedic surgery also differed on the basis of socioeconomic status. Patients with lower income levels were less likely to receive autologous blood transfusion. These findings, consistent with prior research [37], are not surprising given that transfusion of preoperatively self-donated blood is expensive and patients with high income may be more willing to pay for this medical practice [10]. Moreover, it is likely that patients with higher incomes have increased levels of health literacy and thus are more aware of the existence of this procedure. The use of autologous blood transfusion for elective orthopaedic surgery is decreasing, despite an overall upward trend in transfusion rates driven by an increase in allogeneic transfusions [7, 45]. The decrease in this practice may be attributable to growing concerns regarding its cost-effectiveness and utility in

patients without anemia [4, 6, 18, 20], the possibility of iatrogenic anemia leading to increased overall transfusion rates [9, 12, 19], and some reports suggesting no differences regarding postoperative mortality and infection compared with allogeneic transfusions [9, 30]. It therefore is possible that patients of higher socioeconomic status are asking for preoperative donation of blood to their own detriment, and, paradoxically, disadvantaged populations may not be receiving substandard care.

It is known that racial and ethnic minorities are less likely to be insured than whites, in part because their incomes are lower on average [33, 38]. We found that even when insured at levels comparable to whites, Hispanic and black patients tended to be less likely to receive autologous blood transfusion for THA and TKA. In multivariable analysis, we also determined the combined effect of race and economic status and found that racial minorities, regardless of income level, tended to experience lower odds of autologous blood use for THA, TKA, and spinal fusion. These findings underscore the need to promote research on racial disparities, because it seems that there are important factors beyond insurance status and income that are unaccounted for in access to health care among these populations.

As evidenced by the low ratio of autologous transfusion to allogeneic transfusion, minority segments of the population received autologous blood less often, and allogeneic blood more often, than white wealthy patients. It remains unclear whether these patients chose not to donate their own blood before surgery or if they were unaware of this option. Future studies on patient preference for autologous versus allogeneic blood transfusion stratified by race, income, and insurance status would be of value.

Historically disadvantaged populations receive fewer autologous blood transfusions for elective orthopaedic surgery. Numerous factors including patient preferences, access to care, and health literacy have been suggested to contribute to differential use of services across patient groups [3, 13]. Additional research is needed to understand the optimal use of this procedure, to interpret and account for patient preferences, and to eliminate undesirable sociodemographic disparities in the use of autologous blood for orthopaedic surgery.

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