Published in final edited form as:

J Am Geriatr Soc. 2016 December ; 64(12): 2593–2598. doi:10.1111/jgs.14367.

Reducing Hospital Readmission Disparities of Older Black and White Adults After Elective Joint Replacement: The Role of Nurse Staffing

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Abstract

OBJECTIVES—To examine racial differences in readmissions of older adults undergoing elective total hip and knee replacement, to determine the relationship between nurse staffing and readmission, and to study whether the relationship between staffing and readmission differs for older black and white adults.

DESIGN—Cross-sectional analysis of multiple linked secondary data sources.

SETTING—Nonfederal acute care hospitals in California, Florida, New Jersey, and Pennsylvania (n = 483).

PARTICIPANTS—Patients aged 65 and older undergoing elective total hip or total knee replacement (N = 106,848; n = 102,762 white, n = 4,086 black).

MEASUREMENTS—Unplanned readmission within 30 days of discharge.

RESULTS—Older black patients were more likely to have an unplanned readmission (7.5%) than their white counterparts (5.6%). Even after adjusting for patient- and hospital-level factors, older black patients had 40% greater likelihood of readmission (odds ratio (OR) = 1.40, 95% confidence interval (CI) = 1.21–1.61). Each additional patient per nurse was associated with 8% greater odds of readmission for older white patients (OR = 1.08, 95% CI = 1.01–1.15) and 15% greater odds for older black patients (OR = 1.15, 95% CI = 1.08–1.22) after adjusting for patient- and hospital-level factors.

CONCLUSION—Older minorities are more likely than their white counterparts to experience an unplanned readmission after elective orthopedic surgery. More-favorable nurse staffing was associated with lower odds of readmission of older black and white patients, but better-staffed hospitals had a greater protective effect for older black patients.

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Conflict of Interest: The editor in chief has reviewed the conflict of interest checklist provided by the authors and has determined that the authors have no financial or any other kind of personal conflicts with this paper.

Author Contributions: McHugh: acquisition of data, development of study concept, drafting and revising the manuscript. Lasater: analysis and interpretation of data, drafting and revising the manuscript. Both authors are accountable for all aspects of the work and gave final approval of the manuscript submission.

Keywords

readmission; disparity; nursing; joint replacement

Although the number of racial minorities undergoing elective hip and knee replacement has swelled in recent years, minorities bear a disproportionate burden of postoperative complications, including greater risk of post-surgical readmission.^{1–7} Recent evidence points to associations between readmission and hospital nurse staffing, yet less is known about the effect of staffing and readmissions in minority populations.^{8–10} This study examined associations between hospital nurse staffing and readmissions of older black and white patients undergoing elective total hip and knee replacement.

Racial disparities in readmission outcomes can be attributed to individual factors, including socioeconomic status and acuity,^{2,3,5–7} as well as factors associated with the hospitals where minorities are likely to receive care.^{3,5} Growing evidence suggests that the quality of nursing care received during the perioperative period is important to ensuring successful recovery without unnecessary rehospitalization. In medical and surgical populations, more-favorable nurse-to-patient staffing ratios are associated with lower odds of readmission.^{8–10} Missed nursing care—essential care that is not performed because of lack of staffing, time, and resources—has also been linked to readmissions in individuals with heart failure.¹¹ After surgery, inadequate staffing has been linked to greater risk of mortality in older black adults.¹² This evidence suggests that aspects of hospital nursing care, particularly nurse staffing levels, may have a protective effect against negative health outcomes in racial minorities.

The benefits of hospital nursing care may be evident even in older adults undergoing elective orthopedic surgery, who—by virtue of undergoing a major elective operation—are less likely to be frail and clinically complex.¹³ Even for the healthiest individuals, postoperative care requires intensive around-the-clock nursing care, including continuous surveillance for complications, early ambulation, medication and treatment administration (e.g., wound care, pain management), and ongoing discharge planning and education about self-care after major surgery. Yet unmanageable workloads compromise nurses' capacity to deliver care, resulting in necessary nursing care being delayed or omitted.^{14–16} The effects of compromised hospital nursing care may be more deleterious to particularly vulnerable populations, who may lack the means to mobilize resources after discharge, potentially as a result of low socioeconomic status, lack of access to primary or specialist care providers, and limited English proficiency. Although readmissions are a function of various circumstances, this study examined how hospital nurse staffing levels are related to postsurgical readmissions of older racial minorities after elective joint replacement.

This study built on prior readmission and disparities literature to examine how nurse staffing levels influence readmission outcomes of older black and white patients undergoing elective total hip and knee replacement. The objectives of this study were threefold: to examine racial differences in 30-day unplanned readmission of older adults undergoing elective total hip and knee replacement; to determine the relationship between nurse staffing and readmission; to study whether the relationship between nurse staffing and readmission

differs for older black and white individuals (i.e., is moderated by race). It was hypothesized that more-favorable nurse staffing would have a more marked effect on the odds of readmission for older black patients than older white patients.

METHODS

Design and Data Sources

This cross-sectional analysis used multiple linked data sources from 2006, including the Multi-State Nursing Care and Patient Safety Survey of registered nurses in four states (California, Florida, New Jersey, Pennsylvania), the American Hospital Association (AHA) Annual Survey of hospital organizational characteristics, and the Medicare Provider Analysis and Review (MedPAR) dataset of hospitalizations. U.S. Census data from 2000 were used to derive a proxy measure of socioeconomic status.

Study Population

The sample included 106,848 older black and white adults who underwent elective total hip or knee replacement in a nonfederal acute care hospital in one of the four study states. The criteria that the Centers for Medicare and Medicaid Services (CMS) use to calculate hospital readmission penalties, which are described in detail in the CMS readmission measure technical reports,¹³ guided participant inclusion and exclusion decisions. Generally, study participants were aged 65 and older, enrolled in fee-for-service Medicare, had an elective total hip or knee replacement, and were discharged alive. Patients were excluded from the study if they left the hospital against medical advice, were transferred to another hospital, or had more than two procedures during the index admission.¹³ Small numbers of some racial and ethnic minority groups prohibited analysis that was inclusive of the full range of racial and ethnic populations. Therefore, the analysis was restricted to individuals who were white or black based on their Medicare enrollment data.

Hospitals in this study were adult nonfederal acute care facilities with at least 10 live total hip or knee replacement discharges during the study period. Hospitals included in this study also had at least 10 direct care registered nurses who responded to the nurse survey. Prior work empirically confirms that 10 nurse respondents provides reliable estimates of hospital organizational features, including staffing.¹⁷ This study included 22,664 direct care registered nurse survey respondents who were working in 483 hospitals. The average number of nurse respondents per hospital was 66 (range 10–282).

Variables and Measures

The outcome of interest was unplanned readmission within 30 days of discharge. The algorithm that CMS uses to distinguish planned and unplanned readmissions was followed as described in the CMS readmission measure technical report.¹³ Distinguishing unplanned readmissions was particularly important for this surgical population because many people are discharged from the hospital and readmitted on the same day for inpatient rehabilitation. Admission to inpatient rehabilitation, for example, is considered a planned readmission and is therefore not indicative of an unfavorable outcome.¹³

Race was the independent variable of interest to examine the effect of race on the odds of readmission. Nurse staffing was the independent variable of interest to examine the effect of an additional patient in the average nurse's workload on the odds of readmission. The staffing variable was derived from the nurse survey by dividing the number of patients by the number of nurses a nurse reported were on his or her unit during his or her last shift. The responses were then aggregated to create a hospital-level measure of nurse staffing. Nurse staffing was reported categorically for descriptive purposes and then modeled as a continuous variable.

Covariates were included in the regression analysis to adjust for differences between participants and hospitals. Participant covariates included those adjusted for in the CMS readmission measure and included age, sex, type of procedure (hip or knee), number of procedures (1 or 2), and comorbidities.¹³ Additional participant covariates included in a sensitivity analysis were proxy socioeconomic status and length of stay. A proxy measure of socioeconomic status was derived from 2000 U.S. Census data that reports a neighborhood socioeconomic summary index score for each ZIP code.¹⁸ Participant ZIP codes from the MedPAR data were linked with Census data to provide an estimate of each participant's socioeconomic status. This approach has been previously used in the literature on disparities and readmission.^{11,12}

Hospital covariates were derived from the AHA Annual Survey database and included size, teaching status, and technology status.⁹ Hospital size was categorized as small (< 100 beds), medium (101–250 beds), and large (>250 beds). Teaching status was defined as the ratio of medical residents or fellows to hospital beds and categorized as nonteaching (no medical residents or fellows), minor teaching (< 1:4), and major teaching (>1:4). A hospital with high technology status was defined as a facility that had the capacity to perform open-heart surgery or major organ transplantation. Additional hospital-level covariates included in the sensitivity analysis were hospital volume of total hip and knee replacements and operating margin. Hospital operating margin was defined as the ratio of total hospital direct care revenues to total hospital operating expenses multiplied by 100.⁹

Statistical Analysis

First, the characteristics of participants and hospitals in the sample were determined. Analysis of variance and chi-square tests allowed how participants differed, in terms of their demographic and health characteristics and the places where they sought care to be examined according to race. Next, the influence of race on the odds of 30-day unplanned readmission was examined. Logistic regression models were used to estimate the unadjusted effects and then the effects adjusted for participant and hospital characteristics. Another set of logistic regression models were used to estimate the effect of an additional patient per nurse in the average nurse's workload on readmission. An interaction between staffing and race was used to examine whether the relationship between nurse staffing and readmission differed for older black and white participants. Finally, sensitivity analyses were performed to determine the robustness of the findings once additional potential confounders were accounted for. All of the regression models accounted for the clustering of participants within hospitals by including robust standard errors.¹⁹ An $\alpha < .05$ for a two-tailed test was

set a priori as a threshold for establishing statistical significance. Analyses were performed using Stata version 12.0 (Stata Corp., College Station, TX).

RESULTS

More than 95% of the 106,848 participants were white, and fewer than 4% were black (Table 1). Older black participants were significantly more likely to have an unplanned readmission within 30 days, at a rate of 7.5 per 100 black participants, versus 5.6 per 100 white participants. Older black participants were significantly younger, more likely to be female, and more likely to live in lower socioeconomic status areas. Older black participants were also more likely to have longer stays than older white participants. In all participants, common reasons for readmission included needing a packed cell transfusion and experiencing a postoperative infection. Older black participants were more likely to experience a complication of the joint prosthesis, undergo arthrocentesis, and report chest pain. Older white participants were more likely to experience atrial fibrillation and osteoarthritis and undergo venous catheterization (Table 2).

The majority of hospitals in the sample were large, urban, nonprofit, nonteaching hospitals (Table 3). Older black participants were also generally more likely to receive care in these environments and were generally more likely to be in better-staffed hospitals than their white counterparts. Hospital nurse staffing ranged from 2.9 to 9.8 patients per nurse, with an average of 5 patients per nurse.

Older black participants were significantly more likely to be readmitted within 30 days (Table 4). After adjusting for participant and hospital characteristics, older black participants were 40% more likely to have an unplanned readmission than their white counterparts (OR = 1.40, 95% CI = 1.21–1.61). The sensitivity analysis, which included additional participant (proxy socioeconomic status, length of stay) and hospital covariates (volume of procedures, operating margin), explained some of the variation in readmission outcomes, but older black participants were still 30% more likely to be readmitted (OR = 1.30, 95% CI = 1.13–1.50).

Nurse staffing was significantly associated with readmissions in all participants (Table 4). After adjusting for participant and hospital characteristics, each additional patient per nurse was associated with 8% higher odds of readmission (OR = 1.08, 95% CI = 1.02–1.15). Race moderated the effect of staffing such that older black participants had 15% higher odds of readmission (OR = 1.15, 95% CI = 1.08–1.22) with each additional patient per nurse, whereas their older white counterparts had 8% higher odds of readmission (OR = 1.08, 95% CI = 1.01–1.15) with each additional patient per nurse. The sensitivity analyses did not meaningfully influence these findings.

DISCUSSION

This analysis of Medicare beneficiaries undergoing elective total hip and knee replacement aimed to determine whether nurse staffing was associated with 30-day unplanned readmission and whether this relationship differed for older black and white participants. The study found significant racial disparities in postoperative readmissions of older black participants who underwent elective joint replacement, even after adjusting for participant

and hospital characteristics. The principal finding—older black participants were more likely to be readmitted when cared for in hospitals with higher nursing workloads—provides evidence that more-favorable nurse staffing ratios may have a protective effect against readmissions in older minority populations.

All hospitalized older adults are vulnerable to the profound negative consequences of hospitalization.²⁰ Even relatively healthy older adults undergoing elective procedures are at risk of serious complications of hospitalization, such as physical deconditioning, which is associated with prolonged recovery and greater probability of rehospitalization.^{20–22} This study and others identify hospital nursing care as an essential requirement for every hospitalized older adult, with particular importance for racial minorities.¹²

Many of the interventions recommended for postsurgical care require sufficient numbers of nurses to provide them in a timely and effective manner. After major orthopedic surgery, even the healthiest individuals require extensive nursing care, including continuous monitoring for early warning signs of complications (e.g., postoperative delirium), administration of medications and treatments (e.g., pain management, wound management), ambulation within 48 hours of surgery, and attention to other physiological and psychosocial cues (e.g., patient and caregiver coping, assessment of cognitive and functional status, need for home health or rehabilitation at discharge).

Older black participants had more comorbidities and were more likely to live in a lower socioeconomic status area than older white participants. Together, these findings suggest that older black patients may be more clinically complex, requiring more-vigilant surveillance for complications that might increase the odds of readmission. For example, two common reasons for readmission of participants were postoperative infection and hemorrhage. These complications often progress slowly over time and have subtle early warning signs. When nurses have unmanageable workloads, the vigilant surveillance required to identify and intervene in progressing complications may be compromised.

Older black participants were more often cared for in hospitals with better nurse staffing ratios, and although this was protective, they were still more likely than whites to be readmitted. Other studies have found that older black adults are more likely to experience postsurgical mortality and failure to rescue when cared for by nurses with higher workloads.¹² The current study findings suggest that attention to nursing workloads may be a strategy for reducing postoperative readmissions of older adults undergoing orthopedic surgery. With a growing number of minorities undergoing elective procedures, it is increasingly important to understand the mechanisms by which older minorities are at higher risk for readmission in addition to their clinical complexity. These findings shed light on how the nursing care received in the hospital may contribute to readmission, particularly in vulnerable populations. Investing in better nurse-to-patient staffing ratios may yield more-pronounced reductions in readmissions in minority populations with the greatest risk of readmission.

The Hospital Readmission Reduction Program—a section of the Affordable Care Act responsible for financially penalizing hospitals with worse-than-expected readmission rates

—has catalyzed efforts to reduce readmissions.²³ Beginning in 2015, elective total hip and knee replacement became the first surgical conditions on the growing list of conditions at risk for the readmission penalty. Although the Hospital Readmission Reduction Program was begun in 2012, there is little evidence to suggest an effect on reducing readmissions. In general, researchers find the Affordable Care Act pay-for-performance initiatives have had little effect on outcomes over time.²⁴ It is likely that the current reimbursement penalties are too small to provide incentives for meaningful changes in the organization of healthcare delivery in hospitals.²⁵ Many of the hospital efforts to reduce readmissions that have emerged in response to the reimbursement initiatives depend on having adequate numbers of nurses to provide care. The variation in staffing demonstrated in the current study may be what is underlying why some interventions are successful in randomized control trials but yield mixed results when implemented under real-world conditions.²⁶

Pay-for-performance programs are more likely to penalize safety-net hospitals, which serve a disproportionate share of low-income and underserved individuals and tend to demonstrate smaller incremental improvements overtime.²⁷ The current study findings identify older racial minorities as a vulnerable population at particular risk of readmission after elective joint replacement. Attention to nurses' workloads is important for improving health outcomes of hospitalized individuals and may be a strategy for reducing readmissions and avoiding penalties under the Hospital Readmission Reduction Program. The current study findings suggest that investing in nurse staffing may reduce postsurgical readmissions, particularly of older minorities.

Limitations

These findings are limited to association because of the cross-sectional study design, and causal relationships between nurse staffing and readmission can only be inferred. Although the four states in the study represent more than 25% of all elective hip and knee replacements nationally,²⁸ regions with larger proportions of black individuals such as the South are not represented. An imperfect measure of socioeconomic status that is collected only every 10 years and aggregated to the ZIP code was used. Finally, the study is one of hospitals' organizational decisions related to nurse staffing. Given that nurse staffing decisions are set at the hospital level, and evidence suggests that staffing has greater variation between than within hospitals,²⁹ a hospital-level measure of nurse staffing was used. Future research would ideally include unit- and hospital-level staffing and data indicating which units within hospitals cared for participants.

CONCLUSIONS

Older black adults who undergo elective hip or knee replacement are more likely to experience a 30-day unplanned readmission than their white counterparts. For all older adults, being cared for by a nurse with a heavier workload is associated with greater odds of readmission, although the deleterious effects of less-favorable staffing is more pronounced for older black adults. Efforts to reduce unplanned readmissions after elective joint replacement should include heightened attention to the role of nursing care, particularly for older minority populations.

ACKNOWLEDGMENTS

This study was supported by grants from the National Institute of Nursing Research (R01-NR04513, T32-NR0714, L. Aiken, principal investigator) and the National Institute on Aging (R01-AG041099-01, M. McHugh, principal investigator) and from the Robert Wood Johnson Foundation Nurse Faculty Scholars Program (M. McHugh, principal investigator).

Sponsor's Role: None.

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Table 1

Participant Characteristics According to Race (N = 106,848)

Characteristic	White, n = 102,762	Black, n = 4,086	P-Value
Number of unplanned readmissions <30 days after discharge	5,732 (5.6)	305 (7.5)	<.001
Age, mean $\pm$ SD	75.6 $\pm$ 5.9	73.7 $\pm$ 5.7	<.001
Sex, n (%)			
Male	38,269 (37.2)	1,055 (25.8)	<.001
Female	64,493 (62.8)	3,031 (74.2)	
Proxy socioeconomic status, n (%)			
Low	23,455 (23.8)	2,119 (54.7)	<.001
Average	49,932 (50.6)	1,338 (34.5)	<.001
High	25,233 (25.6)	418 (10.8)	<.001
Type of procedure, n (%)			
Hip	31,100 (30.3)	1,091 (26.7)	<.001
Knee	71,662 (69.7)	2,995 (73.3)	
Number of procedures, n (%)			
1	97,777 (95.2)	3,899 (95.4)	.42
2	4,985 (4.9)	187 (4.6)	
Number of comorbidities, mean $\pm$ SD	1.8 $\pm$ 1.3	2.0 $\pm$ 1.2	<.001
Length of stay, days, mean $\pm$ SD	3.7 $\pm$ 1.9	4.2 $\pm$ 2.5	<.001

SD = standard deviation.

Table 2**Reasons for 30-Day Unplanned Readmission**

Reason for Readmission	n (%)
White participants	
Postoperative infection	325 (5.7)
Packed cell transfusion	310 (5.4)
Atrial fibrillation	231 (4.0)
Osteoarthritis	231 (4.0)
Venous catheterization	180 (3.1)
Black participants	
Packed cell transfusion	26 (8.5)
Complication due to joint prosthesis	15 (4.9)
Postoperative infection	14 (4.6)
Arthrocentesis	13 (4.3)
Chest pain	10 (—) ^a

Percentages may not sum to 100% because of rounding.

^aBecause of Centers for Medicare and Medicaid Services cell size suppression policy, numbers of 10 or less are not displayed.

Table 3

Hospital and Participant Sample According to Hospital Characteristics

Hospital Characteristic	Hospital, n = 483	n (%)		P-Value
		White, n = 102,762	Black, n = 4,086	
Geographic location				
Urban	432 (89.4)	95,212 (92.7)	3,991 (97.7)	<.001
Rural	51 (10.6)	7,550 (7.4)	95 (2.3)	
Ownership type				
For profit	91 (18.8)	17,235 (16.7)	697 (17.1)	.63
Nonprofit	354 (73.3)	78,732 (76.6)	3,162 (77.4)	.25
Government, nonfederal	38 (7.9)	6,795 (6.6)	227 (5.6)	.008
High technology	235 (48.7)	66,549 (64.8)	2,857 (69.9)	<.001
Hospital size				
Small	47 (9.7)	5,024 (4.8)	88 (2.1)	<.001
Medium	217 (44.9)	32,824 (31.9)	1,166 (28.5)	<.001
Large	219 (45.3)	64,914 (63.2)	2,832 (69.3)	<.001
Teaching status				
Nonteaching	256 (53.0)	53,684 (52.2)	1,531 (37.5)	<.001
Minor	197 (40.8)	41,299 (40.2)	1,935 (47.4)	<.001
Major	30 (6.2)	7,779 (7.6)	620 (15.2)	<.001
Ratio of number of patients to number of registered nurses				
<4.0	69 (14.3)	12,981 (12.6)	446 (10.9)	<.001
4.0–4.9	178 (36.9)	43,442 (42.3)	1,816 (44.4)	
5.0–5.9	160 (33.1)	35,522 (34.6)	1,555 (38.1)	
6.0–6.9	52 (10.8)	8,185 (8.0)	203 (5.0)	
7.0	24 (5.0)	2,632 (2.6)	66 (1.6)	

Percentages may not sum to 100% because of rounding.

Table 4

Effects of Race and Nurse Staffing on 30-Day Unplanned Readmissions

Odds of 30-Day Unplanned Readmissions	Odds Ratio (95% Confidence Interval)			
	Unadjusted	Adjusted for Hospital and Participant Characteristics	Staffing and Race Interaction	
			Black	White
Black	1.37 (1.19–1.57) ^c	1.40 (1.21–1.61) ^c	—	—
Staffing	1.10 (1.03–1.17) ^b	1.08 (1.02–1.15) ^a	1.15 (1.08–1.22) ^c	1.08 (1.01–1.15) ^a
Sensitivity analysis ^d				
Black	1.35 (1.17–1.55) ^c	1.30 (1.13–1.50) ^c	—	—
Staffing	1.10 (1.04–1.17) ^b	1.09 (1.03–1.16) ^b	1.14 (1.07–1.22) ^c	1.09 (1.03–1.16) ^b

Participant characteristics: age, sex, comorbidities, type of surgery, number of procedures.

Hospital characteristics: size, teaching status, technology status, nurse staffing.

All of the models account for clustering of participants within hospitals. This analysis included 106,848 participants in 483 hospitals.

^a $P < .05$ ^b $P < .01$ ^c $P < .001$.^d Sensitivity analysis covariates: proxy socioeconomic status, length of stay, hospital volume of hip and knee procedures, hospital operating margin.