Arthroplasty Today 3 (2017) 187–191

Contents lists available at ScienceDirect

Arthroplasty Today

journal homepage: http://www.arthroplastytoday.org/

Original research

Post-acute care disparities in total joint arthroplasty

Roy H. Lan [a], Atul F. Kamath, MD [b, *]

[a] College of Arts and Sciences, Wharton School, University of Pennsylvania, Philadelphia, PA, USA
[b] Department of Orthopaedic Surgery, Hospital of the University of Pennsylvania, Philadelphia, PA, USA

ARTICLE INFO

Article history:
Received 5 December 2016
Received in revised form
16 January 2017
Accepted 3 February 2017
Available online 6 March 2017

Keywords:
Socioeconomic status
Hospital length of stay
Post-acute care
Rehabilitation
Total joint arthroplasty
Hospital costs

ABSTRACT

Background: Understanding the socioeconomic factors that influence hospitalization and post-discharge metrics after joint replacement is important for identifying key areas of improvement in the delivery of orthopaedic care.
Methods: An institutional administrative data set of 2869 patients from an academic arthroplasty referral center was analyzed to quantify the relationship between socioeconomic factors and post-acute rehabilitation care received, length of stay, and cost of care. The study used International Classification of Disease, ninth edition coding in order to identify cohorts of patients who received joint arthroplasty of the knee and hip between January 2007 and May 2015.
Results: The study found that females (odds ratio [OR], 2.07; 95% confidence interval [CI], 1.74-2.46), minorities (OR, 2.11; 95% CI, 1.78-2.51), and non-private insurance holders (OR, 1.56; 95% CI, 1.26-1.94) were more likely to be assigned to institutional care after discharge. The study also found that minorities (OR, 1.45; 95% CI, 1.24-1.70) and non-private insurance holders (OR, 1.43; 95% CI, 1.16-1.77) are more likely to exhibit longer length of stay. Mean charges were higher for males when compared to females ($80,010 vs $74,855; $P < .001$), as well as total costs ($19,910 vs $18,613; $P = .001$).
Conclusions: Socioeconomic factors such as gender, race, and insurance status should be further explored with respect to healthcare policies seeking to influence quality of care and health outcomes.

Introduction

Primary and revision knee and hip arthroplasty are experiencing increases in procedural volume across the United States [1-3]. To counter the increase in joint arthroplasty procedures, governmental mandates have focused on cost-saving initiatives, including alternate payment models [4] and the recent implementation of the Comprehensive Care for Joint Replacement model. The Patient Protection and Affordable Care Act has placed an increased focus on quality-driven metrics within US health care, while also attempting to decrease the disparities in healthcare costs and outcomes [5].

The disparities in patient length of stay (LOS), readmission rates, and a variety of other quality metrics have been increasingly studied within the literature [6-11]. In addition, cost analyses of procedures stratified by socioeconomic factors have also been gaining attention [12,13]. In particular, minority patients or any patients with low socioeconomic status have been found to exhibit lower health outcomes [14,15]. However, few studies in the literature focus on the types of post-acute rehabilitation care (PARC) that joint replacement patients receive based on socioeconomic factors, race, or ethnicity [16]. Furthermore, few studies tie together metrics such as LOS and PARC received with financial metrics. Given this context, the present study aimed at determining (1) whether socioeconomic, gender, or race factors impacted PARC; (2) the influence of socioeconomic, gender, and race factors on LOS; and (3) whether socioeconomic, gender, or race factors influenced costs after total joint arthroplasty.

Material and methods

A consecutive series of patients who underwent a hip or knee arthroplasty procedure from 2007 to 2015 were obtained. Study was approved by the institutional review board. Total (99% of cohort) and partial (1%) joint replacement procedures were

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.artd.2017.02.001.

* Corresponding author. 800 Spruce Street, 8th Floor Preston, Philadelphia, PA 19107, USA. Tel.: +1 215 687 8169.
E-mail address: akamath@post.harvard.edu

http://dx.doi.org/10.1016/j.artd.2017.02.001

included. The data set was obtained through a query from our institutional data requisition department. Patients within the study were identified using International Classification of Disease, ninth edition codes 81.51-81.55; all patients exhibiting these codes were included in the study. The study cohort included 2869 patients (termed total cohort). A consecutive subset of patients had complete standardized financial data and were subgrouped into a cost cohort (N = 2612). The 2 study cohorts differ in population number due to missing financial data from 257 patients in the total cohort.

The data sets were then analyzed to determine frequencies, means, and standard deviations for key outcome variables. Univariate and stepwise forward logistic regression analyses were used in order to determine the relationship between our chosen independent variables (gender, race, and insurance) and our dependent variables (institutional care and prolonged LOS). Institutional care was defined as a discharge to a skilled nursing facility (SNF), institutional rehab (IR), or other non-home location. Private insurance was defined as any commercial insurance carrier, whereas managed care plans include Preferred Provider Organizations, Health Maintenance Organizations, and Point-of-Service plans. LOS was generated through hospital admissions data, as is calculated as the difference between time of admission and time of discharge. LOS is calculated in hours but presented in days within the study. The most prevalent zip codes were ranked, and odds ratios were analyzed to see whether they were predictive for an above-average LOS, as zip codes were used as a surrogate for patient residence and median income. Prolonged LOS was defined as longer than the median LOS. Odds ratios, along with the associated 95% confidence intervals and P values, were calculated. A P value of <.05 was considered to be statistically significant. In addition, 2-tailed Fisher exact tests were used to determine the statistical significance of a variety of differences between mean LOS, as well as cost and charge data between subgroups. In the study, all non-white patients were classified as minorities.

Results

A total of 2869 patients underwent total and partial hip or knee procedures within the single institutional database. The demographic data associated with the 2 study cohorts, total cohort and cost cohort, are listed in Table 1. The average clinical values, along with their standard deviations, are listed in Table 2. The 2 cohorts exhibited equivocal populations based on demographic and clinical information. The study population was comprised of predominantly 50- to 80-year-old females, split relatively evenly between white and black race. The body mass index values were evenly distributed. SNFs, home health (HH), and IR were the most prominent PARCs, and the mean LOS was 3.6 days. Also, 16.7% of patients had private insurance. The vast majority of patients had illness severity levels and risk mortality levels of 1.

As seen in Table 3, females were discharged more frequently to SNFs than males (56.3% vs 43.0%; $P < .01$), whereas males were discharged more frequently to HH than females (39.4% vs 23.3%; $P < .01$). Additionally, black and Asian patients were discharged more frequently to SNFs, when compared to white patients (60.0%, 59.2% vs 43.0%; $P < .001$). White patients were discharged more frequently to HH than either black or Asian patients (36.4% vs 21.9%, 20.4%; $P < .01$) within our patient population.

The relationship between socioeconomic factors and key outcomes is presented in Table 4. Females were more likely to be assigned to institutional care (odds ratio [OR], 2.07; 95% confidence interval [CI], 1.74-2.46; $P < .001$), as were minorities (OR, 2.11; 95% CI, 1.78-2.51; $P < .001$) and non-private insurance holders (OR, 1.56; 95% CI, 1.26-1.94; $P < .001$). Univariate regression analysis also showed similar correlations for LOS (Table 5): prolonged LOS indicated patients who stayed longer than the median LOS (3.3 days). Minorities were more likely to exhibit longer LOSs (OR, 1.45; 95% CI, 1.24-1.70; $P < .001$), as were non-private insurance holders (OR, 1.43; 95% CI, 1.16-1.77; $P < .001$). However, females did not exhibit a longer LOS (OR, 1.11; 95% CI, 0.94-1.3; $P = .11$). Also, patient zip code was not determined to be a significant predictor of LOS.

Table 6 indicates that there is no significant difference between the mean LOS between males and females. However, black patients

Table 1
Demographic and clinical data by cohort.

Variables	Total cohort, N = 2869 (%)	Cost cohort, N = 2612 (%)
Age (y)		
≤50	441 (15.4)	373 (14.3)
50-60	880 (30.7)	790 (30.2)
60-70	945 (32.9)	876 (33.5)
70-80	471 (16.4)	449 (17.2)
≥80	132 (4.6)	124 (4.7)
Gender		
Male	1037 (36.1)	952 (36.4)
Female	1832 (63.9)	1660 (63.6)
Race/ethnicity		
White	1349 (47.0)	1244 (47.6)
Black	1391 (48.5)	1245 (47.7)
Asian	49 (1.7)	46 (1.8)
Other	80 (2.9)	77 (2.9)
Body mass index (kg/m^2)		
<25	342 (11.9)	309 (11.8)
25-29.9	714 (24.9)	657 (25.2)
30-34.9	712 (24.8)	651 (24.9)
35-39.9	481 (16.8)	435 (16.7)
≥40	620 (21.6)	560 (21.4)
Discharge location		
SNF	1477 (51.5)	1330 (50.9)
HH	835 (29.1)	780 (29.9)
IR	516 (18.0)	464 (17.8)
RD	37 (1.3)	34 (1.3)
OT	4 (0.1)	4 (0.2)
Length of stay		
<3	426 (14.8)	397 (15.2)
3.0-3.99	1969 (68.6)	1800 (69.0)
4.0-4.99	250 (8.7)	214 (8.2)
≥5	224 (7.8)	201 (7.7)
Insurance classification		
Private	—	435 (16.7)
Medicaid	—	507 (19.4)
Medicare	—	650 (24.9)
Managed care	—	525 (20.1)
Managed Medicare	—	438 (16.8)
Other	—	57 (2.2)
Illness severity level		
1	2317 (80.8)	2123 (81.3)
2	485 (16.9)	430 (16.5)
3	57 (2.0)	51 (2.0)
4	10 (0.3)	8 (0.3)
Risk mortality level		
1	2597 (90.5)	2368 (90.7)
2	238 (8.3)	215 (8.2)
3	18 (0.6)	15 (0.6)
4	16 (0.6)	14 (0.5)

RD, routine discharge; OT, other.

Table 2
Average clinical values and standard deviations (SD).

Variable	Total cohort	Cost cohort
Mean age ± SD	61.0 ± 11.7	61.4 ± 11.7
Mean body mass index ± SD	33.3 ± 8.1	33.2 ± 8.0
Mean length of stay ± SD	3.6 ± 1.5	3.6 ± 1.5
Illness severity level ± SD	1.2 ± 0.5	1.1 ± 0.5
Risk of mortality level ± SD	1.1 ± 0.4	1.1 ± 0.5

Table 3
Demographic factors by post-acute rehabilitation care.

Variable	Gender		Race/ethnicity			
	Male, N = 1037 (%)	Female, N = 1832 (%)	White, 1349 (%)	Black, 1391 (%)	Asian, 49 (%)	Other, 80 (%)
SNF	446 (43.0)	1031 (56.3)	580 (43.0)	834 (60.0)	29 (59.2)	34 (42.5)
HH	409 (39.4)	426 (23.3)	491 (36.4)	304 (21.9)	10 (20.4)	30 (37.5)
IR	163 (15.7)	353 (19.3)	250 (18.5)	240 (17.3)	10 (20.4)	16 (20.0)
RD	16 (1.5)	21 (1.1)	28 (2.1)	9 (0.6)	0 (0.0)	0 (0.0)
OT	3 (0.3)	1 (0.05)	0 (0.0)	4 (0.3)	0 (0.0)	0 (0.0)

RD, routine discharge; OT, other.

Table 4
Significant independent socioeconomic predictors for institutional care.

Independent variable	OR	*P* value	95% CI
Female	2.07	<.001	1.74-2.46
Minority	2.11	<.001	1.78-2.51
Non-private insurance	1.56	<.001	1.26-1.94

Table 5
Significant independent socioeconomic predictors for prolonged length of stay.

Independent variable	OR	*P* value	95% CI
Female	1.11	.11	0.94-1.3
Minority	1.45	<.001	1.24-1.70
Non-private insurance	1.43	<.001	1.16-1.77

experience longer LOS than white patients (3.7 vs 3.5 days; $P = .004$). The data also indicate that managed care patients exhibit statistically significant shorter LOS than non–managed care patients (3.3 vs 3.6 days; $P < .001$). It is important to note that this managed care vs non–managed care comparison is separate from the private vs non-private comparison.

As seen in Table 7, whites are more likely to hold private insurance than blacks (21.1% vs 11.3%; $P < .001$), as well as Medicare (32.5% vs 17.8%; $P < .001$) and managed care (26.8% vs 13.6%; $P < .001$). Blacks are more likely to hold Medicaid than whites (28.3% vs 10.5%) as well as managed Medicare (27.1% vs 6.6%; $P < .001$). There were no significant differences in insurance coverage between males and females as determined by 2-tailed Fisher exact tests.

Cost data were stratified by demographic as well as insurance classifications in order to determine disparities in financial costs (Table 8). Disparities in mean charges between males and females were found to be statistically significant ($80,010 vs $74,855; $P < .001$), as were mean direct costs ($14,641 vs $13,696; $P = .001$), indirect costs ($5,270 vs $4,918; $P = .001$), and total costs ($19,910 vs $18,613; $P = .001$). Race and insurance classification disparities were not found to be statistically significant.

Discussion

As joint replacement procedures have become more common within the United States, cost-saving initiatives—focused in-hospital and post-discharge quality and resource utilization have become more prevalent [17]. With this focus on cost-containment, it becomes important to improve quality while at the same time reducing unnecessary costs. This includes

Table 6
Mean length of stay by demographic and insurance classifications.

Variable	Mean length of stay ± SD	*P* value
Gender		
Male	3.7 ± 1.9	(-)
Female	3.6 ± 1.3	(-)
Race/ethnicity		
White	3.5 ± 1.6	(-)
Black	3.7 ± 1.5	.004
Asian	3.4 ± 0.7	(-)
Other	3.4 ± 0.8	(-)
Insurance classification		
Private	3.5 ± 1.5	(-)
Medicaid	3.6 ± 1.4	(-)
Medicare	3.8 ± 1.8	(-)
Managed care	3.3 ± 1.0	<.001
Managed Medicare	3.8 ±1.7	(-)
Other	3.8 ± 1.8	(-)

(-) = nonsignificant *P* value; SD, standard deviation.

Table 7
Demographic factors by insurance classification.

Variable	Gender		Race/ethnicity			
	Male, N = 952 (%)	Female, N = 1660 (%)	White, 1244 (%)	Black, 1245 (%)	Asian, 46 (%)	Other, 77 (%)
Private	167 (17.5)	268 (16.1)	263 (21.1)[a]	141 (11.3)	11 (23.9)	20 (26.0)
Medicaid	179 (18.8)	328 (19.8)	131 (10.5)	352 (28.3)[a]	11 (23.9)	13 (16.9)
Medicare	261 (27.4)	389 (23.4)	404 (32.5)[a]	222 (17.8)	10 (21.7)	14 (18.2)
Managed care	210 (22.1)	315 (19.0)	333 (26.8)[a]	169 (13.6)	10 (21.7	13 (16.9)
Managed Medicare	106 (11.1)	332 (20)	82 (6.6)	338 (27.1)[a]	4 (8.7)	14 (18.2)
Other	29 (3.0)	28 (1.7)	31 (2.5)	23 (1.8)	3 (6.5)	3 (3.9)

[a] Denotes significant *P* value calculated by chi-square test.

identifying areas of improvement with respect to PARC. There continues to be a significant emphasis on the disparities in quality and costs between socioeconomic groups [18]. Although a number of studies have investigated the effects of different socioeconomic factors on quality, few studies tie in both outcomes and cost data. The goals of this study were to determine (1) whether socioeconomic factors and/or race affected PARC disposition; (2) whether socioeconomic factors and/or race impacted LOS; and (3) whether socioeconomic factors and/or race impacted financial metrics.

Regarding PARC, Buntin et al. [19] reported that non-whites were more likely to use IR after hip and knee replacement, whereas whites were proportionally more likely to use SNFs. In contrast, our study found no statistically significant difference between minorities and non-minorities when using IR. However, our study did demonstrate more SNF utilization in minority patients. The lack of an increase in IR may be related to stricter criteria (eg, bilateral TJA patients) for acceptance into IR during the time course of this study compared with the study by Buntin et al. The role of other factors like support at home need to be fully explored. In a study of patients undergoing hip fracture and joint replacement, Ottenbacher et al. [14] found that non-Hispanic white and black patients were statistically more likely go home after joint replacement, when compared to Asian or Hispanic counterparts. After joint replacement procedures, 36% of Hispanic patients received inpatient rehabilitation, whereas 58% of non-Hispanic white patients, 67% of black patients, and 56% of Asian patients received inpatient rehabilitation. Evidence from a study by Freburger et al. [20] indicated that minorities received less institutional care than white patients. The authors highlight that the uninsured received less intensive care (as defined by hours of rehabilitation per day); patients with Medicaid, those of lower socioeconomic status, and those living in rural areas received the home-based care. The effect of race was modified by insurance status and by state: in general, minorities received less intensive rehabilitation care. In comparison to some studies, our study found that minorities are more than twice as likely to receive institutional care as whites. In addition, this study also found that females are nearly as likely to use institutional care as minorities. Factors which may contribute to an increase in need for institutional care among women and minorities may include prevalence of comorbidities, living environment, and social support at home.

The relationship between LOS and socioeconomic factors has been well studied within the total joint replacement space [6-11]. Bosco et al. [21], along with other studies [22,23], found that low socioeconomic status (defined by income and zip code), age, and race/ethnicity all contribute to longer LOS. The evidence from this present study indicates that minority status and non-private insurance status are strong predictors for longer LOS. However, unlike the prior studies, gender was not a statistically significant predictor of longer LOS. Also of note, this study did not find that zip code was a statistically significant predictor of longer LOS. Zip code was used in this study as a surrogate for geography of the patient population, as well as their median income. In addition, this study indicates that patients with managed care plans had reduced LOS when compared to those patients with other forms of insurance. However, it is important to note that these differences in LOS may be more statistically than clinically significant.

Although a number of studies investigate disparities in cost for a variety of procedures, few conclusions have been made as to the disparities in financial costs when stratified by certain socioeconomic variables [23-25]. In our study population, whites were more

Table 8
Cost by demographic and insurance classifications.

Variable	Mean charges ± SD	Mean direct cost ± SD	Mean indirect cost ± SD	Mean total cost ± SD
Gender				
Male	$80,010[a] ± $42,470	$14,641[a] ± $8639	$5270[a] ± $3159	$19,910 [a] ± $11,691
Female	$74,855 ± $18,549	$13,696 ± $3098	$4918 ± $1297	$18,613 ± $4260
Race/ethnicity				
White	$76,593 ± $33,562	$14,093 ± $6758	$5019 ± $2540	$19,112 ± $9190
Black	$76,875 ± $24,701	$13,973 ± $4458	$5080 ± $1706	$19,053 ± $6054
Asian	$74,719 ± $50,737	$14,051 ± $10,549	$4969 ± $3822	$19,021 ± $14,324
Other	$77,931 ± $18,796	$14,269 ± $3491	$4979 ± $830	$19,249 ± $4130
Insurance classification				
Private	$76,954 ± $40,185	$14,061 ± $6811	$5077 ± $2959	$19,138 ± $9713
Medicaid	$78,789 ± $27,506	$14,347 ± $5328	$5068 ± $1841	$19,415 ± $7033
Medicare	$77,825 ± $26,633	$14,150 ± $4602	$5137 ± $1888	$19,287 ± $6360
Managed care	$73,525 ± $31,238	$13,655 ± $7752	$4818 ± $2426	$18,474 ± $10,119
Managed Medicare	$76,429 ± $21,872	$13,903 ± $3862	$5098 ± $1698	$19,001 ± $5480
Other	$76,219 ± $22,898	$14,489 ± $4297	$5271 ± $1609	$19,760 ± $5663

SD, standard deviation.
[a] Significant *P* value.

likely to hold private insurance, Medicare, and managed care than blacks, whereas blacks were more likely to hold Medicaid and managed Medicare. This study also found a statistically significant disparity in costs when stratified by gender: males had higher mean charges, direct costs, indirect costs, and total costs than females. Race/ethnicity and insurance classification did not have a significant impact on mean charges, direct costs, indirect costs, or total costs.

There are a number of limitations within the study that may affect the generalizability of its results. Although a moderate sample size was used, larger sample sizes may allow for better statistical analysis between subgroups. When compared to results in the literature, differences in patient populations, payer mix, and socioeconomic status may have led to different findings. In addition, the study did not control for factors such as income levels, education, or preoperative health status with multivariate analysis. The patient population within the study may limit potential multivariate regression analysis over a number of variables, when coupled with subset analyses. Also, not many ethnicities were represented within the study outside of white and black. Additionally, this study included predominantly females (63.9%). There could be a number of coding errors that are currently unknown that may significantly impact the conclusions of the study. In addition, because the data were drawn from a single hospital, the patient population may not be entirely generalizable to the US population. Lastly, no subgroup analysis was performed between total hip or knee arthroplasty, as the purpose of the study was to investigate total joint arthroplasty as a group. Despite these limitations, this study meaningfully advances the current understanding of disparities in PARC, LOS, and financial cost of procedures as influenced by socioeconomic factors.

Conclusions

This study builds upon previous studies that have investigated the links between socioeconomic variables and clinical outcomes. The evidence from the study indicates that socioeconomic factors have significantly impacted all 3 variables studied: PARC disposition, LOS, and financial metrics. Understanding the socioeconomic factors that influence clinical outcomes and financial costs of care is vital. There is currently a movement emphasizing “value-based health care,” and bundling programs such as Comprehensive Care for Joint Replacement or the bundled care program initiative are being adopted without appropriate risk stratification. Many studies demonstrate [2,5,7,10] that minority patients and patients of low socioeconomic status already have utilization disparities related to receiving total joint replacement (Refs see my article and references). Risk stratification based upon orthopaedic and medical comorbidities as well as race, ethnicity, and socioeconomic factors is important to not promote decreased willingness of hospitals and providers to provide care to the most expensive and at-risk patient populations. This study draws a number of conclusions, linking socioeconomic status to PARC, LOS, and financial costs of joint arthroplasty procedures. In future care coordination efforts, these socioeconomic factors must be taken into consideration in order to provide higher quality care and health outcomes, all while aiming to reduce costs and inefficiencies. Further study on socioeconomic disparities may not only influence the medical and surgical care of joint arthroplasty patients but also influence the policy measures that define our present systems of care.

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