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Christine I. Nichols
Medtronic Advanced Energy

Joshua G. Vose
Medtronic Advanced Energy

Ryan M. Nunley
Washington University School of Medicine in St. Louis

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Clinical Outcomes and 90-Day Costs Following Hemiarthroplasty or Total Hip Arthroplasty for Hip Fracture

Christine I. Nichols, MA, MBA [a, *], Joshua G. Vose, MD [a], Ryan M. Nunley, MD [b]

[a] Department of Medical Affairs, Medtronic Advanced Energy, Portsmouth, New Hampshire
[b] Department of Orthopaedic Surgery, Washington University School of Medicine, St. Louis, Missouri

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ABSTRACT

Background: In the era of bundled payments, many hospitals are responsible for costs from admission through 90 days postdischarge. Although bundled episodes for hip fracture will have a separate target price for the bundle, little is known about the 90-day resource use burden for this patient population.
Methods: Using Medicare 100% Standard Analytic Files (2010-2014), we identified patients undergoing hemiarthroplasty or total hip arthroplasty (THA). Patients were aged 65 and older with admitting diagnosis of closed hip fracture, no concurrent fractures of the lower limb, and no history of hip surgery in the prior 12 months baseline. Continuous Medicare-only enrollment was required. Complications, resource use, and mortality from admission through 90 days following discharge (follow-up) were summarized.
Results: Four cohorts met selection criteria for analysis: (1) hemiarthroplasty diagnosis-related group (DRG) 469 (N = 19,634), (2) hemiarthroplasty DRG 470 (N = 77,744), (3) THA DRG 469 (N = 1686), and (4) THA DRG 470 (N = 9314). All-cause mortality during the study period was 51.6%, 29.5%, 48.1%, and 24.9% with mean 90-day costs of $28,952, $19,243, $29,763, and $18,561, respectively. Most of the patients waited 1 day from admission to surgery (41%-51%). Incidence of an all-cause complication was approximately 70% in each DRG 469 cohort and 14%-16% in each DRG 470 cohort.
Conclusion: This study confirms patients with hip fracture are a costly subpopulation. Tailored care pathways to minimize post-acute care resource use are warranted for these patients.

Hip fracture places a substantial resource burden on the US healthcare system. Each year more than 250,000 people over the age of 65 are hospitalized for hip fracture [1], and this number is projected to increase with the aging of the population. Currently, the US healthcare system is rapidly shifting away from a fee-for-service system to quality-based care. This shift is most evident in the implementation of Medicare's Bundled Payments for Care Improvement Initiative (BPCI), the Comprehensive Care for Joint Replacement (CJR) model, and the recently passed surgical hip/femur fracture treatment model. For hospitals enrolled in CJR or BPCI, hospitalizations grouped under diagnosis-related group (DRG) 469 (major joint replacement of the lower extremity with major complications or comorbidity) or 470 (major joint replacement of the lower extremity without complications or comorbidity) “trigger” a bundled payment episode. DRGs are sufficiently broad to include hospitalizations for both elective THA and arthroplasty due to hip fracture [2].

Given this shift in payment policy, there is a need to establish mean outcomes and costs incurred over the entire episode of care for patients admitted for hip fracture on a population level. Although Medicare has stated that a separate target price will be set for hip fracture patients vs those undergoing elective THA, there is a paucity of information on this high-cost, high-risk patient population. This study aims at estimating the total resource use and cost among Medicare patients admitted for hip fracture from point of admission through 90 days postdischarge.

Methods

Overview and Data Source

This retrospective database analysis used healthcare claims data from the Centers for Medicare & Medicaid Services (CMS) 100% Limited Data Set (LDS) research files (2010-2014) to identify

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* Reprint requests: Christine I. Nichols, MA, MBA, Department of Medical Affairs, Medtronic Advanced Energy, 180 International Drive, Portsmouth, NH 03801.

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patients undergoing hemiarthroplasty or THA for hip fracture. CMS LDS files contain de-identified beneficiary-level health information, compliant with the Health Insurance Portability and Accountability Act (HIPAA Privacy Rule).

Patient Selection and Study Time Period

To best evaluate differences in outcomes by procedure type while accounting for the separate target episode prices for DRG 469 vs 470, 4 study cohorts were created: (1) hemiarthroplasty grouped as DRG 469, (2) hemiarthroplasty grouped as DRG 470, (3) THA grouped as DRG 469, and (4) THA grouped as DRG 470.

Patients were included in this analysis if aged 65 or older, with Medicare-only insurance coverage, with an admitting diagnosis of hip fracture and principal procedure of hemiarthroplasty or THA. The date of admission with diagnosis of hip fracture was defined as the index date for analysis; a baseline period was defined as the 12 months before the index date with follow-up defined as the discharge date plus 90 days. Patients were excluded if they had history during the baseline period of a primary or revision hip arthroplasty procedure, diagnosis of cancer, concurrent diagnosis of other fractures of the lower limbs, and/or open femoral neck fractures (to eliminate fractures due to high-velocity trauma), or any form of supplemental Medicare-Advantage insurance. Continuous Medicare enrollment was required over the 12-month baseline through the index hospitalization discharge date. In order to account for "catastrophic cost" patients, which CMS has ruled will not impact CJR episode target prices [3], patients were excluded from analysis if their total 90-day cost was 2 standard deviations or greater above the mean within the study cohort.

Study Measures

This study summarized patient demographics, clinical history and comorbidities listed during baseline, inpatient complications and initial length of stay (LOS), days from admission to surgery, discharge destination, readmissions, mortality, and total costs over the 90-day episode of care. Days from admission to surgery was defined as the date on the Medicare claim for an arthroplasty procedure code, therefore may not be as precise as procedure time information listed in a full electronic health record. Costs provided in this dataset refer to the Medicare total claim amount paid. Follow-up post-acute care costs were summarized conditional upon a patient staying in a facility of interest (ie, conditional means). Follow-up costs were summed from the day of discharge through 90 days for each discharge destination of interest (inpatient rehabilitation facility [IRF], skilled nursing facility [SNF], home with home health), with costs summed over the entirety of follow-up (ie, capturing multiple stays if multiple stays occurred). Total 90-day costs included the sum of total index hospitalization cost, total readmission cost, outpatient visit costs, and post-acute care costs (IRF, SNF, home health), presented as an unconditional mean (ie, an average across the entire study cohort—regardless of specific post-acute care utilization). Finally, all post-acute care costs were only calculated for patients who survived through at least 90 days follow-up, in order to accurately capture all costs occurring during that time period. This methodology provides conservative estimates of total post-acute care costs as patients who died during follow-up almost certainly had greater healthcare utilization; however, the cost information associated with these patients also had greater potential for missing information. All costs were inflation-adjusted to 2014 USD using the medical care component of the consumer price index.

Data Analyses

Descriptive analyses were conducted for all study measures outlined above, including mean, median, and standard deviation values for continuous measures and proportions for binary measures. Statistical significance testing compared baseline demographic and clinical characteristics between the hemiarthroplasty and THA groups, using the chi-square test for categorical variables (or Fisher exact test for cell counts <10) and Kruskal-Wallis test for continuous variables.

Cox proportional hazards models were constructed to evaluate predictors of a hospital readmission within 90 days, controlling for age group, sex, region, hospital size, fracture type, DRG grouping, selected comorbid diagnoses, history of long-term anticoagulation use, presence of an all-cause complication during the index hospitalization, presence of a transfusion during the index hospitalization, index hospitalization LOS, days to surgery from admission, and initial discharge destination. Additionally, Cox models were performed to evaluate predictors of mortality during the index hospitalization or over 90 days follow-up using the same set of covariates. All analyses were performed using the Instant Health Data Suite (Boston Health Economics, Inc, Waltham, MA) and SAS software (version 9.2, SAS Institute, Cary, NC) packages.

Results

Demographics and Clinical Characteristics

Between January 1, 2010, and December 31, 2014, 19,634 patients met eligibility criteria for analysis in the hemiarthroplasty DRG 469 cohort; 77,744 in the hemiarthroplasty DRG 470 cohort; 1686 in the THA DRG 469 cohort; and 9314 in the THA DRG 470 cohort. Median age ranged from 79 to 85 years and most of the patients were female (64%-76%; Table 1).

Most of the patients had a diagnosis of "unspecified" fracture of the neck of the femur (≥65% across all cohorts), followed by transcervical fractures (approximately 30% for all cohorts) and pertrochanteric fractures (≤5%; Table 1). Overall, most of the patients waited 1 day from admission to surgery; however, approximately one-fifth of patients in the DRG 469 cohorts waited 3 days or more. Nearly one-third of patients in the DRG 469 cohorts had preexisting diagnosis of anemia, and a quarter had history of long-term anticoagulant use (a conservative estimate—as this relies on the presence of a diagnosis code rather than pharmacy records which were not available). A large proportion of patients (9%-24%) had a history of concurrent psychosis diagnosis (alcohol or drug induced, transient and persistent unclassified mental disorders, delusional disorders, other psychoses, and pervasive developmental disorders), followed by anxiety disorder (8%-12%).

Index Hospitalization and Discharge Destination

Median interquartile range (IQR) hospital LOS was 8 (6-11) days for each DRG 469 cohort, and 5 (5-7) days for each DRG 470 cohort. More than 50% of patients in each DRG 469 cohort remained in the hospital 8 days or longer, compared to 15% in each DRG 470 cohort. Incidence of an all-cause complication was approximately 70% in each DRG 469 cohort and 14%-16% in each DRG 470 cohort. Incidence of transfusion was significantly greater among each THA cohort compared to the hemiarthroplasty cohorts ($P < .001$), ranging from 24.7% to 42.3%. Among the DRG 469 cohorts, mortality during the index hospitalization was significantly higher than the DRG 470 cohorts (17.6% vs 2.4% for hemiarthroplasty, $P < .001$; 18.6% vs 2.7% for THA, $P < .001$).

Table 1
Patient Demographics and Clinical Characteristics.

Parameter	Hemiarthroplasty DRG 469	Hemiarthroplasty DRG 470	P Value[a]	THA DRG 469	THA DRG 470	P Value[b]	P Value[c]
Sample size (N)	19,634	77,744		1686	9314		
Age							
Mean ± SD	83.89 ± 7.16	82.94 ± 7.19	<.001	81.27 ± 7.62	78.51 ± 7.69	<.001	<.001
Median	85	84		82	79		
Age-group (%)			<.001			<.001	<.001
65-74	11.7	14.1		20.7	33.4		
75-84	37.2	40.2		42.1	41.8		
85-89	28.3	27.3		22.9	16.8		
≥90	22.7	18.4		14.4	7.9		
Female (%)	64.5	75.6	<.001	63.8	74.1	<.001	.030
Census division (%)			<.001			.005	<.001
South Atlantic	20.3	21.7		20.5	24.6		
East North Central	17.3	16.0		15.5	14.6		
Middle Atlantic	11.4	12.3		13.8	11.9		
West South Central	11.0	12.2		12.5	12.4		
Pacific	10.3	9.5		9.8	9.1		
West North Central	10.1	8.8		10.3	8.5		
East South Central	8.8	8.8		8.6	8.6		
Mountain	5.5	5.9		5.2	6.1		
New England	5.3	4.9		3.8	4.1		
Hospital size (# of beds, %)							
Small (≤200)	35.1	38.3	<.001	35.8	34.1	.198	<.001
Medium (201-400)	39.3	37.6	<.001	35.1	35.9	.536	<.001
Large (>400)	25.6	24.1	<.001	29.2	30.0	.511	<.001
Fracture type (%)							
Transcervical	29.9	30.1	.639	28.9	29.6	.597	.251
Pertrochanteric	3.7	3.1	.000	6.9	5.0	.003	<.001
Unspecified part of neck of femur	66.9	67.0	.759	64.7	65.9	.357	.004
Time from admission to surgery date (%)			<.001			<.001	<.001
Day of admission	19.6	26.0		18.2	25.8		
1 d	43.6	51.4		41.3	48.1		
2 d	19.3	15.7		19.7	17.6		
≥3 d	17.6	7.0		20.7	8.5		
Comorbid diagnoses in baseline (%)							
Rheumatologic disease							
Rheumatoid arthritis	2.5	2.4	.697	4.3	3.1	.014	<.001
Osteoarthrosis	18.8	17.4	<.001	20.5	18.3	.035	.030
Bone disorders							
Osteoporosis	15.8	15.8	.788	17.1	15.3	.057	.501
Osteopenia or osteomalacia	4.1	4.2	.568	4.3	5.2	.133	<.001
Hematologic							
Anemia	29.2	19.0	<.001	28.5	15.3	<.001	<.001
Long-term anticoagulant use	22.7	16.3	<.001	22.6	13.6	<.001	<.001
Weight[d] (%)							
Obese	2.4	1.3	<.001	3.9	1.9	<.001	<.001
Overweight	0.5	0.4	.182	0.7	0.4	.329	1.000
Underweight	1.8	0.9	<.001	1.0	0.4	.003	<.001
Cognitive status (%)							
Alcohol or substance abuse	5.6	4.0	<.001	6.3	4.1	<.001	.608
Anxiety disorder	11.8	9.4	<.001	11.0	7.7	<.001	<.001
Psychoses	24.3	19.4	<.001	14.5	8.5	<.001	<.001
Major depressive disorder	1.5	1.3	.067	1.6	0.9	.014	.009
Dementia	6.8	5.6	<.001	4.6	2.1	<.001	<.001
Charlson score breakout (%)			<.001			<.001	<.001
0	46.6	63.2		49.8	71.5		
1	14.0	11.6		16.4	12.8		
2	14.9	12.8		13.4	8.0		
≥3	24.5	12.4		20.3	7.6		

THA, total hip arthroplasty; DRG, diagnosis-related group; SD, standard deviation; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; BMI, body mass index.
[a] Comparison of hemiarthroplasty DRG 469 to hemiarthroplasty DRG 470.
[b] Comparison of THA DRG 469 to THA DRG 470.
[c] Comparison of hemiarthroplasty overall (both DRGs combined) to THA overall (both DRGs combined).
[d] Indicated by an ICD-9-CM diagnosis for overweight/obesity/underweight. No BMI-specific information was available in this dataset.

Overall, mortality was not different between the hemiarthroplasty and THA cohorts ($P = .142$).

Most of the patients were discharged to an SNF following the index hospitalization (62.5% hemiarthroplasty DRG 469, 63.8% hemiarthroplasty DRG 470, 56.6% THA DRG 469, and 50.2% THA DRG 470), followed by IRF (16.5%, 23.1%, 22.9%, and 27.3%, respectively). Among patients initially discharged to an SNF, median LOS ranged from 22 to 26 days (over the entirety of 90-day follow-up,

Table 2
Readmissions.

Parameter	Hemiarthroplasty DRG 469	Hemiarthroplasty DRG 470	P Value[a]	THA DRG 469	THA DRG 470	P Value[b]	P Value[c]
Sample size (N)	19,634	77,744		1686.00	9314.00		
Any readmission within 90 d (%)	25.7	18.4	<.001	26.3	13.9	<.001	<.001
Time to readmission (d)							
Mean ± SD	31.7 ± 24.7	34.9 ± 25.4	<.001	31.0 ± 25.2	35.9 ± 26.0	<.001	.588
Median (IQR)	25.0 (11.0-49.0)	29.0 (13.0-54.0)		23.0 (11.0-47.0)	29.0 (13.0-56.0)		
Readmission LOS (d)							
Mean ± SD	6.8 ± 4.8	6.3 ± 7.1	<.001	6.6 ± 4.4	6.0 ± 4.3	.002	.006
Median	6.0 (4.0-8.0)	5.0 (4.0-7.0)		5.0 (4.0-8.0)	5.0 (4.0-7.0)		
Mortality during readmission (%)	16.2	15.3	.230	15.1	11.1	.138	.042
Readmission diagnoses and procedures (%)							
Any infection	17.7	16.1	.007	17.8	10.7	<.001	<.001
Septicemia	14.0	11.4	<.001	13.1	7.3	<.001	<.001
Bacteremia	1.2	0.9	.056	1.6	0.5	.027	.225
Bone infection	0.8	0.6	.437	0.7	0.4	.429	.406
Infection NOS	3.0	4.0	.001	4.3	2.9	.168	.263
Dislocation of prosthetic joint	4.5	4.5	1.000	7.4	8.4	.614	<.001
Wound disruption	1.6	1.6	.748	1.6	1.9	.784	.836
Periprosthetic fracture	0.8	1.2	.009	1.4	2.2	.386	.008
Implant loosening or failure	0.2	0.3	.620	0.7	0.8	1.000	.004
Unspecified mechanical complication of implant	0.4	0.5	.631	0.5	0.6	1.000	.592
Revision surgery	0.9	1.0	.528	1.8	2.6	.426	<.001
Diagnosis of any infection and revision surgery	0.1	0.1	.409	0.5	0.2	.271	.132

THA, total hip arthroplasty; DRG, diagnosis-related group; SD, standard deviation; IQR, interquartile range; LOS, length of stay; NOS, not otherwise specified.
[a] Comparison of hemiarthroplasty DRG 469 to hemiarthroplasty DRG 470.
[b] Comparison of THA DRG 469 to THA DRG 470.
[c] Comparison of hemiarthroplasty overall (both DRGs combined) to THA overall (both DRGs combined).

including any repeat admissions). Among patients discharged to an IRF, median LOS was 11-25 days.

Readmissions and Overall Mortality

Incidence of readmission within 90 days of discharge was 26% for each DRG 469 cohort (hemiarthroplasty and THA), 18% among hemiarthroplasty DRG 470, and 14% among THA DRG 470 (Table 2), with readmission significantly more common among all hemiarthroplasty procedures (regardless of DRG grouping) vs THA ($P < .001$). Across all cohorts, median time to readmission ranged from 23 to 29 days with median LOS of 5-6 days. Mortality during readmissions ranged from 11.1% to 16.2%, with mortality significantly greater in the hemiarthroplasty cohorts compared to THA ($P = .042$). The most common diagnoses for readmission were infection (10.7%-17.7% dependent on the cohort), dislocation of the joint (4.5%-8.4%), and wound disruption (1.6%-1.9%). Overall, mortality between index admission and 90 days postdischarge was 51.6% for hemiarthroplasty DRG 469, 29.5% for hemiarthroplasty DRG 470, 48.1% for THA DRG 469, and 24.9% for THA DRG 470. Median time to mortality was 21, 38, 19, and 39 days, respectively.

Total 90-Day Costs

The median cost of the index hospitalization was approximately $21,000 for each DRG 469 cohort and $13,000 for each DRG 470 cohort (Table 3). Among patients with a readmission, median readmission cost was approximately $9000 for DRG 469 and $7500 for DRG 470. Median cost for IRF stays ranged from $13,707-$17,299; for SNF stays, median cost ranged from $9269 to $12,671. Overall, regardless of specific post-acute care utilization or readmissions, the median total 90-day cost among patients surviving 90 days was $27,201 for hemiarthroplasty DRG 469; $17,143 for DRG 470; $29,900 for THA DRG 469; and $17,408 for THA DRG 470.

When median total 90-day costs (among patients surviving 90 days) were compared by census region, costs ranged from approximately $15,400 in the West North Central census region (IA, KS, MN, MO, NE, ND, SD) to approximately $20,000 in New England (CT, ME, MA, NH, RI, VT) for each of the DRG 470 cohorts. For the hemiarthroplasty DRG 469 cohort, total 90-day costs ranged from $24,408 in the East South Central (AL, KY, MS, TN) region to $30,200 in the Pacific; and for THA DRG 469 costs ranged from $24,698 in East North Central (Il, IN, MI, OH and WI) to $33,772 in New England.

Multivariate Analyses

Cox proportional hazards models were used to evaluate factors associated with increased risk of readmission within 90 days. At least 3 of the 4 study cohorts included the following as significant predictors of readmission (all $P < .05$): age 90 or older (relative to age 65-74), male gender, residence in the West South Central (relative to New England), diagnosis of obesity or overweight, anxiety disorder, psychoses, history of long-term anticoagulant use, presence of an all-cause complication during the index hospitalization, receipt of a transfusion during index, and initial discharge to an SNF (compared to home with home health or under self-care).

Separate Cox proportional hazards models evaluated factors associated with increased risk of mortality either during the index visit or over 90 days follow-up (Table 4). The following factors were significant (all $P < .05$) for each of the 4 study cohorts: age 90 or older, male gender, diagnosis of psychoses, presence of an all-cause complication during the index visit, and discharge to a location other than home, home health, SNF, or IRF. In exploratory generalized linear models evaluating index LOS, presence of a transfusion during the index hospital stay and time from admission to surgery of 3 days or longer were significant predictors of longer LOS in 3 of the 4 cohorts; however, all other measures predictive of LOS were not consistently significant across study groups.

Discussion

This retrospective analysis of Medicare claims data quantifies the resource burden of patients admitted for hip fracture, treated

Table 3
Costs.

Parameter	Hemiarthroplasty DRG 469	Hemiarthroplasty DRG 470	*P* Value[a]	THA DRG 469	THA DRG 470	*P* Value[b]	*P* Value[c]
Total index hospitalization cost							
N	18,949	77,021		1613	9176		
Mean ± SD	\$21,245 ± 4239	\$13,443 ± 2855	<.001	\$21,168 ± 4422	\$13,537 ± 3198	<.001	<.001
Median (IQR)	\$20,826 (18,648-23,624)	\$12,707 (11,584-14,457)		\$20,549 (18.580-23,512)	\$12,661 (11,495-14,534)		
Among those readmitted, total readmission cost							
N	5005	14,130		441	1272		
Mean ± SD	\$10,473 ± 6408	\$9284 ± 5398	<.001	\$10,188 ± 6202	\$9316 ± 5493	.003	.769
Median (IQR)	\$8940 (6251-12,394)	\$7666 (5490-11,642)		\$8418 (5987-12,002)	\$7477 (5273-11,739)		
Post-acute care costs through 90 d[d]							
Patients with an IRF stay							
N	149	514		22	72		
Mean ± SD	\$16,558 ± 5890	\$15,865 ± 4892	.037	\$14,164 ± 6454	\$14,505 ± 4351	.848	.006
Median (IQR)	\$17,299 (13,146-21,447)	\$16,065 (13,229-19,644)		\$16,097 (9338-18,942)	\$13,707 (10,778-17,952)		
Patients with an SNF stay							
N	2759	7721		238	640		
Mean ± SD	\$13,140 ± 8373	\$12,083 ± 7424	<.001	\$13,668 ± 8781	\$10,836 ± 6921	<.001	<.001
Median (IQR)	\$11,934 (6597-18,455)	\$11,099 (6241-17,139)		\$12,671 (6623-19,111)	\$9269 (5407-15,330)		
Patients with home health							
N	837	4798		115	1214		
Mean ± SD	\$3857 ± 1729	\$3681 ± 1582	.001	\$3897 ± 1689	\$3342 ± 1257	.001	<.001
Median (IQR)	\$3692 (2757-4864)	\$3442 (2694-4575)		\$3646 (2805-4868)	\$3191 (2610-3884)		
Total outpatient visit costs[e]							
N	6732	35,339		742	5153		
Mean ± SD	\$896 ± 1395	\$583 ± 867	<.001	\$928 ± 1434	\$608 ± 794	.008	<.001
Median (IQR)	\$315 (89-978)	\$249 (80-725)		\$344 (108-995)	\$309 (97-836)		
Total 90-d cost[f]							
N	5614	18,880		411	1286		
Mean ± SD	\$31,121 ± 12,583	\$20,483 ± 9499	<.001	\$33,401 ± 13,329	\$20,640 ± 9302	<.001	<.001
Median (IQR)	\$27,201 (21,668-38,236)	\$17,143 (13,625-24,101)		\$29,900 (23,068-43,321)	\$17,408 (14,033-24,167)		

THA, total hip arthroplasty; DRG, diagnosis-related group; SD, standard deviation; IQR, interquartile range; IRF, inpatient rehabilitation facility; SNF, skilled nursing facility.
[a] Comparison of hemiarthroplasty DRG 469 to hemiarthroplasty DRG 470.
[b] Comparison of THA DRG 469 to THA DRG 470.
[c] Comparison of hemiarthroplasty overall (both DRGs combined) to THA overall (both DRGs combined).
[d] Post-acute care costs were summed from the day of discharge through 90 days for the facility of interest; conditional upon a patient visit at the facility of interest during follow-up.
[e] Outpatient visits included the following locations: emergency department, clinic, office, outpatient hospital, outpatient rehab, other outpatient.
[f] Total 90-day cost is summed for the entire study cohort, regardless of specific post-acute care utilization (unconditional mean). Total cost is the sum of the index hospitalization, readmission, IRF, SNF, home health, and outpatient visit costs. This cost is calculated only among patients surviving 90 days of follow-up.

with either hemiarthroplasty or THA, through the 90-day postoperative period. This population and time window are of importance due to recent changes in reimbursement policy via the shift to bundled payments with either Medicare's mandatory implementation of the CJR program or the voluntary BPCI program. As this legislation effectively shifts financial responsibility from Medicare to hospitals, it is critical for care systems and providers to be able to benchmark their costs against both themselves historically and other hospitals.

Under the CJR program, patients admitted with a primary diagnosis of hip fracture who are treated with arthroplasty will trigger a bundled payment episode [3]. If the total cost of care is below the target price set for the hospital, a repayment will occur at the end of the reconciliation period (annually for CJR and quarterly for BPCI); conversely, if costs are greater than the target price, the hospital will be responsible for repaying Medicare a percentage of the target price. Given that both hemiarthroplasty and THA fall under DRG 469 and 470 [2], both procedures conceivably count toward a bundled payment episode; however, there is no formal mention of hemiarthroplasty in the CMS final ruling [3]. Fractures treated via nonarthroplasty means (DRGs 480-482) will instead fall under the recently passed surgical hip/femur fracture treatment bundle. Whether it is hemiarthroplasty or THA alone that "counts" as an episode under CJR, hospitals are potentially at risk for financial losses without careful oversight of care optimization and discharge planning.

Our study found that most of the patients who underwent hemiarthroplasty or THA were discharged to an SNF or IRF; median SNF LOS ranged from 22 to 26.5 days and 11-14 days for an IRF. Furthermore, a large proportion (14%-26%) of patients were readmitted within 90 days. A somewhat surprising finding was the high mortality rate observed from admission through 90 days postdischarge, which ranged from 25% to 30% for the DRG 470 cohorts and 48%-52% for the DRG 469 cohorts. Unlike elective arthroplasty procedures where approximately 5% of patients fall into DRG 469, 15%-20% fell into this DRG for THA and hemiarthroplasties for fractures, respectively. This larger percentage of patients grouped into the higher-severity DRG confirms that fracture patients are presenting more frequently with severe comorbidities and complications when compared to their elective counterparts. Our mortality rates may also appear high compared to prior estimates as the follow-up in this study extends to 90 days (rather than the more frequently reported 30-day follow-up). Additionally, the Medicare dataset used in this study is linked to Social Security information, thereby providing the most robust estimate of patient mortality available (compared to provider-only information). Considering approximately 20% of patients with fracture grouped into DRG 469 waited 3 or more days before surgery, which may have been necessary to stabilize complicated medical issues, a focus on faster preoperative patient optimization to mitigate the risk of complications and mortality may be indicated [4,5].

When examining the question of whether to perform a hemiarthroplasty or THA, patient age, functional status, comorbidity burden, and ultimately patient preference must be taken into account. It has been cited that operative technique is the leading

Table 4
Logistic Regression Analyses—Predictors of 90-Day Mortality.

Parameter	Hemiarthroplasty DRG 469			Hemiarthroplasty DRG 470			THA DRG 469			THA DRG 470		
	Hazard Ratio	95% CI	*P* Value	Hazard Ratio	95% CI	*P* Value	Hazard Ratio	95% CI	*P* Value	Hazard Ratio	95% CI	*P* Value
Age (relative to 65-74)												
75-84	**1.32**	**1.15-1.51**	**<.0001**	**1.31**	**1.17 - 1.47**	**<.0001**	1.24	0.75 - 2.03	.397	1.15	0.77 - 1.73	.482
85-89	**1.44**	**1.26-1.65**	**<.0001**	**1.54**	**1.38 - 1.73**	**<.0001**	**1.74**	**1.05 - 2.89**	**.033**	1.38	0.91 - 2.09	.125
≥90	**1.75**	**1.53-2.01**	**<.0001**	**1.98**	**1.77 - 2.22**	**<.0001**	**2.89**	**1.73 - 4.82**	**<.0001**	**2.07**	**1.36 - 3.15**	**.001**
Male	**1.25**	**1.17-1.33**	**<.0001**	**1.42**	**1.35-1.49**	**<.0001**	**1.49**	**1.13-1.96**	**.004**	1.16	0.93-1.45	.199
Census division (vs New England)												
East North Central	**1.26**	**1.07-1.49**	**.006**	0.97	0.85-1.09	.569	1.47	0.85-1.09	.569	1.19	0.62-2.29	.591
East South Central	1.19	0.99-1.43	.064	0.94	0.82-1.08	.409	1.00	0.82-1.08	.409	1.11	0.55-2.25	.770
Middle Atlantic	1.11	0.93-1.33	.246	1.03	0.91-1.17	.677	1.22	0.91-1.17	.677	1.12	0.57-2.18	.745
Mountain	**1.30**	**1.06-1.59**	**.011**	**1.17**	**1.02-1.35**	**.029**	1.42	1.02-1.35	.029	1.24	0.6-2.56	.560
Pacific	**1.22**	**1.02-1.47**	**.028**	1.00	0.87-1.14	.945	0.90	0.87-1.14	.945	0.92	0.44-1.93	.833
South Atlantic	**1.27**	**1.08-1.5**	**.004**	1.07	0.96-1.21	.231	1.18	0.96-1.21	.231	1.17	0.62-2.21	.634
West North Central	0.94	0.78-1.12	.479	0.89	0.78-1.02	.093	1.26	0.78-1.02	.093	0.76	0.36-1.59	.459
West South Central	0.98	0.82-1.18	.836	1.05	0.93-1.2	.435	1.34	0.93-1.2	.435	1.33	0.69-2.58	.391
Hospital size (relative to large)												
Small (≤200)	**0.92**	**0.85-1**	**.039**	1.01	0.95-1.07	.806	0.79	0.56-1.12	.186	**1.33**	**1.01-1.75**	**.042**
Medium (201 to 400)	0.95	0.87-1.02	.164	1.02	0.96-1.09	.486	0.98	0.7-1.37	.918	1.20	0.91-1.59	.205
Fracture type (relative to unspecified)												
Transcervical	1.01	0.94-1.08	.765	0.96	0.91-1.01	.105	1.04	0.77-1.42	.782	1.06	0.85-1.33	.600
Pertrochanteric	0.88	0.74-1.05	.147	1.04	0.91-1.18	.604	1.62	0.98-2.68	.059	1.40	0.95-2.07	.088
Specific comorbid diagnoses												
Obese or overweight	0.96	0.77-1.19	.707	1.09	0.9-1.32	.387	1.09	0.54-2.19	.805	1.31	0.6-2.85	.494
Underweight	1.09	0.89-1.35	.401	**1.39**	**1.17-1.65**	**.0002**	1.22	0.51-2.91	.656	**2.13**	**1.02-4.48**	**.045**
Anxiety disorder	0.95	0.86-1.05	.334	1.04	0.96-1.12	.365	0.91	0.6-1.37	.646	1.26	0.91-1.76	.166
Psychoses	**1.08**	**1.01-1.16**	**.025**	**1.36**	**1.29-1.43**	**<.0001**	**1.56**	**1.13-2.15**	**.007**	**1.68**	**1.31-2.14**	**<.0001**
Major depressive disorder	1.13	0.88-1.44	.334	0.97	0.8-1.17	.727	1.08	0.38-3.11	.880	0.65	0.24-1.78	.406
Dementia	1.10	0.99-1.23	.069	1.05	0.97-1.14	.202	1.12	0.69-1.81	.644	1.19	0.82-1.73	.358
LT anticoagulant use	1.00	0.93-1.07	.960	**0.93**	**0.88-0.99**	**.029**	0.98	0.72-1.35	.923	1.18	0.91-1.54	.210
All-cause complication during index	**1.22**	**1.14-1.31**	**<.0001**	**1.27**	**1.2-1.34**	**<.0001**	**1.56**	**1.14-2.14**	**.006**	**1.32**	**1.03-1.7**	**.030**
Transfusion during index	0.98	0.92-1.05	.580	**0.94**	**0.89-0.99**	**.012**	**1.36**	**1.03-1.79**	**.031**	0.88	0.71-1.1	.259
Days to surgery (relative to day of admission)												
1 d	0.98	0.9-1.07	.689	0.99	0.94-1.05	.792	1.26	0.86-1.86	.237	0.99	0.76-1.28	.925
2 d	1.05	0.95-1.16	.336	1.00	0.93-1.08	.910	1.24	0.79-1.96	.346	0.91	0.66-1.25	.563
3+ d	1.06	0.96-1.17	.258	**1.17**	**1.07-1.28**	**.001**	1.21	0.78-1.88	.389	1.03	0.71-1.51	.872
Index hospitalization discharge destination (relative to home health or home self-care)												
IRF	0.86	0.69-1.07	.172	**0.69**	**0.61-0.79**	**<.0001**	0.74	0.28-1.98	.548	0.67	0.4-1.13	.132
SNF	1.17	0.96-1.42	.109	1.07	0.96-1.2	.233	1.71	0.69-4.22	.246	1.16	0.73-1.86	.534
Other	**6.15**	**5.02-7.53**	**<.0001**	**2.21**	**1.93-2.53**	**<.0001**	**6.55**	**2.57-16.7**	**<.0001**	**3.22**	**1.79-5.76**	**<.0001**

Bolded values indicate significance at the 95% confidence level ($P < .05$).
DRG, diagnosis-related group; THA, total hip arthroplasty; CI, confidence interval; IRF, inpatient rehabilitation facility; SNF, skilled nursing facility; LT, long term.

factor in determining total hospitalization cost; however, Medicare reimbursement is the same (only varying dependent upon DRG classification) [6]. This raises the question of which technique is "better" for the patient, for which there is no consensus. In a Cochrane meta-analysis, Parker and Gurusamy [7] concluded that there is "insufficient evidence" to determine whether hemiarthroplasty or THA is the optimal treatment for acute hip fracture. In another large, retrospective analysis of 2437 patients who underwent THA vs 38,328 patients with hemiarthroplasty, authors found no significant difference in 90-day complications (including mortality or readmission for infection, dislocation, revisions, or thromboembolic disease; odds ratio = 0.89; 95% CI, 0.79-1.02) [8]. By comparison, our study found slightly greater risk of all-cause complications during the index hospitalization among patients treated with hemiarthroplasty vs THA ($P < .001$), and greater risk of readmission and mortality (both $P < .001$) within 90 days. These findings suggest that in clinical practice, patients with a hemiarthroplasty procedure were more comorbid upon presentation relative to patients with a THA, thereby predisposed to the surgeon choosing a hemiarthroplasty. This procedural selection is supported by our Charlson score calculations (an objective proxy for patient comorbidity status), with 20%-25% of hemiarthroplasty patients having a score of 3 or greater relative to 8%-12% of THA patients.

Conclusions

In summary, patients admitted with hip fracture are a challenging subpopulation to manage within a bundled care environment. A myriad of factors affect the 90-day cost of care and the clinical outcome, including time from admission to surgery, choice of surgical procedure, patient comorbidity status, postoperative complications and readmissions, and use of post-acute care facilities. These factors will have to be closely monitored in a bundled environment, ultimately with the goal of reducing unnecessary medical resource use, improving outcomes and survival.

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