



Outcomes

Effect of statewide reduction in extended care facility use after joint replacement on hospital readmission



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ABSTRACT

Background: Extended care facility use is a primary driver of variation in hospitalization-associated health care payments and is increasingly a focus for savings under episode-based payment. However, concerns remain that extended care facility limits could incur rising readmissions, emergency department use, or other costs. We analyzed the effects of a statewide value improvement initiative to decrease extended care facility use after lower extremity arthroplasty on extended care facility use, readmission, emergency department use, and payments.

Methods: We performed a retrospective cohort study using complete claims from the Michigan Value Collaborative for patients undergoing lower extremity joint replacement. We compared the change in extended care facility use before (2012–2013) and after (2016–2017) the aforementioned statewide initiative with 90-day postacute care, readmission, and emergency department rates and payments using *t* tests.

Results: Of the patients included, 68,537 underwent total knee arthroplasty; 27,131 underwent total hip arthroplasty. Statewide, extended care facility use and postacute care payments decreased (extended care facility: 27.5% before vs 18.1% after, payments: \$4,999 vs \$3,832, $P < .0001$) without increased readmission rates (8.0% vs 7.6%, $P = .10$) or payments (\$1,087 vs \$1,026, $P = .14$). Emergency department use increased (7.8% vs 8.9%, $P < .0001$). Per hospital, there was no association between extended care facility use change and readmission rate change ($r = 0.05$). Hospital change in extended care facility use ranged from +2.3% (no extended care facility decrease group) to –16.6% (large extended care facility decrease group) and was associated with lower total episode payments without differences in change in readmission rate/payments or emergency department use.

Conclusion: Despite decreased use of extended care facilities, there was no compensatory increase in readmission rate or payments. Reducing excess use of extended care facilities after joint replacement may be an important opportunity for savings in episode-based reimbursement.

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Introduction

Postacute care is the largest driver of variation in payments around hospitalization and is among the fastest growing payments categories.^{1–3} Among postacute care payments, the choice of an

extended care facility (ECF) for postoperative care, including inpatient postacute care providers such as skilled nursing facilities and inpatient rehabilitation, comprises the majority of payment variations after major inpatient surgery (eg, joint replacement).⁴ Joint replacement is a vital example to the understanding of surgical and inpatient care, as it is the costliest inpatient Medicare procedure, with costs totaling 7 billion dollars in 2014 alone.⁵ Another important factor to consider, a bundled payment program has been implemented by Medicare focusing on joint surgery, linking payment for any postacute care within 90 days of surgery to the hospital performing the primary procedure. Although the reactions of

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hospitals to the institution of bundled payments vary, several studies have identified a decrease in payments on postacute care in these programs.^{6–9} Thus, as episode-based payment models become increasingly common, hospitals may be expected to continue to decrease postacute care payments after surgery.

With reduced payments on postacute care, however, there is concern that bypassing extended care after joint replacement or other inpatient care could incur unintended consequences, such as increased readmissions or emergency department visits.^{10,11} Randomized trials have not demonstrated any meaningful clinical benefit from high-cost, inpatient postacute care after joint replacement specifically.^{12,13} However, these studies took place in specialized settings among patients selected for trial enrollment and, therefore, may have issues with generalizability to the broad diversity of practices performing joint replacement and the effectiveness of such techniques in real-world practice. One national evaluation of bundled payment programs for joint replacement sought to address this concern and found that decreased postacute care use did not result in increased readmissions.⁷ However, other studies have found an association between discharge to ECF and a greater risk of readmission after joint replacement, leaving the effects of an intervention to intentionally decrease discharge to ECF unknown.^{14–16} Hospitals considering strategies for episode payment reductions including decreased discharge to ECF require real-world data across a variety of settings to understand the potential consequences of limiting ECF use after joint replacement.

To evaluate the effects of postacute care reductions, we studied a multihospital, quality collaborative's statewide value improvement initiative to decrease ECF use in Michigan. A statewide collaborative quality initiative, comprising more than 95% of joint replacements performed in the state—the Michigan Arthroplasty Collaboration Quality Initiative (MARCQI)—created such a project in 2014.¹⁷ We capitalized on this natural experiment to study changes in rate of ECF use after elective arthroplasty, rate of readmission, and payments on postacute care and readmissions across the state of Michigan before and after the implementation of this state-wide quality improvement initiative.

Methods

Data sources

We analyzed claims data from the Michigan Value Collaborative (MVC, <http://michiganvalue.org>), a statewide collaborative of 77 hospitals in Michigan that, in collaboration with the largest commercial payer in the state (Blue Cross and Blue Shield of Michigan), maintains a validated claims registry derived from episode payments from complete claims for Medicare fee-for-service beneficiaries and Blue Cross and Blue Shield of Michigan preferred provider organizations, the methods of which have been described previously.¹⁸ MVC payment data are price standardized based on methods derived from the Dartmouth Atlas of Healthcare, accounting for factors including inflation, variation across regions, and payer type.¹⁹ MVC performs risk adjustment using observed/expected ratios. Expected total and component payments are calculated using a 2-step regression model, combining models for likelihood and intensity of use, that include age, sex, 79 hierarchical condition category comorbidities, insurance type, and prior 6-month payments provided by the payer.²⁰ We use adjudicated payer claims as our measure of payments, as they represent the actual realized cost of the operation and its associated perioperative care and are more relevant to considerations of the impact of episode-based payment initiatives. Payments were measured for the total episode and in specific components: ECFs, emergency departments, and readmission. Hospital characteristics, including

number of beds, urban/rural status, and the percent of Medicaid patient-days, were derived from the American Hospital Association survey.

All patients who underwent elective, primary total hip arthroplasty (THA) or total knee arthroplasty (TKA) between 2012 and 2017 at a hospital within the MVC network that performed greater than 20 lower-extremity joint replacements over the time period were included. Three of the 77 hospitals were excluded from analysis of ECF use due to low volume of joint replacements. Procedures were identified using Current Procedural Terminology codes and International Classification of Diseases 9 and 10 procedure codes. Revisions of previous THA and TKA surgeries were excluded from our cohorts.

Exposure and outcome measures

Primary exposure was the change in rate of per hospital ECF use between 2012 and 2013 and 2016 and 2017, before and after the initiation the statewide quality improvement initiative in 2014 and allowing for 1 year of wash out. By comparing the hospitals to their own historical data, they acted as their own controls. The implemented quality initiative started in November of 2013 by presenting data on standardized per hospital ECF use to MARCQI participants, which perform 95% of elective THA and TKA in the state of Michigan. Subsequently, in 2014, formal recommendations to create projects encouraging appropriate ECF use—including patient education, care management, and discharge planning—were made to the outlier hospitals. Data on ECF use by all hospitals was then shared at quarterly MARCQI meetings, with ongoing recommendations for hospital-specific quality improvement initiatives.²¹

ECFs were defined as inpatient postacute care institutions, including inpatient rehabilitation and skilled nursing facilities. ECF use was measured in the 90-day period after surgery, in line with most federal bundled payment programs. In the experience of the statewide collaborative (MVC), data from both skilled nursing facilities and inpatient rehabilitation facilities has been similar and was, therefore, considered together. Other exposure measures included patient demographic information (age, sex, ethnicity), patient comorbidities (measured by hierarchical condition category), and hospital characteristics (eg, urban/nonurban, academic/nonacademic, percent Medicaid patient-days, and mean and median length of stay for THA/TKA).

Change in the rate of readmission in the 90-day postoperative period was the primary outcome; the changes in readmission payments, postacute care payments, and emergency department use and payments were secondary outcomes.

Statistical analysis

To determine the impact of the change in ECF use over the study period on our outcome measures, we created 3 evenly split groups of hospitals based on the change in the ECF use between 2012 and 2013 and 2016 and 2017: large decrease in ECF use (“large decrease”), little decrease in ECF use (“small decrease”), and no decrease in ECF use (“no decrease”). Groups were then compared based on the change in readmission rate, emergency department use rate, and payments. Comparisons were performed using analysis of variance to determine whether any group was significantly different based on these outcomes within the 90-day postdischarge period. Tukey's honestly significant difference was used as a post hoc test to assess which specific group actually differed.²² Patient and hospital characteristics among groups were compared using χ^2 and Fisher exact tests, while pair-wise *t* tests were employed to compare mean payments between utilization periods. This

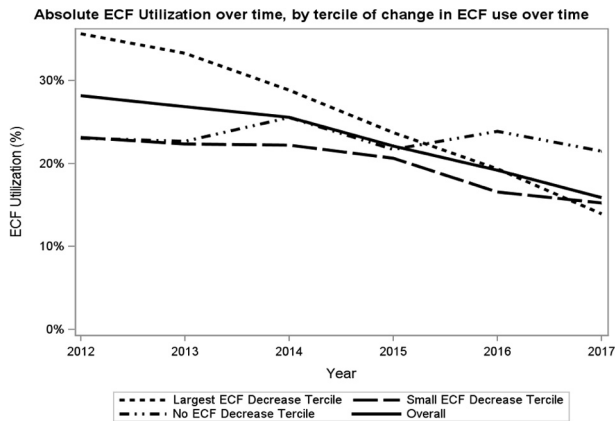


Fig 1. Absolute ECF use over time by degree of change in ECF use. Change in absolute ECF use over time. Data is organized by the groups of change in ECF use over time and shown with the average overall change.

approach allows hospitals to be compared against a cohort with similar change over the study period, as no control group that underwent no intervention was available. The Spearman rank correlation test was used to compare the change in ECF use with the change in readmission rates at each hospital.

Results

The cohort included 68,537 patients who underwent TKA and 27,131 patients who underwent THA at 74 hospitals. The mean number of procedures per hospital per year was 237 (range: 3–1,581).

Trends in postacute care in Michigan

On a statewide basis, ECF use decreased from 27.5% in 2012 to 18.1% in 2016 to 2017 ($P < .0001$, Fig 1). However, readmission rates were unchanged across the same time period, at 8.0% vs 7.6%, respectively ($P = .10$). Emergency department use did increase slightly, from 7.8% to 8.9% ($P < .0001$). Mean postacute care payments across all included hospitals decreased from \$4,999 in 2012 to 2013 to \$3,832 in 2016 to 2017 ($P < .0001$). ECF payments were primarily responsible for this change, decreasing from \$2,987 to \$1,616 ($P < .0001$). Conversely, home health payments slightly increased from \$1,345 to \$1,534 ($P < .0001$). Similarly, emergency department (ED) payments also slightly increased between the 2 periods (\$84 vs \$101, $P < .0001$). Mean payment on readmissions, however, was similar between the 2 periods (\$1,087 vs \$1,026, $P = .14$). Total episode payments averaged \$23,642 in the 2012 to 2013 period and \$22,399 in the 2016 to 2017 period ($P < .0001$).

When hospitals were split into groups based on their change in ECF use, there were significantly fewer patients in the large decrease group (19,523 vs 37,150 and 38,995 in the higher tertiles, $P = .04$, Table I). This group was also slightly younger (67.0 years compared to 67.5 in both tertiles with greater ECF change, $P < .0001$) and had fewer female patients (61.5% vs 61.5% and 62.9%, respectively, $P < .0001$). The proportion of patients with a hierarchical condition category diagnosis corresponding to cancer was highest in the group with the large decrease (9.5% compared to 8.3% in the no decrease group and 8.2% in the small decrease group, $P < .0001$). Median length of stay was lowest among the small decrease group (2 days compared with 3 in the other groups, $P < .0001$). The percent teaching hospital, percent with greater than 300 beds, and percent participating in the Committee on Joint Replacement and

Bundled Payment for Care Improvement initiatives were similar between the 3 groups.

There were no significant differences in changes in patient characteristics across groups during the study period.

Postacute care utilization and payments

On a per hospital basis, there was no association between the change in ECF use in the pre- and postquality improvement periods and the change in readmission rate ($r = 0.05$, Fig 2). When considered by tertile of ECF use, mean ECF use rate ranged from a 2.3% increase over the study period in the tertile with no ECF rate decrease to a 16.6% decrease in ECF use in the tertile with the largest change (Table II). Readmission rates and ED use rates were similar across tertiles, as was readmission and ED payments. Change in overall postacute care payments ranged from a \$78 increase in the tertile without an ECF rate decrease to a \$1,940 decrease in the tertile with the largest ECF decrease, with decreases in total episode payments ranging from $-\$529$ to $-\$2,279$. Change in payments on ECFs specifically varied from $-\$405$ in the no decrease group to $-\$2,182$ in the tertile with the large decrease group. Comparatively, change in home health payments was similar across tertiles (range: $-\$29$ to $\$123$, $P = .61$). Change in total episode payments varied from $-\$65$ in the group with a small ECF decrease to $-\$2,279$ in the group with a large ECF decrease ($P = .05$).

Discussion

In this study, we evaluated the outcomes of a statewide effort by MARCQI to reduce the use of ECFs after hip and knee replacement. Previous work from MARCQI showed a decreased rate of ECF use with stable readmission rate in their cohort; however, this analysis ended in 2015 and included no data on payments.²¹ The most recent MARCQI report, which includes clinical registry data more recent than the payment data available for this analysis, showed that statewide ECF use after arthroplasty has continued to decline further.²³ In this study, we find that, over a 5-year period, this initiative was associated with decreased statewide ECF use, decreased total episode payments, and decreased postacute care payments, with no compensatory increase in readmissions or readmission payments. There was a small increase in the rate of ED use, but no significant change in average ED payments. The statewide ECF use rate dropped by a third over the study period, and total episode payments decreased by over \$1,000 per patient. Within postacute care, ECF payments dropped in all groups, with the greatest change among the hospitals with the largest ECF rate decrease ($-\$2,182$), whereas a small increase in home health payments was similar for all hospitals.

Although randomized controlled trials have sought to examine the effect of decreasing ECF use in the controlled setting, our study is a real-world validation of these techniques, with broader generalizability given the diversity of the hospitals included.^{12,13} The demonstrated lack of change in readmissions is in line with these trials and other literature on the lack of necessity of inpatient rehabilitation after hospital care. If the decrease in ECF use in our study was made up of patients who required an inpatient facility for their recovery after hospitalization, we might find a compensatory increase in readmissions; however, this effect was not observed. Studies in joint replacement show that patients who go to ECFs actually have higher readmission rates.^{14,16} Whether these readmissions are driven by the medical complexity of the patients or a causal relationship from being in an ECF is unknown.^{11,14–16,24} Regardless, given that this study used hospitals as their own controls and clinical characteristics across hospital groups did not vary

Table 1
Hospital and patient characteristics by relative change in ECF use, 2012–2013 versus 2016–2017

	No change	Small decrease	Large decrease	P value
Hospitals (n)	25	25	24	.22
Patients (n)	19,523	37,150	38,995	.04
TKA (n)	5,188	10,172	11,771	.06
THA (n)	14,335	26,978	27,224	.04
Patient characteristics				
Mean age	67.0	67.5	67.5	< .0001
% Female sex	61.5%	61.5%	62.9%	< .0001
HCC groupings				
Cancer	8.3%	8.2%	9.5%	< .0001
Cardiovascular disease	1.6%	1.4%	1.5%	.06
CHF	9.9%	8.6%	9.2%	< .0001
Chronic kidney disease	0.9%	0.8%	1.0%	.03
COPD	15.3%	12.9%	11.8%	< .0001
Diabetes	29.5%	27.2%	26.8%	< .0001
Liver disease	0.9%	0.8%	0.9%	.15
Neurologic disease	4.3%	4.2%	4.2%	.71
Psychiatric disease	5.5%	5.6%	5.7%	.48
Respiratory dysfunction	2.1%	1.6%	3.4%	< .0001
Vascular disease	12.6%	12.8%	13.0%	.35
Hospital characteristics				
Length of stay (d) median*	3.0	2.0	3.0	< .0001
Teaching%	56.0%	60.0%	58.3%	.96
Bed size (>300 beds)	28.0%	44.0%	41.7%	.45
Participating in CMS programs (%)†				
CJR	8.0%	12.0%	0%	.36
BPCI	20.0%	12.0%	4.2%	.28

CHF, congestive heart failure; CMS, Centers for Medicare and Medicaid Services; COPD, chronic obstructive pulmonary disease; HCC, hierarchical condition category.

* Counting day of admission but not day of discharge.

† Participation in CMS programs includes CJR model and the joint replacement BPCI 2 service line.

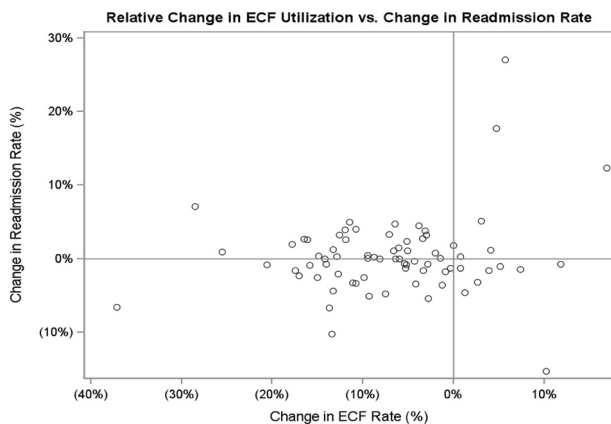


Fig 2. Change in ECF use versus change in readmission rate, per hospital. Each circle represents a single hospital. There was no correlation seen between change in ECF use compared to change in readmission rate ($r = 0.04$).

substantially, it is unlikely that clinical factors related to individual patients alone explain the results of this study.

The findings of this study will be of particular interest to hospitals facing novel payment reforms, such as the Bundled Payments for Care Improvement (BPCI)-Advanced program and the Comprehensive Center for Joint Replacement (CJR). Although recent studies have examined BPCI and CJR specifically, our study is unique in showing that hospital enrollment in such programs was equally distributed across groups of change in ECF use. This indicates exchangeability of these recent results showing reduction in ECF payments and use among hospitals participating in these programs to those that are not yet enrolled but will likely face similar programs in the future.^{25,26} Such hospitals will likely view ECF use as a primary target for savings across patients with

conditions covered by bundled payments—especially given that, in the example of joint replacement, there was no increase in readmissions payments and total episode payments decreased along with this intervention. This is especially true for surgical episodes, where bundled payments have shown greater success in reducing payments compared to chronic medical conditions like congestive heart failure or chronic obstructive pulmonary disease.²⁷ While our findings are limited only to patients undergoing elective arthroplasty, it is possible that similar programs in general surgical conditions might yield similar results given previous research showing similarity in readmissions changes in response to the Hospital Readmissions Reduction Program.²⁸ However, further research is necessary to determine whether there are similar findings in other elective surgeries.

We specifically chose our 90-day timeframe for payments analysis to allow for easy comparison to bundled payment systems. Given the flat rate of readmissions and the literature cited above, we can conclude that the decrease in ECF use was likely comprised of those safe decreases targeted by MARCQI. Our study, in looking at hospitals across Michigan (rather than narrowing in on those involved in voluntary programs such as BPCI-Advanced or regional programs such as CJR) and patients across insurance plans, is more generalizable and provides an important example of success in a statewide initiative for patients undergoing acute inpatient care. Although there may be concern about extending the results of 1 state's study to a national level, the MVC group has a variety of hospitals from academic and community settings, serving urban and rural populations at a variety of hospital sizes. Thus, the broad array of hospitals aiming to succeed in controlling payments in a world of bundled payments should consider decreasing inpatient rehabilitation use as a safe strategy.

Not all factors affecting readmissions and ECF use could be measured by our study. For example, we have no data on patients' functional recovery or other outcomes beyond ECF use, which is a

Table II
Episode consequences by relative change in ECF use, 2012–2013 versus 2016–2017

Change over study period	No change	Small decrease	Large decrease	P value
ECF use	+2.3% (0.2%–4.4%)	–7.0% (–8.0% to –6.0%)	–16.6% (–19.1% to –14.0%)	
Postacute care payments	\$78 (–\$576 to \$732)	–\$945 (–\$1,287 to –\$602)	–\$1,940 (–\$2,685 to –\$1,195)	
ECF payments	–\$405 (–\$761 to –\$48)	–\$1,002 (–\$1,259 to –\$745)	–\$2,182 (–\$2,577 to –\$1,786)	
Readmission rate	+1.2% (–2.1% to 4.5%)	0.0% (–1.1% to 1.1%)	–0.3% (–2.0% to 1.3%)	.60
ED use rate	+3.9% (0.6%–7.2%)	+1.1% (0%–2.2%)	+1.2% (–0.4% to 2.8%)	.12
Home health payments	\$60 (–\$136 to \$255)	–\$29 (–\$247 to \$190)	\$123 (–\$133 to \$380)	.61
Readmissions payments	–\$15 (–\$534 to \$503)	+\$20 (–\$170 to \$211)	–\$101 (–\$349 to \$146)	.88
ED payments	\$44 (–\$12 to \$99)	\$22 (\$5–\$38)	\$27 (–\$1 to \$55)	.67
Total episode payments	–\$529 (–\$1,325 to \$267)	–\$65 (–\$2,074 to \$1,943)	–\$2,279 (–\$3,060 to –\$1,498)	.05

All values displayed with their 95% confidence intervals.

P values not shown for ECF use, postacute care payments, or ECF payments owing to close link with splitting of terciles.

common issue in assessments of similar programs.²⁹ Although randomized trials have demonstrated no benefit from ECF after lower extremity joint replacement,^{12,13} there may be subsets of patients in whom clinical or functional outcomes are improved by discharge to an ECF. A recent study looking at stroke patients did find that there was a higher degree of return to function among patients discharged to an inpatient rehabilitation facility, compared to a skilled nursing facility.³⁰ While we did not make that distinction in this study due to the lack of functional recovery data, future directions for this research include further investigation of specific types of rehabilitation facilities and their benefits for postoperative patients. Additionally, there are difficulties beyond functional outcomes, including increased burden on family and other caregivers, that should be addressed in future, prospective studies.

We were not able to account for other trends in reimbursement policy and clinical practice that may have affected our findings. In a similar time period to the implementation of the quality initiative by MARCQI, there were several policies associated with the Affordable Care Act that went into place, including the Hospital Readmissions Reduction Program, which started its financial penalties in 2012 for primary elective hip and knee replacements. Work by Ibrahim et al has shown that this was associated with a statistically significant decline in readmissions when comparing 2008 to 2010 to the implementation period (2010–2012) and just after (2012–2014).²⁸ However, given that our study compared a similar 2012 to 2013 period to the subsequent 2016 to 2017 postinitiative period, our findings may indicate that readmissions for hip and knee replacements were relatively stable in Michigan across all insurance types (rather than Medicare alone, as Ibrahim et al characterized) after the implementation of the Hospital Readmissions Reduction Program.

Similarly, it is difficult to determine the direct effect of participation in bundled payment initiatives from the Center for Medicare and Medicaid Services—namely, in this case, BPCI Model 2, the BPCI-Advanced program, and CJR. Hospitals who participated in these programs by the end of the study period were similarly distributed among groups of change in ECF use, but we were not able to determine when hospitals entered these programs and, therefore, cannot infer which hospitals may have been responding to specific policy changes.

Despite these limitations, our analysis can still lead to an important conclusion: significant reductions in ECF use after joint surgery were associated with decreased total episode payments and no change in readmission rates on both a statewide and per hospital basis. Given these findings, similar programs to the one created by MARCQI—aimed at reducing usage of ECFs for acute inpatient care where evidence on the utility of inpatient rehabilitation is unclear—should be a focus of policy for payments reform in the context of bundled payments.

Conflicts of interest/Disclosure

The authors have no conflicts of interest to disclose.

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References

1. Mechanic R. Post-acute care—the next frontier for controlling Medicare spending. *N Engl J Med*. 2014;370:692–694.
2. Newhouse JP, Garber AM, Graham RP, et al. Empirical analysis of geographic variation; 2013. <http://www.ncbi.nlm.nih.gov/books/NBK201643/>. Accessed February 7, 2019.
3. Newhouse JP, Garber AM. Geographic variation in Medicare services. *N Engl J Med*. 2013;368:1465–1468.
4. Chen LM, Norton EC, Banerjee M, Regenbogen SE, Cain-Nielsen AH, Birkmeyer JD. Spending on care after surgery driven by choice of care settings instead of intensity of services. *Health Aff (Millwood)*. 2017;36:83–90.
5. Centers for Medicare & Medicaid Services (CMS). Comprehensive care for joint replacement model; 2019. <https://innovation.cms.gov/initiatives/CJR>. Accessed April 16, 2019.
6. Jubelt LE, Goldfeld KS, Chung WY, Blecker SB, Horwitz LI. Changes in discharge location and readmission rates under bundled payment. *JAMA Intern Med*. 2016;176:115–117.
7. Dummit LA, Kahvecioglu D, Marrufo G, et al. Association between hospital participation in a Medicare bundled payment initiative and payments and quality outcomes for lower extremity joint replacement episodes. *JAMA*. 2016;316:1267–1278.
8. Finkelstein A, Ji Y, Mahoney N, Skinner J. Mandatory Medicare bundled payment program for lower extremity joint replacement and discharge to institutional postacute care: Interim analysis of the first year of a 5-year randomized trial. *JAMA*. 2018;320:892–900.
9. Navathe AS, Troxel AB, Liao JM, et al. Cost of joint replacement using bundled payment models. *JAMA Intern Med*. 2017;177:214–222.
10. Chimenti CE, Ingersoll G. Comparison of home health care physical therapy outcomes following total knee replacement with and without subacute rehabilitation. *J Geriatr Phys Ther*. 2007;30:102–108.
11. Mallinson TR, Bateman J, Tseng HY, et al. A comparison of discharge functional status after rehabilitation in skilled nursing, home health, and medical rehabilitation settings for patients after lower-extremity joint replacement surgery. *Arch Phys Med Rehabil*. 2011;92:712–720.
12. Mahomed NN, Davis AM, Hawker G, et al. Inpatient compared with home-based rehabilitation following primary unilateral total hip or knee replacement: A randomized controlled trial. *J Bone Joint Surg Am*. 2008;90:1673–1680.
13. Buhagiar MA, Naylor JM, Harris IA, et al. Effect of inpatient rehabilitation vs a home-based program on mobility in patients with total knee arthroplasty: The HIHO randomized clinical trial. *JAMA*. 2017;317:1037–1046.
14. Bini SA, Fithian DC, Paxton LW, Khatod MX, Inacio MC, Namba RS. Does discharge disposition after primary total joint arthroplasty affect readmission rates? *J Arthroplasty*. 2010;25:114–117.
15. Ramos NL, Karia RJ, Hutzler LH, Brandt AM, Slover JD, Bosco JA. The effect of discharge disposition on 30-day readmission rates after total joint arthroplasty. *J Arthroplasty*. 2014;29:674–677.

16. Ponnusamy KE, Naseer Z, El Dafrawy MH, et al. Post-discharge care duration, charges, and outcomes among Medicare patients after primary total hip and knee arthroplasty. *J Bone Joint Surg Am.* 2017;99:e55.
17. Michigan Arthroplasty Registry Collaborative Quality Initiative (MARCQI). Michigan Arthroplasty Registry Collaborative Quality Initiative (MARCQI) Report: 2012-2016; 2017. <http://marcqi.org/FINAL-REPORT-rev-10-28-17.pdf>. Accessed September 1, 2020.
18. Ellimoottil C, Syrjamaki JD, Voit B, Guduguntla V, Miller DC, Dupree JM. Validation of a claims-based algorithm to characterize episodes of care. *Am J Manag Care.* 2017;23:e382–e386.
19. Gottlieb DJ, Zhou W, Song Y, Andrews KG, Skinner JS, Sutherland JM. Prices don't drive regional Medicare spending variations. *Health Aff (Millwood).* 2010;29:537–543.
20. Belotti F, Deb P, Manning WG, Norton EC. twopm: Two-part models. *Stata J.* 2015;15:3–20.
21. Charles RJ, Singal BM, Urquhart AG, Masini MA, Hallstrom BR. Data sharing between providers and quality initiatives eliminate unnecessary nursing home admissions. *J Arthroplasty.* 2017;32:1418–1425.
22. Abdi H, Williams Lynn J. Tukey's honestly significant difference. In: Salkind N, ed. *Encyclopedia of Research Design.* Thousand Oaks, CA: Sage Publications, Inc; 2010.
23. Hughes RE, Zheng H, Hallstrom BR. 2019 Annual Report of the Michigan Arthroplasty Registry Collaborative Quality Initiative (MARCQI); 2020. http://marcqi.org/dev/wp-content/uploads/2020/02/2019_AnnualReport_2-15-2020.pdf. Accessed September 1, 2020.
24. Sikora-Klak J, Zarling B, Bergum C, Flynn JC, Markel DC. The effect of comorbidities on discharge disposition and readmission for total joint arthroplasty patients. *J Arthroplasty.* 2017;32:1414–1417.
25. Joynt Maddox KE, Orav EJ, Zheng J, Epstein AM. Post-acute care after joint replacement in Medicare's bundled payments for care improvement initiative. *J Am Geriatr Soc.* 2019;67:1027–1035.
26. Wilcock AD, Barnett ML, McWilliams JM, Grabowski DC, Mehrotra A. Association between Medicare's mandatory joint replacement bundled payment program and post-acute care use in Medicare Advantage. *JAMA Surg.* 2019;155:82–84.
27. Joynt Maddox KE, Orav EJ, Zheng J, Epstein AM. Evaluation of Medicare's bundled payments initiative for medical conditions. *N Engl J Med.* 2018;379:260–269.
28. Ibrahim AM, Nathan H, Thumma JR, Dimick JB. Impact of the hospital readmission reduction program on surgical readmissions among Medicare beneficiaries. *Ann Surg.* 2017;266:617–624.
29. Barnett ML, Mehrotra A, Grabowski DC. Postacute Care - The piggy bank for savings in alternative payment models? *N Engl J Med.* 2019;381:302–303.
30. Hong I, Goodwin JS, Reistetter TA, et al. Comparison of functional status improvements among patients with stroke receiving postacute care in inpatient rehabilitation vs skilled nursing facilities. *JAMA Netw Open.* 2019;2:e1916646.