Debunking the Argument that the Bundled Payment for Care Improvement Program (BPCI) Contributed to Higher Procedure Volumes

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Introduction

A recent study[1] linked Medicare's Bundled Payment for Care Improvement (BPCI) focusing on lower extremity joint replacements to lower costs of care. An accompanying editorial[2] disputed the findings claiming that a reported rise in the volume of procedures between baseline and performance years for the intervention cohort, relative to a comparison group, indicated that total spend may have increased instead of decreasing. Our analysis of Medicare fee-for-service data from 2010 through 2015 by hospital, for all lower extremity joint replacements in the entire United States, indicates no evidence that participation in the BPCI was responsible for any increase in the volume of procedures between baseline and performance years, thus reaffirming the original paper's findings. We also find that trends in regional demographic and market characteristics explain the change in volume over time.

Methods

Data and Sample

We used Medicare Part A claims to count the total annual number of inpatient-based major lower joint replacement procedures performed at any hospital in the years 2011 through 2015 based on Medicare severity related diagnosis groups (MS-DRGs 469 and 470). The data were pulled by CareSet Labs directly from the Medicare data warehouse, and due to data use restrictions, hospitals performing fewer than 11 procedures in a given year were excluded.

Hospitals participating in BPCI were identified from CMS public use files (innovation.cms.gov/Files/x/bpcianalyticfile.xlsx). Included in the cohort of BPCI hospitals were those that began the program in either October 2013 or January 2014 for lower joint replacement procedures. All remaining hospitals, including those participating in later years, were included in the comparison group.

Hospital Referral Region Characteristics

The total number of Medicare Fee-for-Service (FFS) beneficiaries, percent of beneficiaries enrolled in Medicare Advantage, average age of beneficiaries, percentage of female beneficiaries, percentage of non-white beneficiaries, and average patient severity based on Hierarchical Condition Category (HCC) scores for each HRR were obtained from CMS public use files for 2011 and 2014. Medicare FFS and Advantage enrollment, by HRR, for 2015 was made available by CMS for this study (www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/Medicare-Geographic-Variation/Downloads/HRR_Table_All.zip). Each HRR's Herfindahl Index and the number of facilities performing lower extremity joint replacement procedures were calculated from the claims data. The Herfindahl Index is frequently used as a measure of market-level competition, with higher values equating to less competitive markets.[3] The prevalence rate of lower extremity joint

1 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(12):1267-1278.

2 Fisher ES. Medicare's Bundled Payment Program for Joint Replacement: Promise and Peril? *JAMA.* 2016;316(12):1262-1264.

3 White SL, Chirikos TN. Measuring hospital competition. *Med Care.* 1988;26(3):256-262.

replacement procedures by HRR were calculated by summing the volume of these procedures for each hospital assigned to an HRR, by year, and dividing it into the number of fee-for-service Medicare beneficiaries for that HRR.

Statistical Analysis

To re-test the impact of BPCI participation on hospital procedure volumes, we used a difference-in-differences model to compare changes in hospital-specific average annual volumes of joint replacement procedures following implementation of BPCI between hospitals that participated in BPCI and those that did not. We focused BPCI participation on the hospitals that had enrolled in the program in October 2013 or January 2014. Only one hospital enrolled in July of 2014, and the balance of BPCI participating hospitals enrolled during 2015. As such, a difference-in-differences model applied to hospitals that enrolled in 2015 would be irrelevant because any differences in volume would be the result of factors other than BPCI enrollment. Because we had only annual data, we were unable to perfectly align the implementation period in the analysis with the official start of BPCI in October 2013. As a result, we used the period from January 2011 through December 2013 as the baseline period and January 2014 to December 2015 as the implementation period. We included a vector of hospital fixed effects in the model to remove the impact of any potential unobserved confounders and clustered standard errors at the hospital-level.[4] Only hospitals with data for all years were included in this part of the analysis. Our model met all the assumptions required for difference-in-differences analysis.[5]

Given the supposition that BPCI participants may be incented to perform unnecessary procedures, we examined the demographic and market trends associated with increases in joint replacement procedure in HRRs between 2011 and 2014. The models controlled for HRR fixed effects and included covariates for all of the factors described in the previous section. We also added a term for the total BPCI participation rate in the HRR. This was measured as the percentage of all hospitals in the HRR that participated in the BPCI as of 2015. Since this is time invariant, it was interacted with a variable for year 2014 in the model. Standard errors were clustered at the HRR-level.

To account for skewness in hospital and HRR volumes, we used logged volumes as the dependent variable in both analyses. As such, the estimated coefficients in the models are interpreted as the percentage change in volumes associated with a unit change in the explanatory variables.

Sensitivity Analysis

We conducted multiple sensitivity tests to examine the robustness of our findings to different model assumptions and specifications. In the first analysis, we moved the implementation period back a year to the beginning of 2013, included HRR fixed effects to the model, and removed from the non-BPCI group any hospital that participated in BPCI after January 2014. In the second analysis, we added state fixed effects and changed the BPCI participation rate to a categorical variable (i.e., no participation, 1%-20% participation, and >20% participation). None of these changes altered the main findings of our analyses.

4 Wooldridge JM. *Introductory Econometrics: A Modern Approach.* 4e ed. Madison, OH: South-Western; 2009.

5 Ryan AM, Burgess JF, Jr., Dimick JB. Why We Should Not Be Indifferent to Specification Choices for Difference-in-Differences. *Health Serv Res.* 2015;50(4):1211-1235.

Results

Effect of BPCI on Hospital-Level Volumes

The average number of lower joint replacements performed annually among BPCI participants (n=47) was higher than non-participants (n=2,592) in the baseline period. While the adjusted average annual volumes increased by 1.7% (95% CI: 0.9%, 2.6%) among non-participants after the start of BPCI, the increases among participants was not significantly higher (difference-in-differences estimate 4.8%, 95% CI: -1.5%, 11.0%). Thus, the BPCI program had no effect on the number of procedures.

Table 1. Comparison of Increases in Yearly Lower Joint Replacement Volume between BPCI Participants and Others

Year	BPCI Participants in Oct 2013 & Oct 2014		BPCI Participants through 2015	
	Participants	Others	Participants	Others
2010	13,370	436,597	26,985	422,982
2011	13,095	426,689	25,996	413,788
2012	13,568	439,580	27,368	425,780
2013	14,155	460,377	28,956	445,576
2014	14,169	464,500	28,604	450,065
2015	13,704	479,015	28,954	463,765
% Change				
2010-2015	2.5%	9.7%	7.3%	9.6%
2011-2015	4.7%	12.3%	11.4%	12.1%

Regional Factors Associated with Volume Increases

Baseline HRR characteristics and the results of our model examining the relationships between these characteristics and changes in HRR volumes over time are shown in Table 2. HRRs varied greatly in their baseline demographic and market characteristics. Moreover, changes in several of these characteristics were associated with small but statistically significant changes in lower joint replacement volumes over time. For example, increasing volumes between 2011 and 2014 were associated with growth in the population of Medicare fee-for-service beneficiaries and the number of hospitals in an HRR. Alternatively, decreasing volumes were associated with reductions in market competition as measured by the Herfindahl Index, and increases in the proportions of non-white beneficiaries and beneficiaries enrolled in Medicare Advantage. Higher volumes in 2014 were not associated with the proportion of hospitals in the HRR that participated in BPCI as of 2015.

Table 2. Baseline Descriptive Statistics among HRRs and Association Between Covariates and % Change in HRR-Level Lower Joint Replacement Volume (n=306)

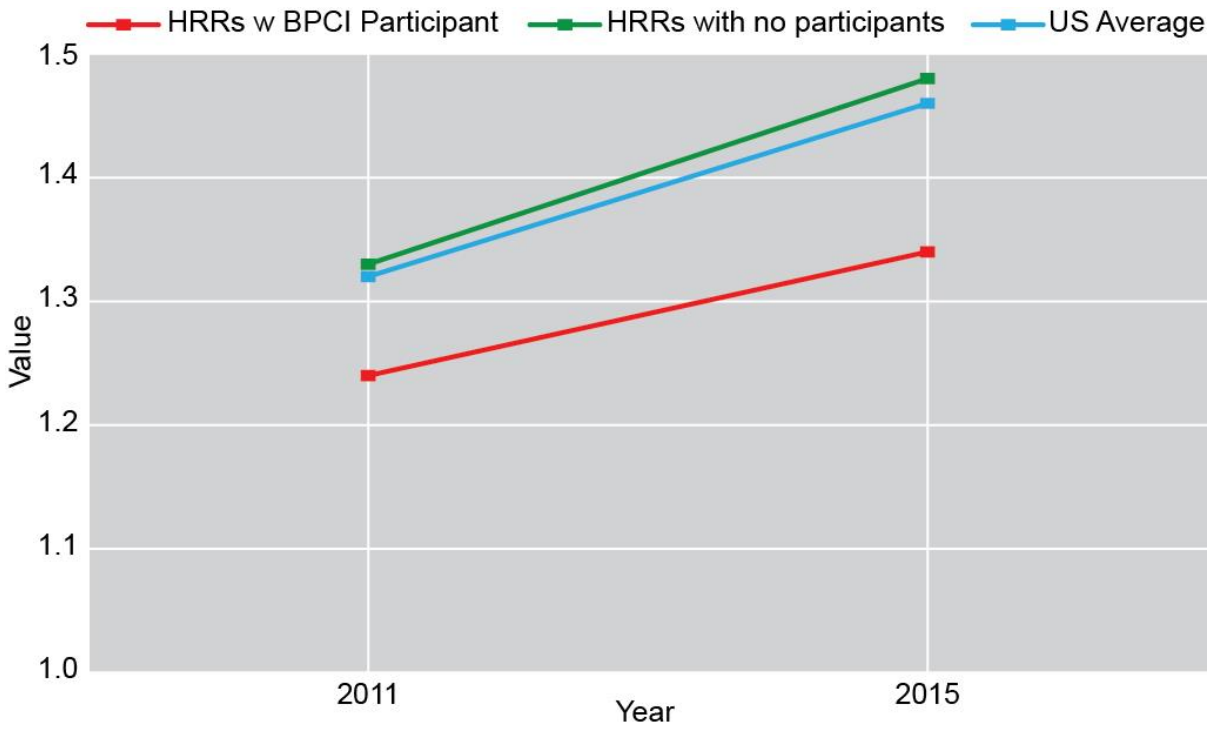
		Association with % Change in Lower Joint Replacement Volume Between 2011 and 2014		
Characteristics	**Mean [Min, Max]**	**Estimate***	**Std Error**	**P**
Volume	1,470 [161, 8,418]			
Medicare FFS Population ('000s)	110 [17, 615]	0.3	0.1	<0.0001
Herfindahl Index	30.8 [4.1, 100]	-0.2	0.1	0.02
# of Facilities in HRR	9.8 [1, 54]	1.2	0.4	0.004
% Enrolled in Medicare Advantage	24.2 [1.2, 61.4]	-0.7	0.2	<0.0001
% of Facilities in BPCI in 2015	4.1 [0, 50]	0.1	0.04	0.09
Mean HCC Score	0.98 [0.77, 1.30]	5.0	3.9	0.90
Mean Beneficiary Age (in years)	71 [67, 75]	-1.1	1.2	0.35
% Female Beneficiaries	55.0 [50.2, 58.9]	0.6	1.5	0.70
% Non-White Beneficiaries	16.9 [1.9, 79.8]	-2.5	0.7	0.001

HCC=Hierarchical Condition Category; FFS=Fee-for-Service; BPCI=Bundled Payment for Care Improvement

**Estimate is the percentage change in HRR volume between 2011 and 2014 from a unit change in the variable.*

In addition, our analysis reveals that the HRRs in which the BPCI participants are located have, on average, lower prevalence rates for these procedures than the national average, both in 2011 (1.21% v. 1.30%) and in 2015 (1.32% v. 1.44%). Individual HRR prevalence rates varied, but not as much as across the entire country, and most of the HRRs (23 of 38) with BPCI participants had prevalence rates lower than the national average in both periods (see Graph 1).

Graph 1. Prevalence Rates By HRR, 2011 and 2015



Discussion

A study by Laura Dummit and colleagues,[1] published in the Journal of the American Medical Association, studied the effects of Medicare's Bundled Payment for Care Improvement (BPCI) for participating hospitals focused on lower extremity joint replacements. Compared to a matched cohort, the study concluded that post-acute care costs had decreased from baseline and that quality outcomes had remained the same. While the volume of procedures increased in the performance year as compared to baseline for both participants and the matched cohort, the authors reported that the somewhat greater increase observed among the BPCI participants was not significantly greater. An accompanying editorial by Elliott Fisher[2] cast significant doubt on the findings by focusing on the differences in procedure volumes between the intervention and matched cohorts, as well as the increase in volume in the intervention cohort. These increases, the author argued, were significant and, when taken into account, point to a net increase in Medicare spend and supports the argument that procedure-focused bundled payment programs may encourage the production of unnecessary procedures.

However, Fisher never took into account the potential for the volume of the procedures at the participating hospitals to reflect differences in the underlying count of Medicare beneficiaries in the local area, nor the differences in regional prevalence rates for these types of procedures—an issue that has been the subject of numerous analyses and papers by the Dartmouth Atlas. Our study shows that the initial group of BPCI participants, those that went into the program in October 2013 and January 2014, had a rate of increase between baseline and performance years that was significantly lower than the national rate. In fact, for that group, the volume of procedures in 2015 was lower than in 2014 (Table 1). The second group of facilities, those that started in early 2015, experienced a larger increase in volume between 2012 and 2015, although none of that increase can be attributed to the

effects of the BPCI program since none of these facilities was enrolled in BPCI until the beginning of 2015.

Instead, a deeper investigation of the facilities that experienced significant increases reveals the effect of common market forces. For example, the effect of consolidation of hospitals that merge surgery units, such as was the case for Novant in North Carolina and Northern Nevada Medical Center in Reno; and the opening of a new Joint Replacement Institute such as the one at Virtua in Voorhees, NJ. The balance of the effect is mostly related to HRR characteristics, such as the growth in the Medicare population or the number of hospitals in the region. These factors, all taken together, affect the frequency with which these procedures are performed. Nationally, the procedure rate varied in 2015 from 57 to 434 per 1000 Medicare beneficiaries, averaging 144. The majority of the BPCI-participating facilities are in HRRs with prevalence rates at or below the national average, and the rate of growth for these procedures in the HRRs that contain BPCI participants was not different from that of the national average.

Our analysis has several potential limitations. The number of BPCI participants in our analysis was small relative to non-participants. While this limited sample size may have contributed to the non-significant result in our difference-in-differences model, as discussed, our findings mirror of those of the earlier evaluation of the BPCI program that looked at its effect on volume. While it's possible our analysis of region-specific factors associated with increased volumes may be explained by lingering omitted variable bias, we feel this is unlikely for several reasons. First, the inclusion of HRR fixed-effects in the models removes the influence of any time invariant factors. Second, the models included an array of important time varying covariates that were moderate or highly correlated with procedure rates. Third, our sensitivity tests produced nearly identical results. Fourth, as discussed, our findings are highly consistent with prior research.

Our findings are consistent with other studies that have shown the effect of supply on the provision of services.[6] HRRs with more competition experience a higher rate of lower joint replacement surgeries than those with less competition. They are also consistent with studies showing that non-whites[7] and beneficiaries enrolled in Medicare Advantage plans[8] have fewer of these types of procedures. And importantly, our study definitively disputes any assertion that the BPCI-participating hospitals contributed to a higher volume of procedures as a result of that participation. In fact, the opposite is true. The rate of increase in the volume of procedures was significantly lower than in the rest of the country. These findings point to the potential of bundled payment to improve quality and lower costs of care while maintaining or lowering the volume of the episodes of care.

6 Fisher ES, Wennberg JE. Health care quality, geographic variations, and the challenge of supply-sensitive care. *Perspect Biol Med.* 2003;46(1):69-79.

7 Fiscella K, Franks P, Gold MR, Clancy CM. Inequality in quality: addressing socioeconomic, racial, and ethnic disparities in health care. *JAMA.* 2000;283(19):2579-2584.

8 Landon BE, Zaslavsky AM, Saunders RC, Pawlson LG, Newhouse JP, Ayanian JZ. Analysis Of Medicare Advantage HMOs compared with traditional Medicare shows lower use of many services during 2003-09. *Health Aff (Millwood).* 2012;31(12):2609-2617.