Navathe AS, Liao JM, Polsky D, Shah Y, Huang Q, Zhu J, et al. Comparison of hospitals participating in Medicare's voluntary and mandatory orthopedic bundle programs. Health Aff (Millwood). 2018;37(6).

APPENDIX

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Appendix Exhibit A1. Method for Assigning Standardized Costs to Medicare Claims

Medicare payments are necessarily adjusted to account for geographic factors and provider characteristics. In order to compare relative levels of care utilization, we developed a method to assign standardized costs for claims. This method assigns the same standardized cost for a particular service regardless of the specific characteristics of the patient and provider involved, allowing for an apples-to-apples comparison in service utilization across providers. Costs were standardized to 2016 dollars.

Inpatient Payments
Inpatient payments (Inpatient Claim File) were defined as payments for the index inpatient admission.

To standardize costs, we multiplied the corresponding Diagnosis-Related Group (DRG) weight by the 2016 national standard base payment. DRGs are a classification system used to categorize inpatient stays for the purpose of reimbursement, and weights reflect the relative resource intensity of the inpatient stay. Documentation of the 2016 national standard base payment ($5,906) and DRG weights and were downloaded from CMS.gov.

Readmission Payments
Readmission payments (Inpatient Claim File) were defined as payments for additional inpatient claims to the hospital holding the index hospitalization, during the period after the initial discharge while the episode was still active.

To standardize costs, we applied the same methodology as for inpatient payments.

Health Care Provider Payments
Health Care Provider payments (Claim line file for Part B Carrier and DME) were defined as payments for physician services.

To standardize costs, we used the 2010-2016 national Medicare fee schedules to assign a standardized cost based on the Healthcare Common Procedure Coding System (HCPCS) code. For HCPCS codes that were not used in 2016, we converted the standardized cost to 2016 dollars. Claim lines with a place-of-service code indicating a facility were assigned the facility fee and claim lines with other place-of-service codes were assigned the non-facility fee. The unit cost was multiplied by the number of units and assigned at the claim line level. Claim level standardized costs were obtained by summing corresponding line level costs. For Level II HCPCS codes identifying produces, supplies, and services not under the national fee schedule, we assigned a standardized cost based on the mean payment by year, converting to 2016 dollars.

Outpatient Payments
Outpatient payments (Outpatient Revenue Center File) were defined as payments for outpatient services, generally performed at emergency departments and outpatient hospital clinics.

To standardize costs, we multiplied the corresponding Ambulatory Payment Classification (APC) weight by the 2016 national standard base payment. For claims not under the Outpatient Prospective Payment System (OPPS), we used the corresponding HCPCS code mean payment by year, converted to 2016 dollars, and adjusted for the local Medicare Wage Index which was assumed to be 1. For APC codes missing weights, we assigned the standardized cost using the corresponding HCPCS code mean payment by year and converted to 2016 dollars. APCs are a classification system analogous to DRGs for inpatient payments, and weights reflect the relative resource intensity of the service. Documentation of the 2016 national standard base payment ($73.725) and APC weights were downloaded from CMS.gov.

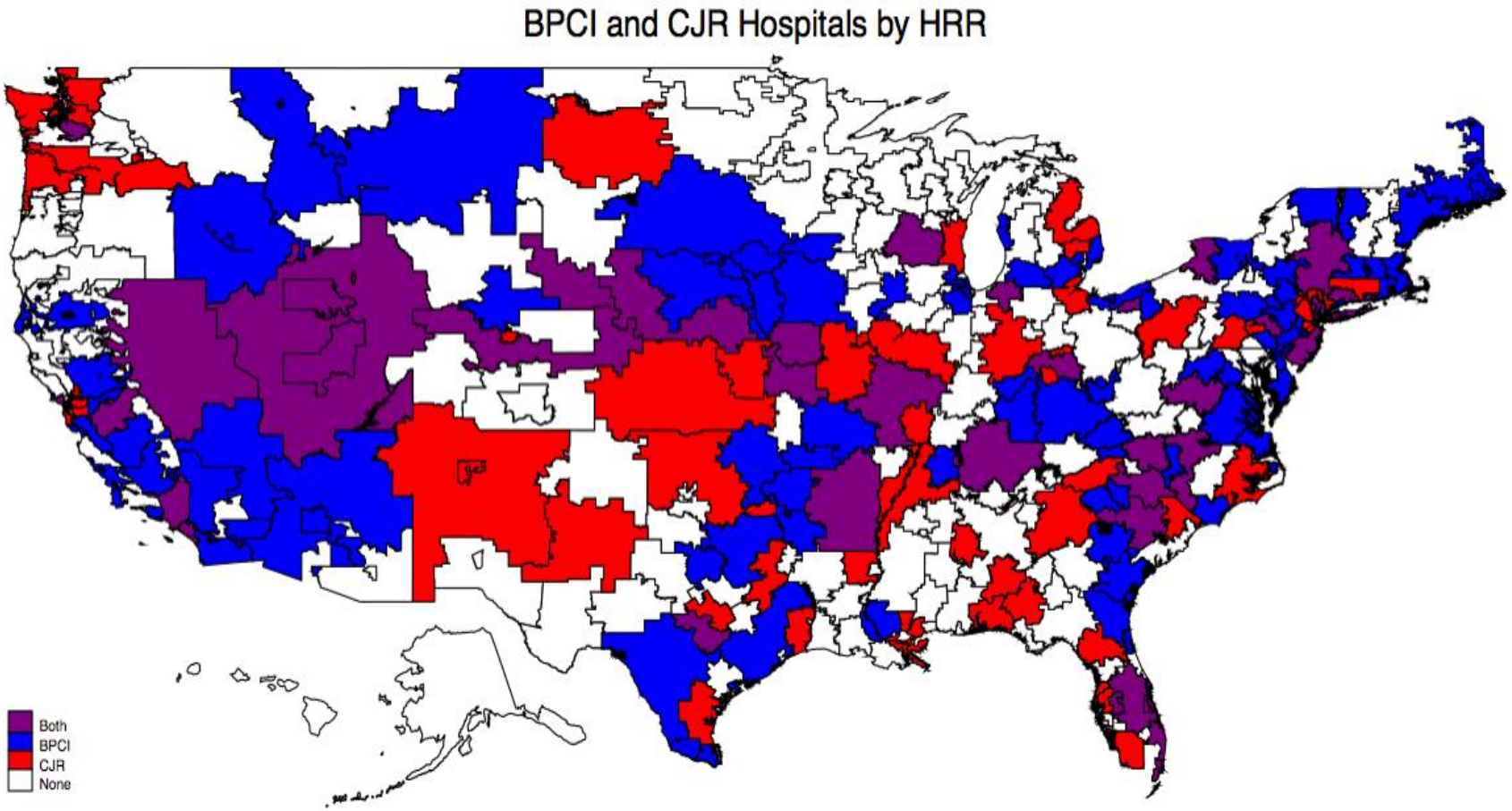
Post-Acute Care Payments
Post-acute care payments were defined as payments for skilled nursing facilities (SNF), inpatient rehabilitation facilities (IRF), and home health agencies (HHA).

To standardize SNF payments (SNF Revenue Center File), we used the 2016 national Resource Utilization Group (RUG) rate schedule. Unit costs were multiplied by the revenue center unit count and assigned at the claim line level. Claim level standardized costs were obtained by summing corresponding line level costs. RUG categories reflect the relative resource needs of the patient, indicated by the HCPCS code. For SNF claims with missing RUG, we used the actual Medicare payment amount. Documentation of the 2016 national RUG rate schedule was downloaded from CMS.gov.

To standardize IRF payments (Inpatient Claim file), we multiplied the corresponding Diagnosis-Related Group (DRG) weight by the 2016 IRF national standard base payment ($15,529). IRF claims are indicated by the CMS Hospital Provider Number. Documentation of the 2016 national standard base payment and DRG weights were downloaded from CMS.gov.

For HHA payments (HHA Revenue Center File), the mean value of the revenue center payment by year was calculated for each Home Health Resource Group (HHRG). HHRG categories reflect the relative resource needs of the patient, indicated by the first four digits of the Health Insurance Prospective Payment (HIPPS) code. Unit costs were multiplied by the revenue center unit count, converted to 2016 dollars, and assigned at the claim level. Claim level standardized costs were obtained by summing corresponding line level costs.

Appendix Exhibit A2. BPCI and CJR Hospitals by Hospital Referral Region (HRR)



Appendix Exhibit A3. Characteristics of hospitals participating in BPCI and CJR, limited to 34 markets continuing by mandate in CJR

	BPCI Hospitals (n=302)	CJR Mandate Hospitals (n=483)	P-value
Size, mean	325	280	0.02
Hospital Size, %			
Small (<100 beds)	10.6	20.2	0.001
Medium (100-399 beds)	63.9	59.8	
Large (≥ 400 beds)	25.5	19.8	
Ownership Status, %			
For-profit	20.2	27.3	<0.001
Not-for-profit	76.1	59.8	
Government	3.64	12.8	
Teaching Status, %			
Major teaching	13.9	11.0	<0.001
Minor teaching	60.3	47.8	
Non-teaching	25.8	41.2	
Geographic Region, %			
South	37.4	43.7	<0.001
Midwest	19.5	5.59	
West	18.5	20.8	
Northeast	24.5	30.6	
Urban-Rural Status, %			
Urban	94.4	100	<0.001
Rural	5.63	0	
Patient Mix			
Medicare Utilization Ratio, mean (SD)	52.8	50.4	0.008
Medicaid Utilization Ratio, mean (SD)	19.3	21.3	0.02
% Medicare by admissions, mean (SD)	47.7	45.9	0.02
Elixhauser Comorbidity Score, mean			
469	17.1	13.5	<0.001
470	4.3	3.8	0.0002
Hospital Margin, mean[a]	6.47 (9.74)	6.98 (61.7)	0.85
JCAHO accreditation, %	87.4	86.1	0.60
Sole community provider status, %	2.98	0.62	0.009
Safety-net Hospitals, %	24.8	35.4	0.81
Net patient revenue paid on a shared risk basis, %[b]	2.42	3.22	0.34

SOURCE: Authors' own analysis of American Hospital Association and Medicare claims data from 2010-2016. NOTES: Joint replacement = major joint replacement of the lower extremity. [a]N=302 for BPCI hospitals, N=471 for CJR hospitals [b]N=236 for BPCI hospitals, N=326 for CJR hospitals. Volumes have been adjusted to reflect a 100% Medicare beneficiary inpatient sample. From the AHA, major teaching hospitals are those that are members of the Council of Teaching Hospitals (COTH), minor teaching hospitals are non-COTH members that had a medical school affiliation reported to the AMA, and nonteaching hospitals are all other institutions. Safety-net hospitals are identified by how they are designated according to AHA data. A two-tailed p-value of 0.05 was considered significant.

Appendix Exhibit A4. Unadjusted and Risk-standardized baseline performance measures for BPCI hospitals versus CJR hospitals, limited to 34 markets continuing by mandate in CJR[a]

	BPCI Hospitals (voluntary) (n=302)	CJR Mandate Hospitals (mandatory) (n=483)	P-value
Volume per hospital, median (IQR)[b]			
469[c]	10 (10)	5 (5)	0.0074
470[c]	130 (160)	50 (100)	<0.0001
Joint Replacement Episode Mortality, %[d]			
469	11.9	16.2	0.04
470	0.6	0.7	0.94
Joint Replacement Episode Readmissions, %[e]			
469	21.7	27.7	0.08
470	7.8	8.3	0.29
Joint Replacement Episode Prolonged LOS, mean %			
469	42.5	49.7	0.07
470	11.9	11.8	0.45
Joint Replacement Episode Cost, mean $			
469	46,723	44,605	0.03
470	22,090	23,118	<0.0001
Joint replacement complication rate, % (SD)	3.1 (0.6)	3.0 (0.6)	0.40
Risk-standardized Hospital-Specific Baseline Performance Measures, BPCI vs CJR [a,b,c,d,e]			
	BPCI Hospitals	**CJR Hospitals**	**P-value**
Mortality Rate, %			
469	14.9	16.1	0.80
470	0.69	0.69	0.98
Readmission Rate, %			
469	30.4	25.9	0.54
470	8.04	8.56	0.55
Prolonged LOS, %			
469	52.0	49.7	0.79
470	14.1	13.8	0.88
Cost, $			
469	45,351	44,770	0.86
470	22,134	23,679	0.0002

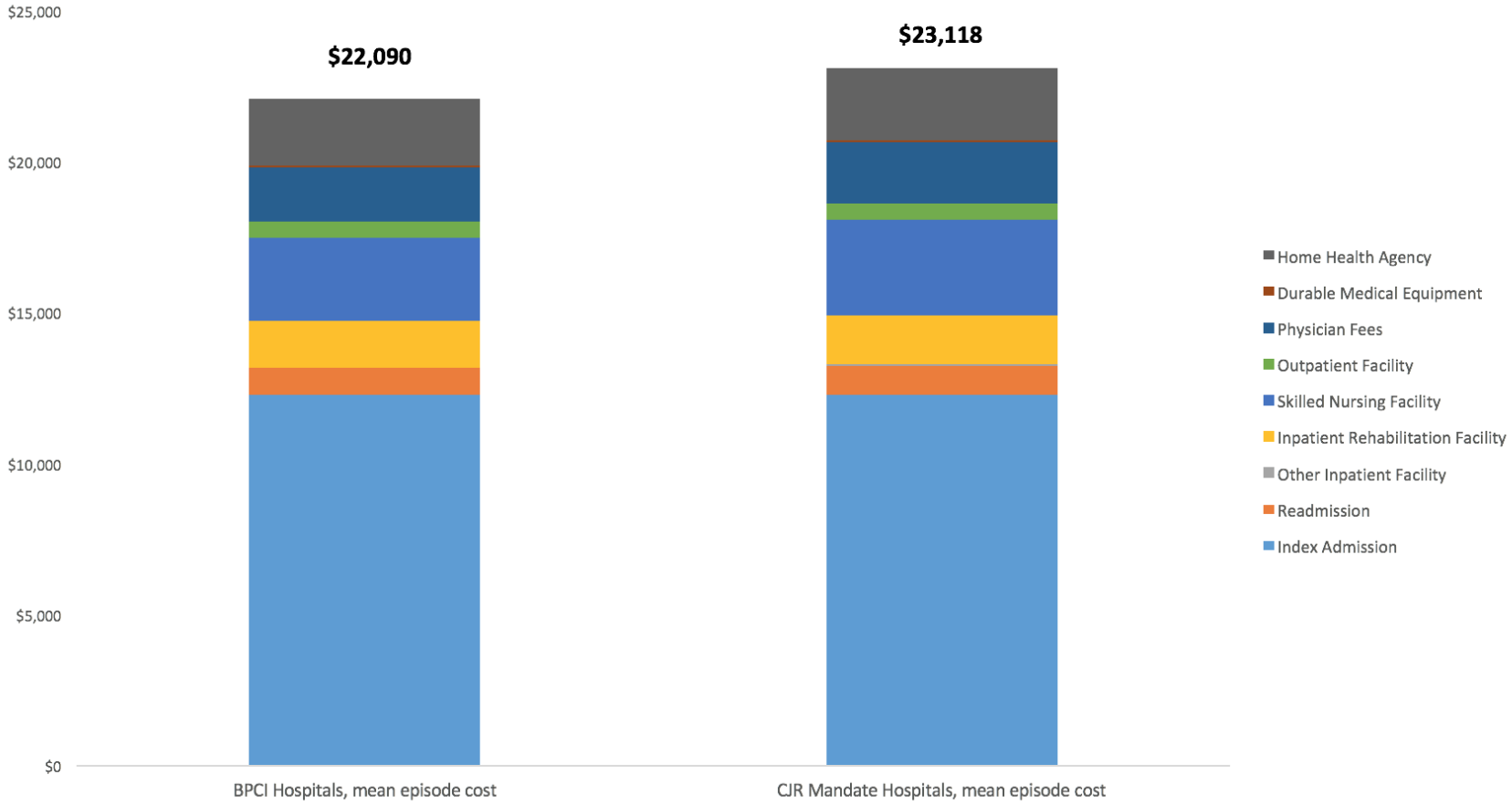
SOURCE: Authors' own analysis of Medicare claims data from 2010-2016. NOTES: Joint replacement = major joint replacement of the lower extremity. [a]Hospitals that transitioned from BPCI to CJR program considered CJR hospitals. The baseline period for BPCI hospitals is 4 quarters before they enrolled in BPCI; for CJR hospitals the baseline period is 4 quarters before April 2016. [b]Volumes have been inflated to reflect the 100% Medicare beneficiary inpatient sample. [c]469 refers to DRG 469. 470 refers to DRG 470. There were 295 BPCI hospitals and 483 hospitals which had non-zero volume and contributed to outcomes in our claims-based analysis. [d]Mortality rate is calculated as the number of beneficiaries who died during an episode in the measurement period over the total number of episodes in the hospital group. [e]Readmission rate is calculated as the number of episodes with a readmission over the total number of episodes with a discharge alive, within the hospital group. A two-tailed p-value of 0.05 was considered significant.

Appendix Exhibit A5. Risk-standardized baseline performance measures for combined MS-DRG 469/470 for BPCI hospitals versus CJR hospitals

Risk-standardized Hospital-Specific Baseline Performance Measures, BPCI vs CJR			
	BPCI Hospitals	**CJR Hospitals**	**P-value**
Mortality Rate, %	1.0	1.3	0.46
Readmission Rate, %	8.5	8.5	0.92
Prolonged LOS, %	15.5	13.5	0.26
Cost, $	22,873	22,945	0.46

SOURCE: Authors' own analysis of Medicare claims data from 2010-2016. NOTES: Mortality rate is calculated as the number of beneficiaries who died during an episode in the measurement period over the total number of episodes in the hospital group. Readmission rate is calculated as the number of episodes with a readmission over the total number of episodes with a discharge alive, within the hospital group. A two-tailed p-value of 0.05 was considered significant.

Appendix Exhibit A6. Average unadjusted episode cost breakdown for MS-DRG 470 by component for BPCI hospitals versus CJR hospitals, limited to 34 markets continuing by mandate in CJR



Appendix Exhibit A7. Average unadjusted cost breakdown by component for BPCI hospitals versus CJR hospitals, MS-DRG 470